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Development of hybrid renewable energy for maximum power transfer for distributed computing

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Abstract
A crucial role for both energy storage and gas will mitigate the unpredictability inherent in renewable energy sources. A rapidly-escalating trend toward substituting renewable energy resources (RES) for fossil fuels (FCs) is part of societal change and progression. RES is the primary target of the new energy internet since it's meant to help diversify away from old fossil fuel energy sources while also increasing RES energy efficiency to the full degree. RES is often abandoned in northern China, particularly in the warm season. While most people today utilize severely filthy coal-fired heating, clean-burning natural gas is increasing in popularity.
In contrast to a carbon-based heating system, a clean heating system employs surplus RES, replaced by carbon-based means to satisfy heat demand. The usage of dependable heating services, distributed heat storage devices, and thermal power support must provide stable and consistent home heating. More advanced versions of this technology would result in wasteful use of resources since they include a combined electricity-heat energy system, which may be bigger or smaller. The research provides an optimum planning approach to maximize the size of clean heat and electrical heating devices and thermal storage devices while also reducing fossil energy use. The Western Inner Mongolia Power Grid simulation finally depicts the operational conditions and optimization findings of the system. It appears extremely necessary to raise the rate of renewable energy utilization and maximize economic income currently. This study suggests a strategy for using renewable energy as a valuable tool in organizing and controlling a complex energy mix. According to empirical research, the optimization approach successfully reduces microgrid costs while increasing renewable energy utilization.

Keywords: hybrid renewable energy, maximum power transfer, distributed computing

1. Introduction
Energy is one of the key resources for economic growth, no matter where in the world you find yourself. As food and agriculture face a growing need for more energy, the importance of energy in all elements of food and agricultural production, processing, service supply, and livelihood enhancement grows. Fossil fuels, such as coal, crude oil, natural gas, and renewable resources, such as solar, wind, and biogas, are the principal energy sources. As a nation, Nigeria has a substantial amount of both energy resources, with regard to both its power production. A major portion of Nigeria's power originates from fossil fuels that have been in use for the previous 40 years. Nigeria's power industry is often seen as a low-income nation, and hence lacks the financial and technological capacity to meet all of the nation's goals to boost alternative energy [2]. Following the decline in global oil prices, Nigeria's economy was shaken severely. Nigeria, which was heavily reliant on oil, wanted to change its economy to be more diversified. To get the economy going again, emphasis was placed on the agricultural sector that had previously been ignored. The whole growth of any country is heavily dependent on agriculture. Providing employment possibilities, improving food security, and helping those who are jobless overcome poverty are all great results when looking at agriculture from a holistic perspective.
Additional benefits for the country's GDP will be realised by using exportable cash crops such as cocoa, palm oil, groundnut, etc. Nigeria's current population is estimated to be about 198 million. With Nigeria's population, it produces a maximum power of 5,000 megawatts, almost all of which is generated by gas and hydro. The ever-increasing amount of energy needed by users is not being met by the energy produced, which results in frequent load shedding and power interruptions. Over 40% of the population in developing countries have little or no access to dependable power. With a sustainable energy source, the yield in agriculture may be enhanced. Access to energy impacts farmers from the very beginning of the agricultural supply chain.

Renewable energy resources, such as hydro, wind, and solar, which are found throughout the nation, are not being completely used [5]. The extent of solar energy development varies by location: just a few individuals live in big cities, and in order to complement the national grid energy shortfall, street lighting is provided [5-6]. In spite of the fact that research on the possibilities of biomass, wind, and solar power in Nigeria has progressed slowly owing to little interest, development has only recently started to get attention [7]. Solar power and wind energy systems rely on the availability of sunshine or wind. When electricity is intermittently accessible, the power is available to provide intermittent loads, which means it must be utilised when it is available or stored. One way to decrease the impact of this difficulty is to use renewable energy resources that go hand-in-hand with the backup supplies. It produces more system performance than a single system because of the usage of a hybrid energy system, which offers better dependability, efficiency, reduced emissions, and a cheaper cost.

In order to grow the economy, the agricultural sector was given more emphasis. To run day-to-day activity, farms need steady energy. Due to Nigeria's frequent power outages, farmers in the country use diesel or gasoline generators to provide daily electricity for operations, which are expensive and have a negative impact on the environment and constantly need routine repair. Farmers' productivity is restricted without a dependable and sustainable electricity supply. The proposed HRES has been built to dependably satisfy the energy demands of the case study (Twins Dairy Farm) using a dynamic energy dispatch control. It is possible to use this approach to get entry to another area that is comparable.

2. Materials and Method

Power as a function of turbine speed is calculated as:

$$P_t = \tfrac{1}{2}\rho C_p(\lambda) S \tfrac{R^2}{\lambda^3}\omega_t^2$$

The electromagnetic torque is as follow:

$$T_t \tfrac{1}{2} C_p \rho\pi \tfrac{R^2}{\lambda^3}\omega_t^2$$

Let's say you've optimally prepared the system; at that point, the torque will have the following shape:

$$T_{emopt} = K_{opt}\omega_t^2$$

With

$$K_{opt} = \tfrac{1}{2} C_p \rho\pi \tfrac{R^5}{\lambda^3}$$

In Figure 1, the MPPT algorithm utilized the observed rotational speed to determine the estimated reference torque. The WECS configuration schematic, shown in Figure 2, shows how the TSR approach is used.

2.1 The use of feedback as a power signal

Maximum output power is assured by using a reference power signal. Though comprehending the wind turbine's maximum power curve is needed, comprehension of the wind turbine is also recommended. The data points that determine the highest turbine power and the matching wind turbine speed must be captured to analyze accurately. The PSF control approach adjusts the turbine power to its optimal value, keeping the turbine power coefficient at its highest value.

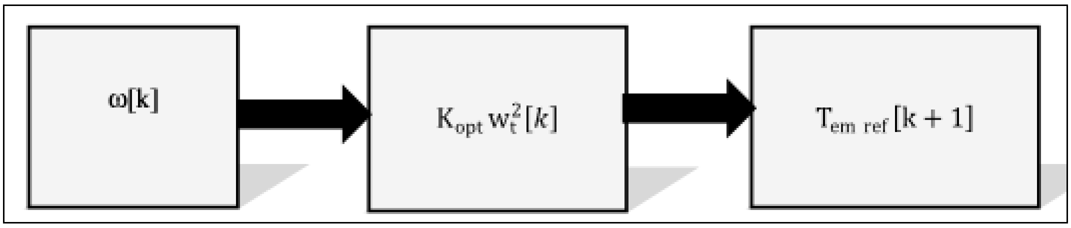


Fig 1: depicts the reference torque as a function of speed.

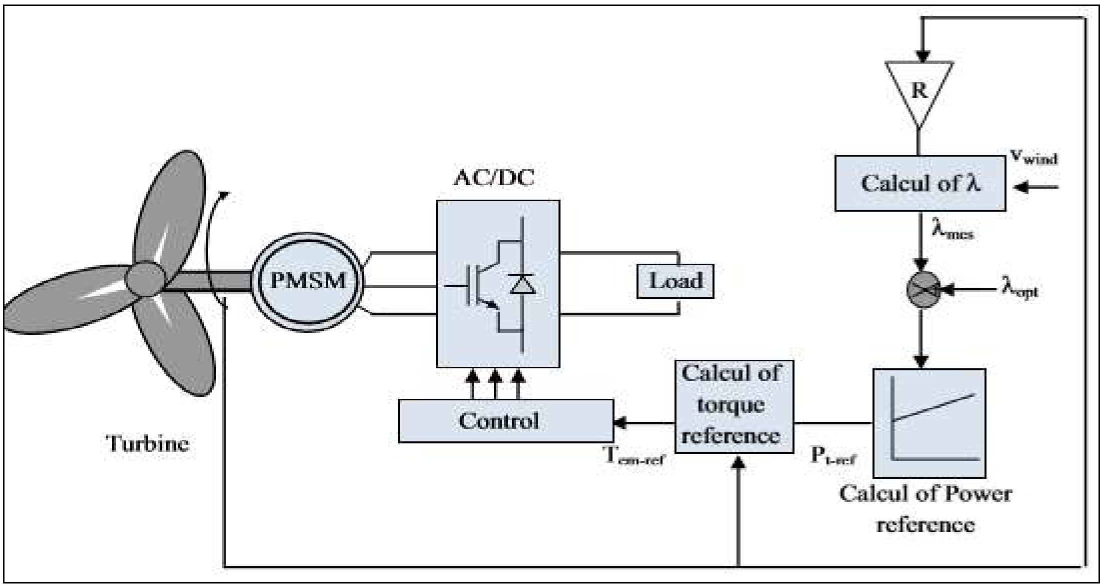


Fig 2: design utilizes the tip speed ratio approach of wind energy conversion

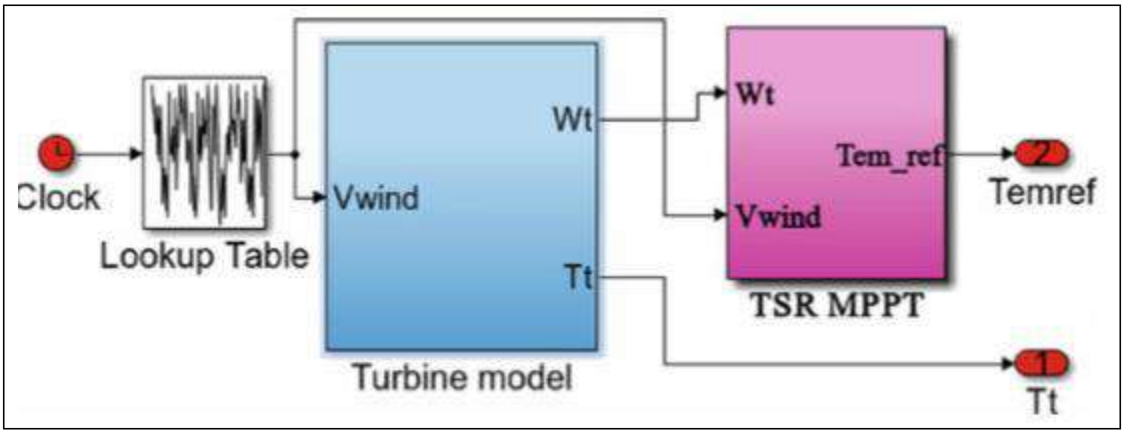


Fig 3: The WTCS block diagram demonstrates the system employing the TSR MPPT technique.

Figure 3 illustrates the block diagram of WTCS, with the PSF technique used under MATLAB/Simulink.

2.2 Perfectly Controlled Torque (OTC)

There is just a tiny variation between optimal torque control and PSF control. The generator torque is automatically adjusted to its ideal when the wind speed changes. Turbine properties $(C_{p\max}\ and\ \lambda_{opt})$ are required.

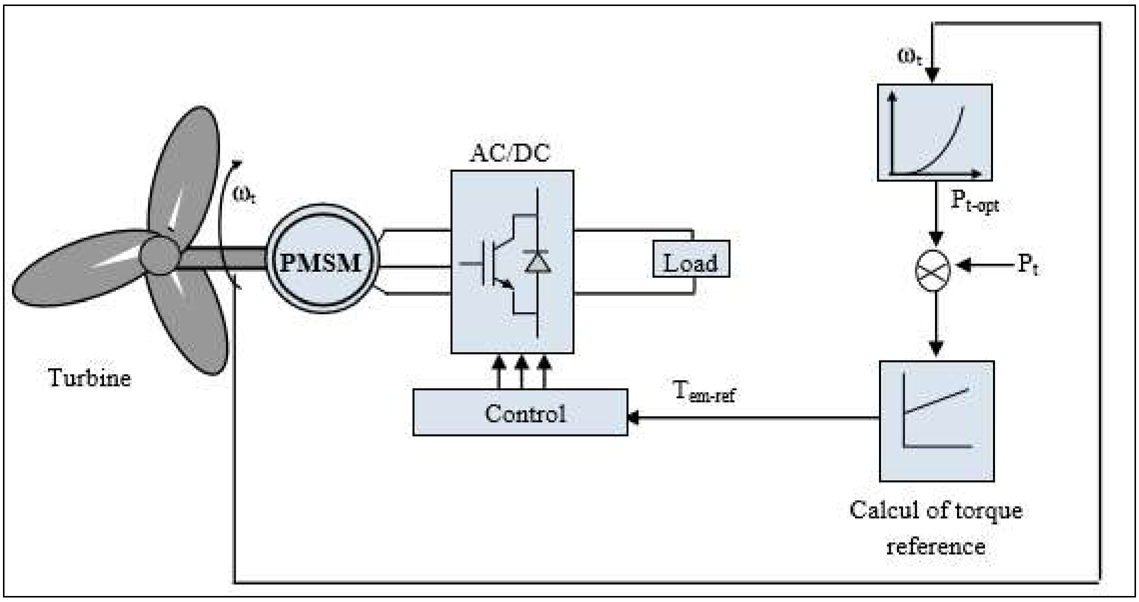


Fig 4: Wind energy conversion system with power signal feedback control

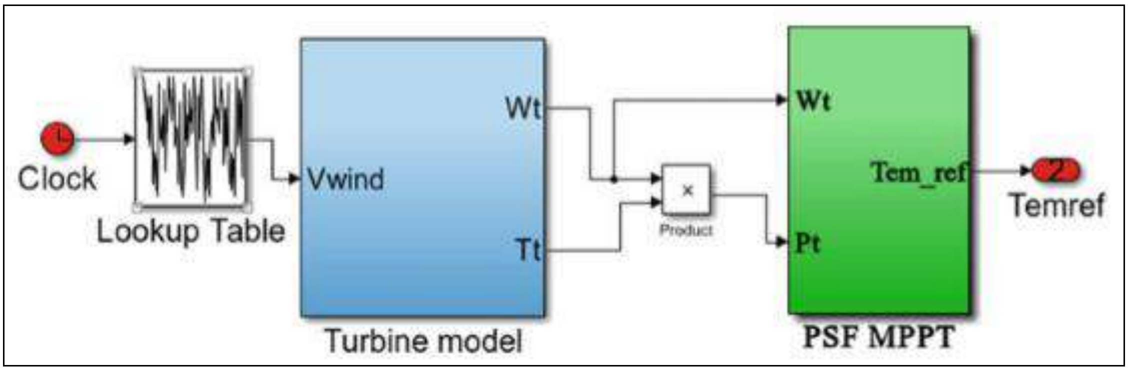


Fig 5: Block diagram showing the network structure of WTCS using the PSF approach

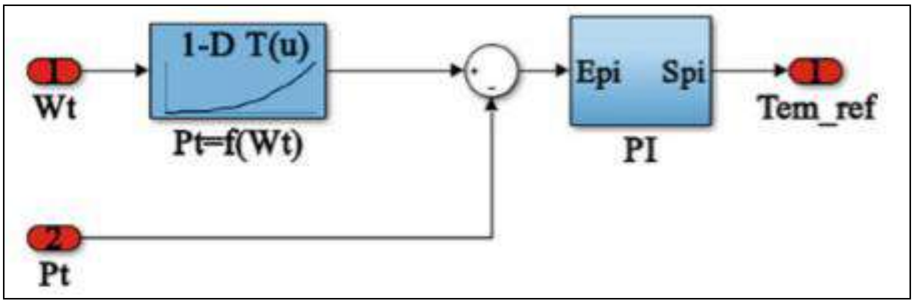


Fig 6: The PSF is shown in MATLAB/Simulink.

We have:

$$v_{wind} = \frac{\mathbf{R}.\omega_t}{\lambda}$$

The rotational speed determines the rotating turbine's power function.

$$P_t(\omega_t) = \frac{1}{2}.\frac{C_p(\omega_t).\rho.\pi.\mathbf{R}^4}{}.\omega_t^3$$

With:

$$P_t(\omega_t) = T_{em}.\omega_t$$

$$C_t.\omega_t = \frac{1}{2}.C_p(\lambda).\rho.\pi.R^4.v_v^3$$

Then:

$$T_{em} = \frac{1}{2}.\frac{C_p(\omega_t).\rho.\pi.\mathbf{R}^4}{\lambda^3(\omega_t)}.\omega_t^2$$

Assume best-case circumstances and then solve for power, speed, and torque values using the following equations:

$$P_{opt} = \frac{1}{2}.C_{p-opt}.\rho.\pi.R^2.v_{wind}^3$$

$$\omega_{opt} = \frac{v_{wind}.\lambda_{opt}}{R}$$

$$T_{cm-opt} = T_{cm-ref} = K_{opt}.\omega_{opt}^2$$

With

$$K_{opt} = \frac{1}{2}.\frac{C_{p-opt}(w_t).\rho.\pi.R^4}{\lambda_{opt}^3(\omega_t)}$$

This block diagram depicts a WECS, which has excellent torque control. By utilizing the MATLAB/Simulink programming environment, it is depicted in the picture (Figure 7).

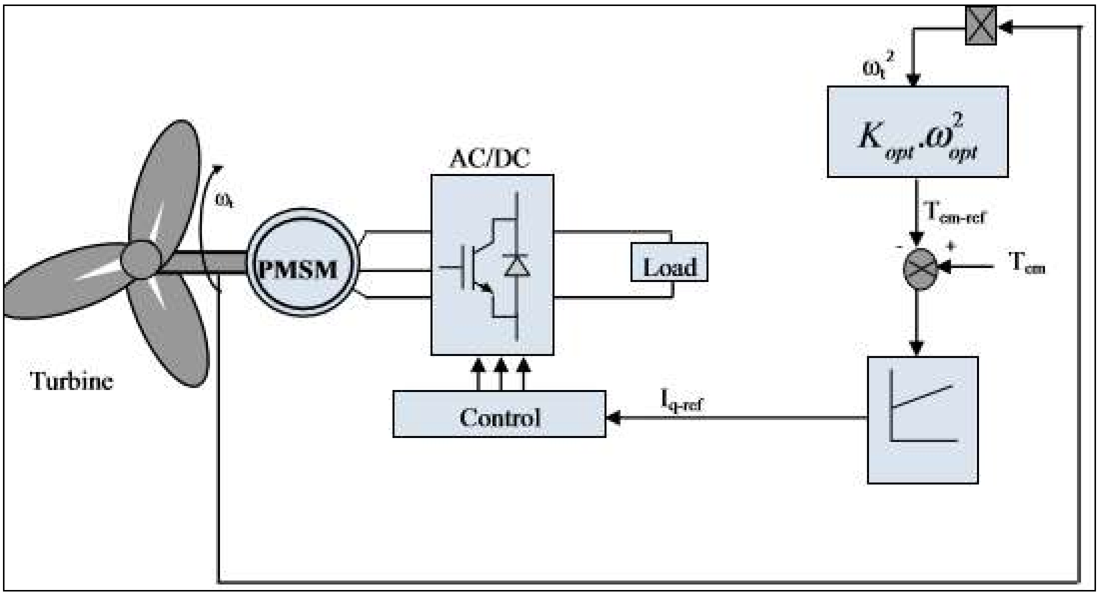


Fig 7: In wind turbine systems depicted in MPPT (Maximum Power Point Tracking) is used.

3. Result and Discussion

The gradient is quite simple. Even if you don't know the exact specifications λ_{opt} and $C_{p\max}$ for each wind speed, you should still have an idea of what they are since there are various general parameters. The turbine's speed reference is adjusted to optimize the turbine's output at each wind speed.

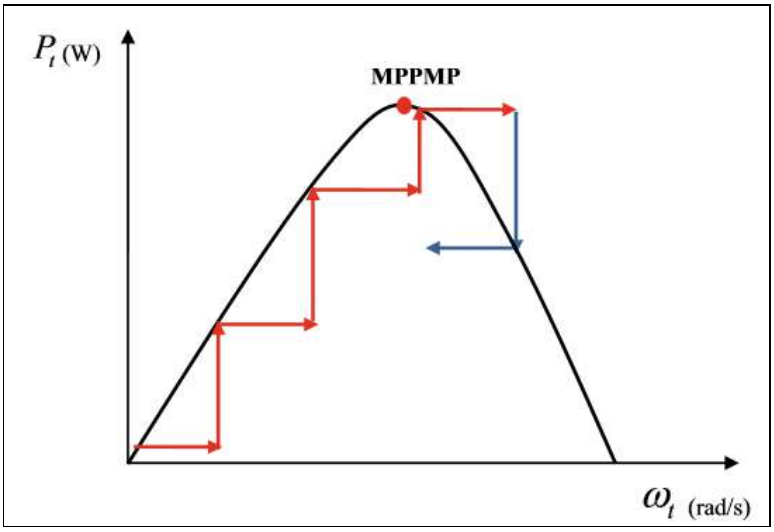


Fig 8: HCS concept

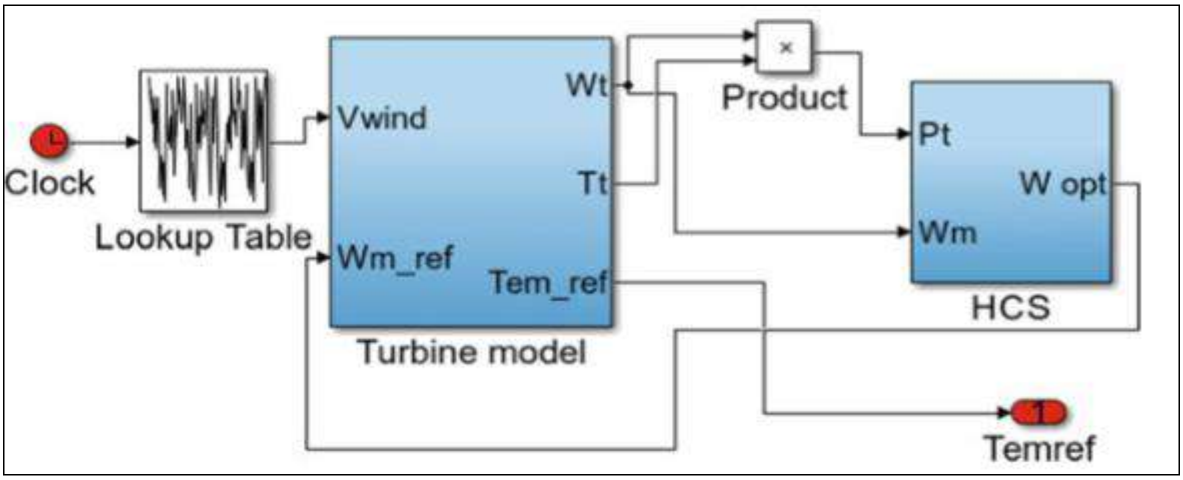


Fig 9: MATLAB/Simulink HCS MPPT

The variation direction of the ratio $\frac{dP_t}{d\omega_t}$ is adjusted to regulate the rotating speed of the generator. The intended maximum power is achieved when this ratio is zero [10].

$$\frac{dP_t}{d\omega_t} = \frac{dP_t}{dt} \cdot \left(\frac{d\omega_t}{dt}\right)^{-1}$$

: shown in Figure 3.57

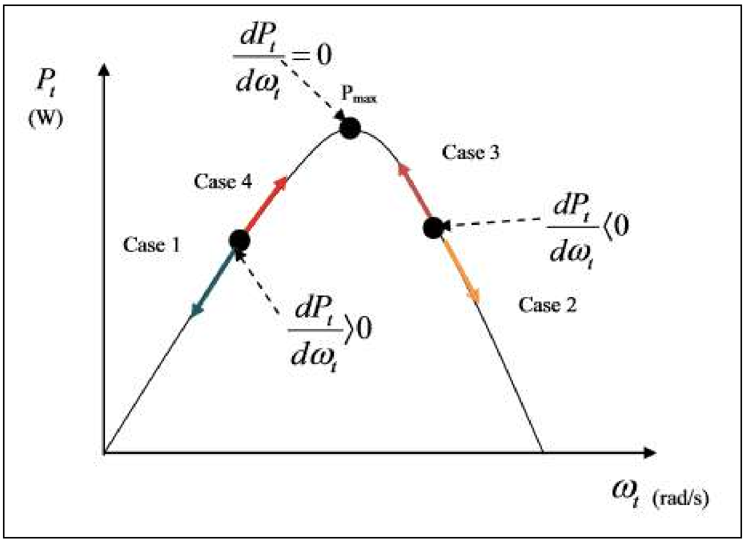


Fig 10: Gradient technique principle $\Delta\omega_t(k+1)$ is increased or reduced by a fixed step $\Delta\omega_t$. Figure 10 shows a visual depiction of the optimization approach.

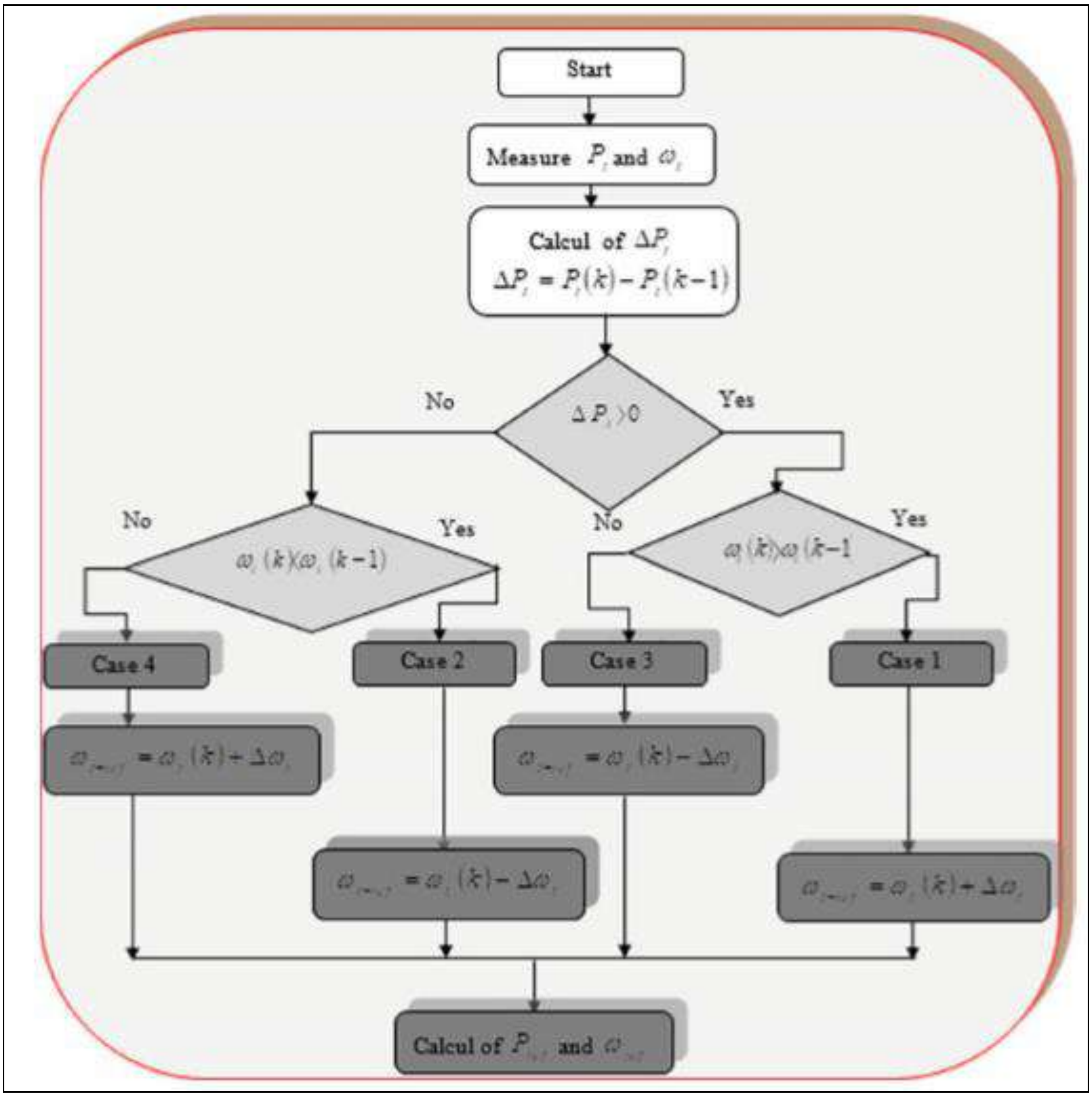
3.1 A combination of MPPT techniques HP & mergers/acquisitions

We can use a hybrid MPPT based on P&O, and OTC MPPT approaches because of that (Figure 11). In Figure 12, the application is shown as a schematic representation.

3.2 Fuzzy logic controller Method

Converging toward the ideal position is made more accessible by maintaining basic rules. Variation of power ΔP_t and variation of speed Te_{ref} supply an alternate torque reference and the reference speed for wind turbines ω_{ref} (Figure 13).

Table 2: illustrates the rules used by the fuzzy controller.



The diagram in Figure 11 depicts the workflow of GM.

3.3 Artificial neural networks are being used (ANN)

An artificial neural network (ANN) is an electronic model that mimics the workings of the human brain's neural structure. This function serves as a methodology that allows ANNs to be employed to construct adaptive and intelligent systems. With ANN models, nonlinear components called neurons are used to create massively paralleled networks that include nonlinear components Training networks for specific problems in each model. The architecture of ANNs is composed of many layers, where an external parameter controls the input activations. The most common structure seen in networks has three levels: the input, hidden, and output layers (Figure 12). Information is most often sent from an external source to an external device through the output layer. An additional layer of processing might be included between the input and output levels. A standard way to machine learning is the back-propagation algorithm.

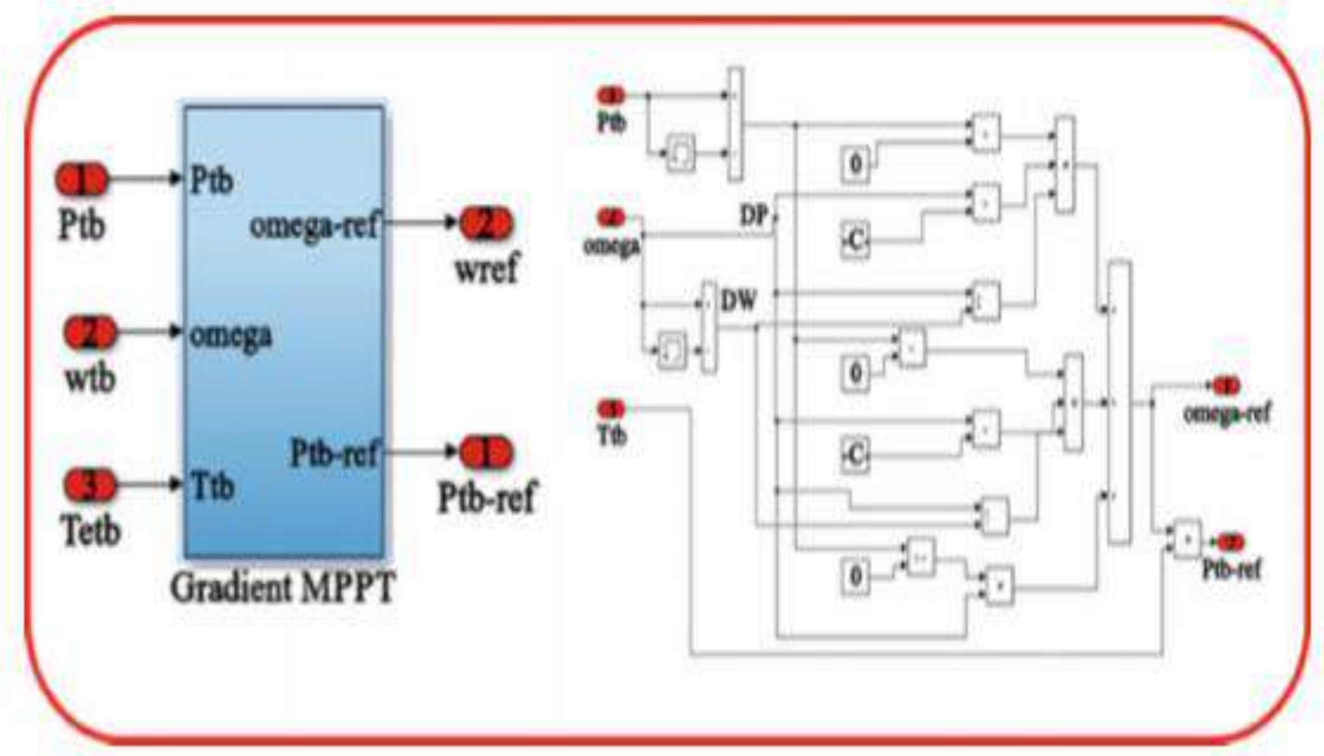


Fig 12: This figure illustrates the gradient approach in MATLAB/Simulink.

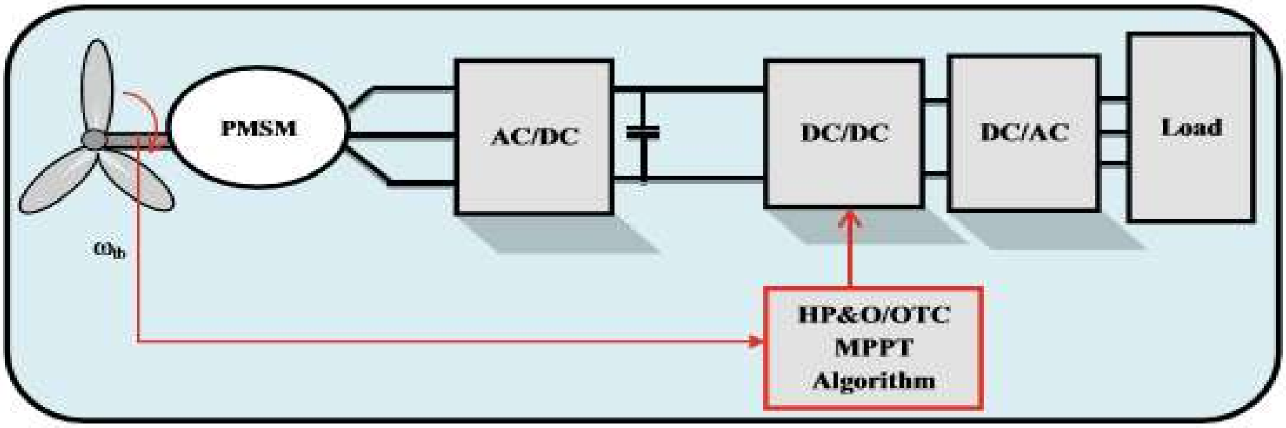


Fig 13: a hybrid combination of HCS and OTC MPPT in a wind turbine system

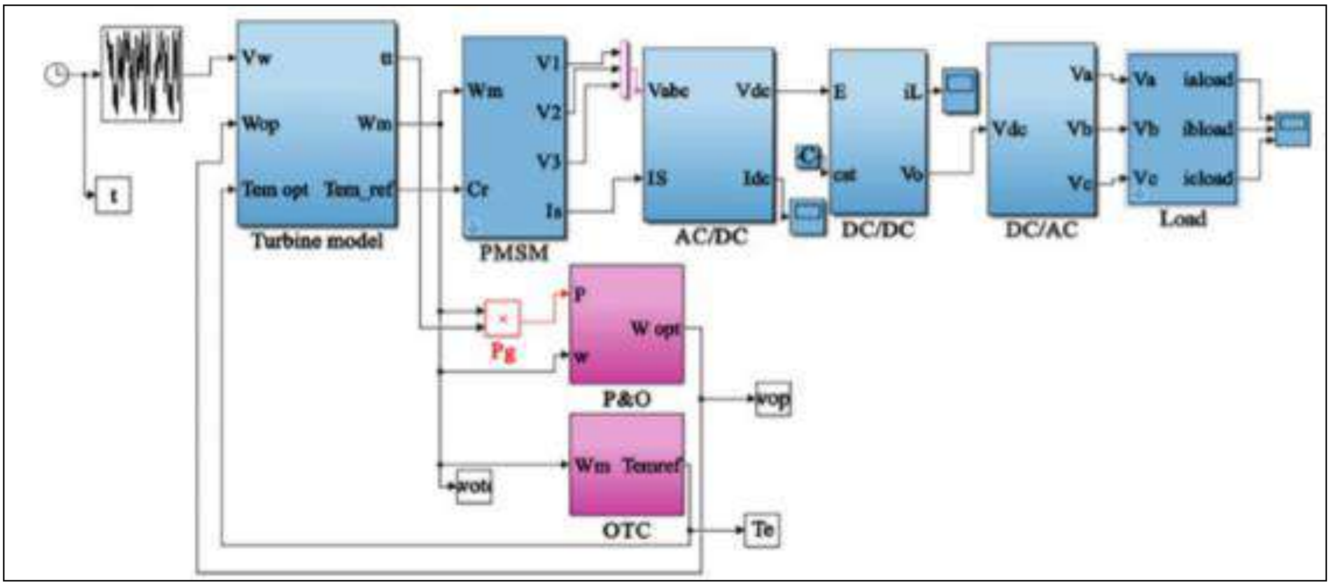


Fig 14: a stand-alone wind turbine system using HP&O/OTC

Table 1: Rules for utilizing a fuzzy controller

Error (E)	Error variation (CE)						
	NB	NM	NS	ZE	PS	PM	PM
NB	NB	NB	NB	NB	NM	NS	ZE
NM	NB	NB	NB	NM	NS	ZE	PS
NS	NB	NB	NM	NS	ZE	PS	PM
ZE	NB	NM	NS	ZE	PS	PM	PB
PS	NM	NS	ZE	PS	PM	PB	PB
PM	NS	PB	PB	PM	PB	PB	PB
PB	ZE	PS	PM	PB	PB	PB	PB

3.4 Radial Basis Function Network (RBFN)

Radial basis function network-like properties also exist in a fuzzy system. Similar to the number of rules in the fuzzy system, the buried layer nodes of the RBFN are all identical to RBFN nodes. In the receptive field, the membership functions of the premise act as membership functions for the premise. For reference, see Figure 15, which shows how a wind energy conversion system using RBFN is configured. A wind turbine is linked to a grid, which is in turn linked to an electricity generator. A P&O control (that's known as a P&O & RBFN control) is used to maximize power, while a PWM control (also known as a PWM & RBFN control) is used to regulate the DC/AC converter. To get the dc voltage W from P&O methods and RBFN controller force V_{dcref}, which uses its reference V_{dcref}, use the RBFN controller force V_{dc} to follow its reference V_{dcref} and then modify the load current reference $I_{Loadref}$.

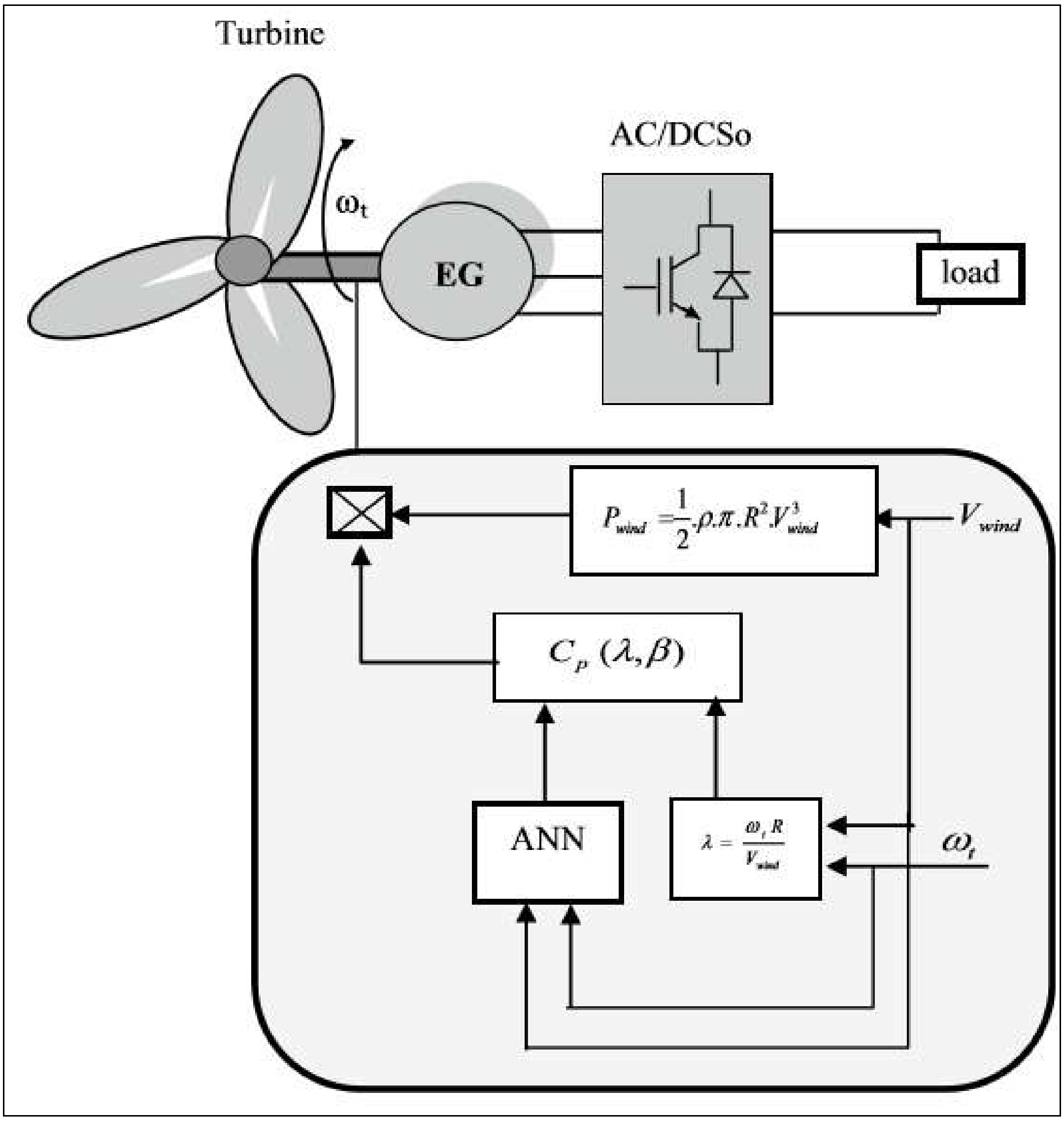


Fig 15: The wind energy conversion system (1) using artificial neural networks (ANNs) for control

3.4.1 A neuro-fuzzy adaptive inference system (ANFIS)

This controller can handle the most intense wind gusts. Fuzzy inference systems are also seen in ANFIS. The fuzzy logic controller employs a neural network (NN) to refine membership functions' input and output parameters (FLC). An unusual neuro-fuzzy circuit, as seen in Figure 16, is shown.

In computer science, the input layer is known as the first layer. This layer retains membership functions for each node that form a bell-shaped range of membership. The second layer has each node perform a connective operation called "AND" on the rules that precede it. Therefore, the nodes in the third layer are logically and functionally equal to the ones in the first layer. The following element of the fuzzy rule is addressed in the fourth layer. This layer's node is adaptable, and it has an output. The weighted average of all rule outputs is the final output in the fifth layer [9].

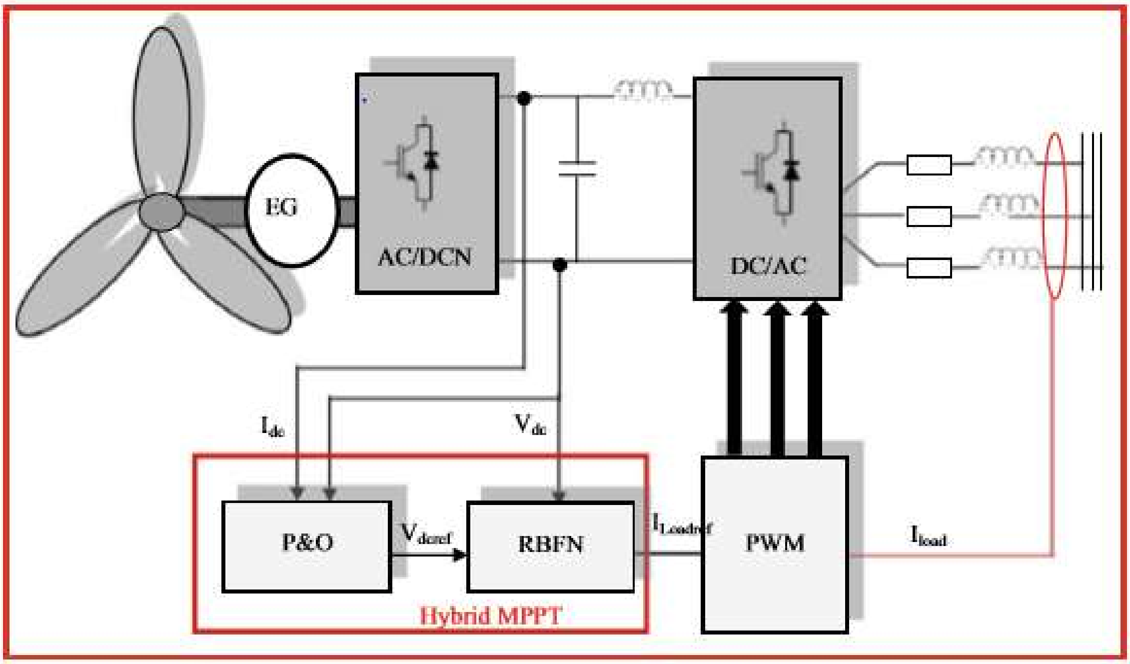


Fig 16: RBFN controller with a wind energy conversion system

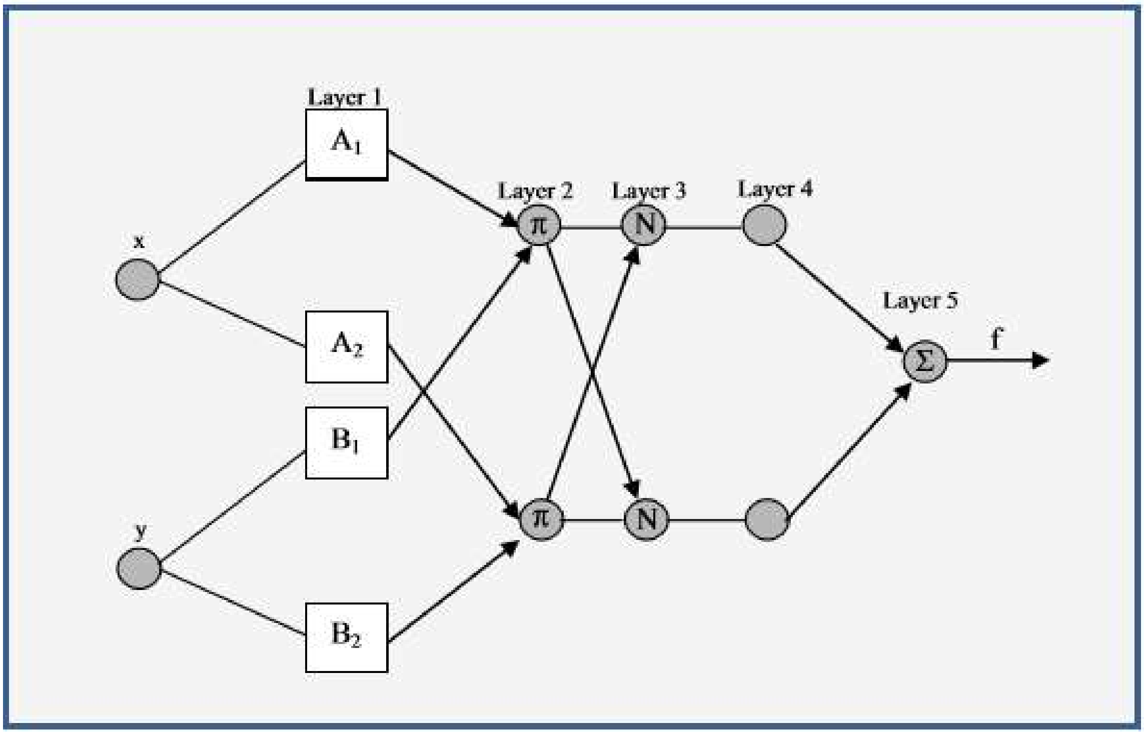


Fig 17: Neuro-fuzzy controller

The first input signal to ANFIS is ***e(t)***, the second is time-dependent ***de(t)/dt***, and the third is power. P_{mec}

4. Conclusion

Automatic positioning of the generator at its optimal location, independent of measurement changes or quick load variations, is a critical control method in optimization. Advanced algorithms are multidimensional. This paper discusses many MPPT (maximum power point tracking) methods for PV and wind turbine systems. A description of the concept or method is what the algorithm is, a flowchart or blocks, and an application for each approach. Most of this study will concentrate on farm efficiency, which can use agricultural energy resources more effectively. This is scalable, which means it can be utilized to go to an equivalent position. Biogas, solar photovoltaics, solar thermal, diesel, and battery backup will be studied extensively. The focus was to keep the initial HRES capital expenditure to a minimum while maintaining the farm's electricity demands. A game plan would be established. The suggested hybrid system will be validated by comparing the results of a system cost analysis and a sensitivity analysis with commercially available software HOMER.

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