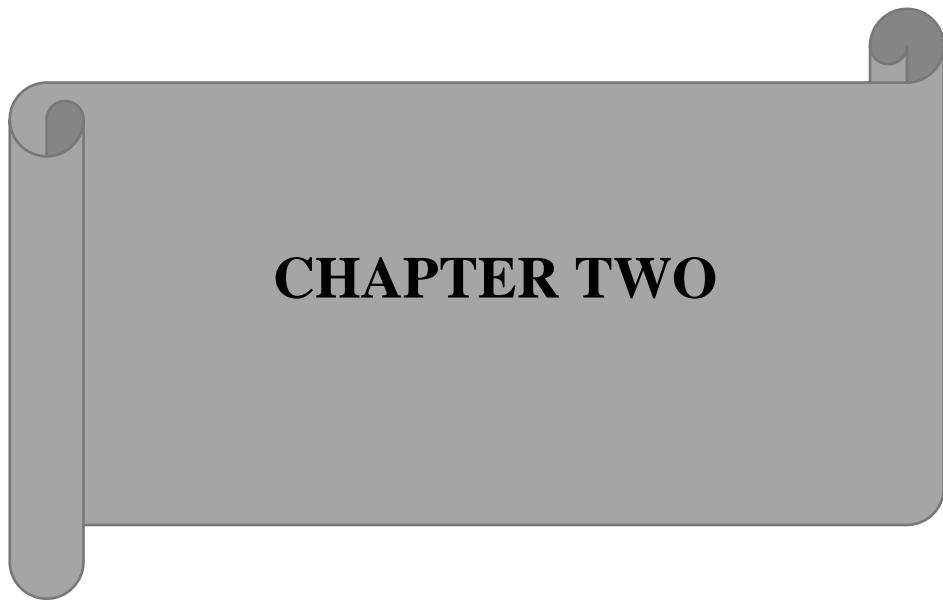


Title:

**Improving The Performance of Watering Plants Using
Hybrid Wind and Solar Energy**



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CHAPTER TWO: LITERATURE REVIEW**2.1 Introduction:**

In the chapter review, the efforts of several researchers who addressed the issue of generating electricity and lifting water from the well in two theoretical and experimental Were highlighted; The role of hybrid energy, especially clean energy in this area, including solar energy and wind energy, was highlighted, and its availability throughout the year was stressed.

The previous studies in watering plants have been on the way of elevating the water to a higher level with the help of various fuels as per the type of fuel either the solar energy which is available individually with the wind energy equipment and then the designing of the same through the experimental and analytical modules.

2.2 Theoretical and Experimental Wind Turbine investigations

(Ogawa and Kimura, 2018) [1] Here is sharing of the control of wingtip vortices of vertical type wind turbine. This wind turbine is composed of three circular cylinders. It has a series of cylinders which are each mounted on the individual vertical bearings and orbit. From previous studies, it is understood that through the presence of wingtip vortices, there are effects that lead to reductions in power as well as aerodynamic noise. was focused in the study that seeks to address the management of wingtip vortices and enhancement of power generation efficiency. 14 models numerical analysis was done to identify control factors to ascertain wingtip vortices. As for the Magnus effect, the pressure distribution on the circular cylinder and the streamlines were also painted around the wingtips for visualization during numerical simulations. the results of this project are:

the results of this project are:

1. A suggestion that keeping shields that are completely covering the circular cylinder blades at both ends play a big role in eliminating the wingtip whirlpools.
2. Curved wings have much better performance than flat wings to improve the efficiency of generated power for each cylinder due to significantly larger Magnus effect resulting from the pressure distribution with large change on both of the curved wing surfaces. Therefore, the outcomes showed that improved model achieved approximately (2) times better power efficiency than the original design.

(Shah, Kumar, Raahemifar, and Fung, 2018) [2] However, the paper offered a general description of wind turbine design, modeling and economical gain. The aim and scope of the current work were to topological and theoretical investigation of and small scale VAWT which could be useful for providing power for low power utilization. The two most advanced profiles for Savories rotor blades were evaluated in the concern of rotations with respect to blades. Computer simulation was used to design an algorithm, by using equipment such as MATLAB developed turbine have also been measured and then used for confirming the model. Aims: To study the various shapes of turbine blades, to formulate mathematical model and subsequently to evaluate proposed turbine, it became evident that the annual energy generation could amount to 7838 kWh; it was determined that the annual cost of electricity saving/s in Ontario could be \$846. 54.

Figures 3 (a,b) depict the comparison in which the solid lines represent the simulation results, and marks denote the measured ones; good as regards the reasonable as agreement is observed. It is constructive to consider the discrepancies between the measured and modeled values in relation to the uncontrollable testing environment and inherent errors in measuring equipment. Annual energy generation criterion is also assessed in economic aspect of the

design which was estimated to yield a yearly energy of 7838.0 kWh when the corresponding yearly profits that was expected to be \$846. 51.

(Ahmed et al., 2018) [3] Investigated a small wind turbine installation that might be applicable for an isolated farm in an agricultural area of Algeria. This confirmed the viability of applying the wind turbine in this place, and They also assessed the output of the additional power reserves in the form of energy stored in water. The size of the water tank is also being improved using the recorded daily consumption rate of water and the extra energy available for storing and for use at later times which will be employed for pumping water during the period when there are no winds.

(Mendoza, 2018) [4] The subject of the analysis was the intricate and relatively unstable flow that is encountered when employing VAWTs, which was investigated using an actuator line model for this specific purpose. It has also become apparent that in different ABL flows, there is a near wake vortex that is much stronger in a VAWT than in a HAWT. Consequently, it underlines that, concerning the fluctuation of the atmospheric turbulence, the performance of the VAWT turns out to be less susceptible. In all the examined scenarios, it has been observed that wake length reduces as turbulence intensities are raised. and if two interacting turbines are totally aligned (one turbine is directly behind another turbine) it often proves useful in increasing the overall performance values by applying the pitched struts to bent the wake.

(Saravanan et al., 2018) [5] he also presented an idea that involves wind energy that is employed to turn the wind blades of the given project. They used shafts to these blades where it formed a complex set up, this system of balancing. At the end of shaft there is fly wheel placed. Whwn the blades of the turbine turn automatically fly-wheel is also set into motion. Since the rotational motion of the wheel is in an eccentric way the rotation motion of the flywheel is translated to linear motion. Regulation of the pumping system involves providing this

reciprocating motion to the handle of the system. In this way, through the handle being up down, the piston is operated with help of pressure variation in the suction of water from lower ground. At last, the water is let out through the outlet. according to the findings within this experiment, the wind blade is the one that offers the constant rotation which in turn aids in supplying water persistently.

(Johari et al., 2018) [6] analyzing methods in the speed and behavior of two types of project for the windmill. A three-blade HAWT and a Darrieus type VAWT has been modeled using CATIA software and the prototype of the models has been developed through 3-D printing process to assess its efficiency. The two wind turbines have been through a number of tests done on both outputs from wind turbines. The outcome of the test will be used to determine which of the two wind turbines will perform better and thus cur to the best design and efficiency. Although with HAWT it is possible to generate a voltage higher than any of the other types and, in this specific case, which have been reached up to 8. 99 V at one instant then again it goes back to 0 V if the angle of wind has changed. Therefore, VAWT, yet, can produce lesser or minimum voltage (1. 4V) but, my voltage output is affected by changing the orientation of the wind in any way at all. The cause-effect relation analysis has subsequently revealed which VAWT is far extra beneficial to be created and utilized for such tropical and windy environments, as it can effectively cope with turbulent and Omni-directional wind.

A new type of Savonius Wind Turbine called Ice-Wind turbine, is proposed by an Iceland based startup, has been investigated experimentally its performance by **(Quang, 2018)** [7] The optimum design is found and there is a comparison between the two bladed Ice-Wind turbine and the Savonius Wind turbine of same power area. The other important factors considered in the analysis include the number of blades, whether or not its end plates are present, how many

stages, the aspect ratio, and the blade arc angle. It is also recommended that the Ice-Wind turbine design should incorporate a one stage, three blades rotor having end plates with an aspect ratio of 0. Of the two blade designs, the one with chord length of 38 and blade arc angle of 112° provides better performance. Ice wind turbine was also tested and found to have similar performance but slightly higher mean static torque and mean rotational speed than the Savonius wind turbine.

(Aized et al., 2019) [8] depicted the method of obtaining speed data of wind, the conception of wind-powered pumping of system and also evaluating the structure of the proposed design under various stochastic wind parameters in Pakistan. Efficiency of the design in this case has been calculated through analytical calculations. The design as proposed is then evaluated by creating Simulation models in ANSYS Fluent. Electricity generation from wind energy, the force of lift and drag on the blades, the rotor power gained and passing through the pump and finally, the surface or volume of water being discharged by the pump, have been determined and cross checked with the result from the simulation. As it has been discussed earlier researchers have found out that for every given rotor imperial scale Windmill shall extrude optimum power when angle of attack of the blade chord to the axis of rotation is within (23° – 27°). Based on the above data, the optimum height for windmill towers for a rotor diameter that ranges from (8–12ft) should be (35–50) ft. The designed wind pump system would be able to pump out the water from the ground level up to a depth of 50 ft depending upon the size of windmill fitted into it. And for the speed of wind of 3. tk> and for the speed of wind 3. at 5m/s, the windmill with a 10-feet diameter can pump about 250 gallons per hour for use in horticulture, animal production as well as domestic consumption.

(Diaz-Maurin et al., 2019) [9] in the case of this paper, a local case study was conducted in Canary Island, Spain and a private desalination plant that utilizes

wind electricity to supply water to an agricultural cooperative in the Southeast of the Island of Gran Canaria was used to elaborate MuSIASEM in giving a sustainable water–energy–food nexus platform. The results obtained confirm that the applied example of the MUSIASEM approach is feasible to develop quantitative evaluations of energy includes water, and food-security and connection based on concepts from complexity theory as well as by defining relations over processors transferring information regarding varying degrees of complexity and analysis.

(Siddique et al., 2020) [10] measured and analyzed of two, of two reversed and three, four blade Ice-Wind turbine, in experiment with performances and conducts; a parametric study. The comparative analysis of Ice Wind offered with two blade and Savonius wind turbine of equal swept area forms the main structure of the revision. Therefore, to investigate about the number of blade's effect, experiments are carried out for three blade with other fixed blade and the experiments are done using a wind tunnel at five wind speed ranging from 6m/s to 14m/s. These turbines rely on Aluminium pieces in their construction. Displacement in mm, static torque in N. m, and rotational speed in rpm are measured using digital displacement meter, digital torque meter, and digital tachometer, respectively. Some observations, which can be made from the experiments include: The amount of blades has a direct influence on the static torque coefficient and the rotational speed of the Ice Wind turbine where the three blade Ice Wind gives higher static torque coefficients and rotational speed than the two, the two-reversed and four blade Ice wind turbine. Hence, the concept of three-blade design is considered in order to produce a better performance.

(Shamshirband et al., 2020) [11] for a small scale and a low investment which does not necessarily require sophisticated technology a windmill as suggested above could prove useful for irrigation and at a much larger scale in Nigeria,

these systems can be connected to the national grid to enhance system reliability and stability. The analyzed winds reveal, while the southern region of the country has rather moderate wind speeds, the northern part of AC has significantly higher wind velocities and ample arid land. Furthermore, these windmills can be taken to farming towns and villages, to support food production given government's programs on food security and power from renewable sources. In addition, according to the study, these windmills may be microgrids that can enhance the Nigerian electrical network dependability and performance.

(Mathivanan, Amrith, Jemshid, and Sadik, 2021) [12] For irrigation it offered a tool for raising water into tanks. Therefore, by utilizing a windmill water pump, this is accomplished that further captures the wind energy. Based on aforementioned research, it is clear that a windmill water flowing system is more practical than a diesel system.

(Md. Islam, 2022) [13] studied an experimental design of a project which is based on designing and manufacturing of the VAWT that is (Vertical Axis Wind Turbine) with exterior wind Source. Regarding basic idea of redesigning the model which was initially of Darrieus type to Savonius type this in turn put the need of redesigning almost all parts of the VAWT, further increasing the torque as well as the rpm, using lightweight blades makes the whole structure portable and last but not the least placing this entire project in a very low cost budget. The observations reveal that the enhancement of design work boosted the new inventions and designs in the wind turbines, the best way for the society to reduce the harm it causes to earth by not utilizing energy sources that leads to pollution and a better source of electricity through the hybrid system.

(Rashidi et al., 2022) [14] offered a RO technology using renewable energy systems for supplying the necessary electricity of RO system which is advantageous from the standpoints of the environmental load and its

applicability to relatively isolated areas and has gained attention in recent decades. This was done on the desalination systems using wind energy by providing water for other aspects which include irrigation, production, and fishing among others. consequently, it can be stated that wind turbines can be relied on to deliver the needed power for desalinations in a manner that is relatively environmentally friendly. However, by integrating systems, professional wind turbine systems can be assured and the few problems that may arise from wind intermittency could be solved.

(Nur A. Ismail, 2022) [15] In addition, the theoretical analysis of Wind Energy and Wind Turbines is conducted, and different aspects of the study of wind energy potential in Bangladesh are also covered. Seasonal variations are also responsible for the electricity consumption where a higher degree of consumption is witnessed in the month of April and May owing to elevated summer temperatures and hike in the use of water in the form of irrigation. recommended for this project was an integrated system with two of the renewable resources namely solar and wind together with a conventional energy source, diesel and Battery. Inverter means an electric device that has the ability to convert the power supply from DC to AC. The results show that the suggested hybrid power system has an initial cost per unit of energy of 0.25 USD, which is less expensive than a typical quick-rent power plant, especially when considering the economic aspect, where the cost per unit of electricity is 0.33 USD/kWh. Furthermore, this hybrid system will generate clean energy with a lower environmental impact than traditional renewable energy sources due to its higher efficiency. As a result, it will be feasible to say that the system under investigation has all the necessary capacities to generate electricity in Bangladesh.

2.3 Theoretical and Experimental Solar PV Investigations

(Aliyu et al., 2018) [16] In the current work, a bibliographic review of solar-powered water pumping system was conversed in detail, as accessible in the prose to act and perform as USER friendly rapid orientation source for investigators and noteworthy engineers stepping into the area. They found out that among the available options the usage of the photovoltaic or the solar-powered system is between the feasible solutions that shed light to much attention. They have been applied in many areas for different purposes including; rural power and lighting as well as water supply in remote areas, watering crops and livestock, and supplies of water for human consumption.

(Al-Badi, Yousef et al., 2018) [17] also provided a procedure that might be followed in sequence to design a PV, pumping system out of which the size of the PV system required for a specific farming enterprise is also found. Furthermore, the carbon dioxide emissions by using a diesel generator and an electrical motor connected to the PV water pumping system are compared with the usage rate of the system against generators that are run by diesel and an electrical motor that is connected to the network of grid. Therefore, to meet the goals of the PV water pumping system, and also rational use of batteries, an innovative set up has been established incorporating DC and AC motors. These tests are conducted to evaluate the validity of the MATLAB model, which has been derived in the above sections. Therefore, from the presented work, one is in a position to appreciate that the use of the PV water pumping systems, that is not only adding to improvement of the standards of living of the people in the rural areas but has also a potential to benefit the environment and, more to the point, the most appropriate way, among the above-discussed methods, of improving the living standard of the people in the remote areas of the world in regard to water pumping.

(Belaud et al., 2020) [18] addressed four main subjects are: In the given scenario, how does the productivity of irrigation and the sustainability of water

resources when being exploited are affected when farmers have access to energy? With regards to the knowledge aspect of the paper, what did the study offer in terms of understanding energy efficacy in irrigation systems at the farm and also levels of collective network? What are social implications and opportunities of such focused efficiency and how can they be enhanced by employing modern technologies, simulation equipment, and better management? Are there opportunities in energy production that benefit irrigation systems? In performing this analysis, the subsequent facts could be concluded, the results of which demonstrate that new chances have been appeared for the utilization of renewable energies in the sector of irrigation: with the help of the photovoltaic panels located on the area where crops are grown, it is possible to generate electricity with higher land and water productivity.

(Allouhi, Beker et al., 2019) [19] Analyzed the best orientation and tilted PV array configurations to provide a submersible pump system of solar to address internal or home water which requires a number of five limited houses in one remote area of Moroccan. The work described in this paper highlighted the step-by-step approach that was followed in the actual design of a proposed real PV water pumping system, which is created on everyday water demand. Also, general system design works and their efficiency were done hourly with analysis such as heating or cooling load, and room ventilation. Analysis of the flows offered in the plan of the proposed system considered both near-optimum configurations. Studying simulations of an object for a year in a year, it was possible to stop at the conclusion that the object of the first choice, the direct coupling, does not turn out to be suitable for config of water pumping in this case. This culture thereby exhibited that a second system with lesser PV arrays and incorporating a MPPT DC converter could irrigate additional water, and also its practicality exceeded the straight connection layout significantly.

Furthermore, empirical economic research has shown that relative to the traditional water supply models, the proposed systems are inexpensive to introduce.

(Vezin, Meunier et al., 2020) [20] derived for the purpose of developing a borehole water level model that can well work with PVWP systems. The methods derived from this study could be applied to any kind of PVWPS and there are today perpetually the aquifers available for a given technology. The following model applies to each type of PVWPS and aquifers CONSTRAINTS: There are certain limitations in the model that has been discussed above. This has been validated comparing it with the data gleaned from the pilots PVWPS installed in the village of Burkina Faso that is a rural off-grid village and is accurate with more than 97 % percentage. As a result of this borehole model, it is possible to specify the changes in availability of groundwater to quantify the effects of borehole resources on PVWPS and the effects of these quantities to determine more appropriately size PVWPS. from this table it is clear that in order to obtain the desired alteration in the level of static water at times there might be a call for the highest power of the modules of PV to be increased as much as double. However, the loss or drawdown having been attributed to the pumping, is almost not significant to deter the initiation of the project.

Since there are many areas in the northern side of Boldana and Akola suffer from salinity due to the lack of choice of wells by farmers. In such a case, **(Sawant and Jadhav, 2020)** [21] This involved a detailed analysis of how agricultural ponds could be connected with a well to ensure that farmers could benefit most in irrigation. It includes considerations such as replacing the grid connected pumps and diesel with other solar pumps, and using disposable and diesel prices as a way of discouraging farmers from over pumping. In the case of SPVs, where there was cost to the service user for installation, there was no cost incurred by the service user to use the pump once it was installed. They are

relatively flexible particularly when it comes to installation, power control and the management of volumes of water. Hence, solar pumps connected to the grid can be a solution for irrigated water scarcity specifically in western and southern regions of India because the type of irrigation could be effective.

(Babaa et al., 2020) [22] Introduction of the innovative technology in addressing the possibilities of using solar power in the irrigation of agricultural land in Oman. As the agriculture serves the essential role to enhance the economy of the country, effectiveness must be delivered in mandate to boost the production and enhance the excellence of crops. Therefore, the task is focused on developing an automatic irrigation system threshold using moisture sensor that is incorporated with Arduino UNO board, that works as a supervisor and also Global System for Mobile Communications that is employed to allocate or handover the info among supervisor and consumer. However, the investigation is applied and it has provided as to the research purposes. Consequently, this smart control irrigation system demonstrate is effective particularly in a case of water scarcity, no electrical power supply, and large acreage of farmland.

(Rana, kamruzzaman, Oliver, and Akhi, 2021) [23] Some of the research carried out to establish: The financial & environment cost of Solar Powered Irrigation System (SPIS). It also investigates about the demand Factor and Cross price pliability of rice additional in case of Boro rice production influenced by SPIS irrigation of Aush rice. Drawing on the results of test of a financial analysis: SPIS user used more electrical energy than DPIS user, enjoyed a greater gross and also a remaining return and enjoyed higher benefit- cost- ratio (BCR). The undertaken analysis of profit, cost, and time elements of SPIS user has stated that the BCR at the research study was equal to 1. 313 and also 1. 029 for DPIS consumer. Besides, the diesel is substituting the half that powers irrigation systems would diminish carbon emission in the environment by over

one million through agricultural source and argued that irrigation systems are inelastic, moreover the result categorically showed that the demand for irrigation would not be greatly impacted by alterations in the rate of irrigation system. Finally, the mentioned conclusion explicates that is for yielding Boro rice farmer have to utilize require quantity of flood water for the field. As for seed to the soil, it was complementary with human labor and as for irrigation it was complemented with human labor.

(Tamoor, ZakaUllah et al., 2021) [24] , The study introduces the PV system design process, including a 1200 Lumens LED bulb fitted at the earthling pit light. In this paper, the design of the PV system is presented, with the PV array factor calculated as 1.35. For data analysis, both descriptive and inferential tests were used effectively to analyze the impact of the solar-powered automated drip irrigation system.

According to the survey, 39.58% and 72.92% of solar drip owners acknowledge that their social position and level of self-efficiency have improved significantly. Additionally, 17% of farmers reported an improvement in the quality of their produce due to the solar drip irrigation system. This data, summarized in the table below, highlights the high value owners place on the system's socioeconomic and environmental benefits. The majority of solar drip system owners benefit significantly in terms of socioeconomic metrics and environmental impact.

(Rana et al., 2021) [25] The results of a study on the variables influencing the adoption of military technology are reported in the SPIS adoption reports that follow. It also includes how the SPIS programmers have affected the general standard of living for farmers in the targeted research area. This was done through farmer interviews, with 140 farmers in total. Random sampling techniques were only used in this study, and profit model examination was also

approved to define the socioeconomic factors influencing the specific adoption process.

(Tahir Alam, 2021) [26] The study also explores the impact of tube wells on the water table and discharge within the Quetta Valley aquifer system. An economic analysis compares the solar photovoltaic water pumping system (SPVWP) with traditional pumping systems used by the Quetta WASA tube wells. Findings indicate that Quetta experiences the highest average solar radiation in Pakistan, suggesting that solar photovoltaic pumping could be highly beneficial and cost-effective. The RETScreen model has been utilized to evaluate the technical feasibility and economic recovery of these tube wells when implementing a solar photovoltaic system.

(Raza and Tamoor, et al. 2021) [27] The socioeconomic and weather effects of the photovoltaic (PV) systems that is installed under the subsidy of government schemes for the operation of efficient irrigation systems (HEIS), sprinkler irrigation systems, and drip have also been studied by the author through a review of case studies conducted in Punjab, Pakistan. For this purpose, the primary data used to concern the on-farm agriculture and irrigation knowledge was collected by a farm-based questionnaire survey for the secondary data information, official reports, document and statistics approved by the government were used.

(Gamal, El-Ghetany et al., 2022) [28] that in order to support the simulated solar model by a computer program to verify that the hydraulic power, direct current maximum power, the area required for the appropriate PV system and the total cost too system was achieved based on the values of T DH of 50, 100 to 200 m of Beni Suef city the comparisons have been with Beni Suef , Aswan and Alexandria Cities. These details when added will add head distance to aisle to give for any head, especially put distance to aisle is not sufficient. Regarding the irrigation system, the comparison of the necessary water demand for several

irrigation systems of summer crops and evening crops. Therefore, the water demand/Fadden ratio for the irrigation system of surface for summertime crops, namely the crop of cotton, was 85.7%, 79.9%, and 66%, indicating the need for irrigation. Sixty-seven percent of the growers said they used drip, sprinkler, and surface irrigation, while seven percent used furrow irrigation. Thin maize crops were reported to be 74.3%, 79.9%, and 66 in the same case. Dynamite had the highest germination percentage of almost 73%, compared to 85%, 7%, 79. 9%, and 66. 6% for soybeans.

(Raza and Tamoor et al., 2022) [29] presented the findings traditional power sources or the national utility grid. The analysis further shows that CO is unconditional and invulnerable. However, the current studies imply that integration of PV systems has led to the use of efficient irrigation systems, reduced expensive costs of the old diesel-based pumping systems where 6. 6 million liters of diesel ted annually, increased farmers' income by 100%, reduced CO2 emissions by 17,622 tons per year, and water savings of 41%. Analyzing the three research questions, the following findings were established: Cost analysis: The unit price of PV-powered HEIS was created to be 0. 76 kw/h, that was four (4%) percent and sixty-six (66%) percent cheaper as compare to the subsidized electricity price and the price of diesel as well (\$1219 kw/ h).

2.4 Theoretical and Experimental Hybrid Energy Investigations

(Camargo, Nitsch et al., 2019) [29] This study examines how and how much it would cost to employ a hybrid renewable and also energy generation system that consists of cells of solar, micro wind turbines, and batteries to meet the electricity requirements of domestic consumers in Germany and the Czech Republic. Information on renewable sources' variability for a large area is necessary while using high-resolution reanalysis data to estimate the sufficient

system sizes. The prerequisites for hybrid systems to create cohesively designed clusters of fifty single-family homes that are energy self-sufficient are identified for each potential location. The outcomes demonstrate that adding the power of wind to these independent systems reduces the otherwise extraordinary installed the PV capabilities needed in lower solar insolation areas, namely higher geographic latitudes, while also lowering the total installation costs when compared to systems with batteries that use only PV. It is important to note that for regions with middle and great wind potential values, storage volumes can decrease notably. Therefore, the utilization of this method provides high results and does not change significantly, even if lower production of PV and is calculated because of snow on the panels. Lastly, comprehensible for electricity and gas experiment, financing costs not included. Additionally, the whole prices of the hybrid systems for the number of 50 household's collections, which are aimed at electricity, full autonomy and with vehicles from Table 7 the prices range among EUR 1. Eight (8) million and five (5) million Euro respectively in the day light robbery subject to an experimental tax regime hence, it's was logical for it to be associated with highly inflated costs of just under EUR 8 million. The costs are shown clearly in distinct sections in the models under examination, broken down by the number of families and the minimum quantity of electricity each would need during a 20-year period. There are therefore up to 10 and up to 3 (the best places in Germany). Therefore, the number of unfavorable places in the Czech Republic is five times greater as compare to present cost of creating electricity while using the grid.

(Elkadeem and Atia et al., 2019) [30] The viability of an isolated grid renewable hybrid energy system for irrigation regions and also electrified agriculture in Sudan, Dongola, was thoroughly investigated by Addison et al. With the aim of achieving the utmost possible and dependable solution at the lowest system price possible with reasonable environmental effects, the

efficiency of the designed system is assessed and evaluated statistically by simulating various hybridization scenarios of battery storage, solar photovoltaic, wind turbine, diesel generator, and also converter technologies with a base case in the form of a diesel generator built energy system. After that, a sensitivity analysis will be conducted to consider how system characteristic variability may affect both the efficiency and design of the system. The results demonstrate that, in a load-demanding area, the suggested hybrid system has the most efficiency and benefits over the other load scenarios that were studied. Therefore, not only the lowest value of the level rate of energy is achieved by the system that is 0. 387\$/kWh, and also the noteworthy the overall net present price that is 24. 16 million dollars, but also a noteworthy positive proportion of the return on investment, which is 39. Compared to the base scenario, the reduction in fuel consumption and carbon emissions was almost 94% and 95%, respectively.

(Donado et al., 2019) [31] supplied the Hybrid Renewable Energy Systems as (HYRES), a helpful computational instrument for attempting to assess usability of systems of energy, including power generators with a renewable basis. Before performing multiple objective optimization using Genetic Algorithms (GAs), HYRES gathers various inputs related to climate, reliabilities, statistical forces, and economic perceptions. This approach has higher price-benefit ratios as compare to the mono-objective option that is still widely utilized in many of the industrial systems, such as the HOMER micro-grid modelling system around the world. When in the various case investigations where the system is verified the results analysis will show that it has characteristics of utility, feasibility and reliability. It is an efficient instrument that can help perform viability analysis for systems with renewable generating facilities in question. When a system has a number of potential designs, HYRES will look more appealing as it means that decision-makers as inputs, and parameters with

respect to climatic conditions, statistical reliability, and economic perception can be varied. Comprehensive comparisons with the HOMER results suggest that HYRES is statistically acceptable and that the specific additional features make the tool more suitable for researching different scenarios for a case study. Among them are the following: ability to select multiple objectives when using GAs; and flexibility of the system with reference to constraints such as first capital price, least dependability level and extreme allowable area for the panel of solar and quantity of wind turbines as well.

(Shivam, Tzou, and Wu, 2020) [32] Utilising the Köppen-Geiger climate classification, this study examines the wind and sun energy resources of four distinct zones in Taiwan's southern region. The suggested solar-wind hybrid system, which consists of inverters, vertical axis wind turbines, multi-crystalline photovoltaic modules, and also the battery energy storage systems, is the theme of the investigation. The weather data for the exercise were derived from global reanalysis while the daily load profile was based on climate at one-hour interval. The following is the basic outline for multi-objective optimization through simulation on solar-wind hybrid system in consideration to the feed in tariff provision of Taiwan laws and environmental constraints besides the area of installation. In the case of analyzing the option of installing photovoltaic modules at each of the four studied sites, the decision was made that it is profitable in the sense of the grid-connected mode at all sites, incorporating new solar-wind hybrid system is regarded as a more noble decision in terms of environmental impact.

(Javed, Ma, Jurasz, and Amin, 2020) [33] In this paper, a review paper of solar-wind PHS system is presented with regards to the economic, environment and technical feasibility aspects of such system where the authors have focused on meta- analysis of SC-SM based stochastic economic dispatch of RE-based PHS system mentioned in papers of the last 10-years which may be beneficial

for the researchers interested in modelling and techno-economical optimization of PHS integrated to wind-solar power supply. Though the hybrid types such as the one introduced here, PHS-battery, is still in its developing process as they can compensate one another's weaknesses, it will be an area of interest for future investigation.

(Al-Addous, Al Hmidan et al., 2020) [34] Nonetheless, the design, modelling, analysis, and feasibility assessment of a hybrid wind and water pumping storage system were accomplished. This work was completed for the King Talal Dam (KTD), which is situated in Northern Jordan. Potential sources of preliminary system data were gathered. It is apparent that Jordan has received more attention than the Middle East and North Africa (MENA) region as a whole. The Jordanian market for renewable energy is a thriving industry that encourages businesses, investors, engineers, and developers to construct and/or integrate renewable energy hybrid projects and pure REN systems, frequently for the production of electricity. Software known as "windfarm" is used to measure and analyses wind data for five. as average speed of wind is comprised within the range of 16m/s. After that, the hybrid system is designed, and then the simulation of the designed system is done for 2-3 hours of daily operation during the peak load. Technical outcomes are then supplemented with a cost analysis that takes into consideration the Jordanian market prices in determining the feasibility of each identified option. Therefore, the annual total estimated permitted energy generation from a 10 MW wind farm and 5 is 26,663,933 kWh. As a result, the table below compares the pumped storage: Table 6. 5: 2 MW Pumping Storage System Comparison. The hybrid system also showed that the system's mostly commercial deployment is not entirely hopeful. PJM's pumped storage technology, however, continues to be strictly technological and benefits the grid at the same time. Additionally, the project study shows that this kind of technology reduces energy imports, improves the integration of

renewable energy systems, and increases the operational resilience of the grid. The study has estimated an annual reduction in emissions of 15 million tons equivalent, which is noteworthy.

(Ssenyimba, Kiggundu, and Banadda, 2020) [35] designed a suitable wind-solar hybrid system in the Ugandan area of Kalangala to irrigate a one-acre banana plantation. According to the simulation results, the system could function at 20 m/s without experiencing any deformation. With a net real rate of return of 3.5% annually, the income stream's net present value for the first five years at $r = 5\%$ was 12,935,468 UGX. As a result, the study will serve as a helpful reference when deciding which hybrid irrigation systems to buy.

(Srikanth et al., 2020) [36] investigated a transparent, experimental solution to the problem of pumping water during power outages. The solution involved assembling electricity for the water pumping system using photovoltaic cells and a windmill, along with a rechargeable battery, transformer, relay, voltage regulator, LM358 comparator, inverter, and LDR sensor. The design and architecture of a novel approach to electricity were put forth in this project. One benefit of the technology is that it can assist with water pumping even in situations where energy is available.

(Stoyanov, Bachev et al., 2021) [37] Experimental research has shown that using hybrid systems to power water pumping offers a way to get around the unpredictable nature of renewable energy sources. Three criteria are used to compare the combinations: system oversizing, crop need satisfaction, and investment cost. Additionally, the introduction of battery storage is considered. The findings indicate certain patterns in the sizing of hybrid systems and the potential to use the suggested methodology for a range of locations, generators, and crops.

(Mazzeo, Matera et al., 2021) [38] while the paper ‘Hybrid Systems: A Review on Research Trend in the Last 25 years’ gave a qualitative and quantitative view of the future work of the research, the present research work will embark the process of literature review along with statistical data collection and analysis starting with the evidences collected from the 550 most recent and relevant articles on the topic of hybrid systems out of nearly around 800 articles found in total, published between the period of The review aim was to provide an upgrading matrix literature database which categorizes the content of all articles in terms of the organization of the geographical distribution and sub-assemblies and modes of operation and ancillary components required for the establishment of the intended uses and the methodology of the studies involved (simulation, experimental discrimination and alternatively the economic, energy, environmental & social analysis etc.) & software used etc. The total number of 550 research articles were scrutinized, compared and categorize to depict a big factual framework of the analyzed articles, which illustrates the state of art significantly while focusing some primary trends & finding of the Hybrid wind and solar PV experimental, Simulation & Optimization Projects. Last of all, an investigation is conducted on the size of the system parts in order to understand which renewable power source is more chosen at the low and high scaling of installed power for independent use, for connection with the electricity grid as well as in all respects depending on the usage type. The study reveals that the relative heavens of solar PV systems exist at low installed powers particularly for residential applications and standalone systems further analysis reveals that Wind systes alongside enhanced employment at lower installed powers is significantly more commonly used as the power escalates than solar PV systems. This review recommended as database useful for engineers, technical professionals, and national and international policy makers.

(Khan et al., 2021) [39] carried out a unique feasibility assessment for an off-grid hybrid renewable energy system in order to construct a water pumping system that Sudan may utilise for agriculture. This project considers 12 sites in Sudan based on crop water requirements for various crops, borehole depth, and stochastic characteristics of renewable energy resources. It simulates, evaluates, and compares original different hybridization cases, such as solar photovoltaic, wind turbine, and battery storage. Primary data on the soil, weather, and climate at 12 locations in Sudan were used for the case studies, but the main goal was always to find the most effective and dependable approach that would guarantee a fair system cost. The case studies' conclusions show that a number of factors, including cost, system size, solar radiation levels, wind speed fluctuation, and solar radiation intensity, heavily influence the technique of choice. With the exception of two sites, hybridization is not now the preferred option at most of them. Additionally, it is anticipated that the rivalry for lower wind technology prices would intensify or open the door to the potential of hybrid generation.

(Granit, 2022) [40] examines the impacts of small-scale renewable energy technology on the rural indigenous population of La Guajira, Colombia, concurrently with the Energy-Water-Food Security nexus. In order to provide information for a cross-case study of people who have access to solar energy, wind/Walker Energy, and people who don't have access to electricity, the research used focus groups, interviews, and survey research. The study's result made clear that La Guajira's energy expansion needs to take into account more than only wind energy development and take into account how it would affect the Energy-Water-Food Nexus. Although a lack of modern energy services to the Wayuu people is a critical issue of their life and have the potential produce some immediate problems solutions regarding the short-term water and food security, on the other side, the long-term water related tradeoffs should be managed in most appropriate way for sustainable development of the area. Also,

thinking of the other solutions than continued use of the groundwater abstraction the possibility of using solar based greenhouse-desalination technologies for the communities living in the desert regions; water desalination for coastal areas; promoting alternative revenue-generating ventures by expanding access to renewable energy sources that will contribute to the diversification of livelihood options and therefore reduce reliance on a potential delectable water sources.

Table (2.1): Summary of previous studies

Here is the table created from the previous studies:

Author's Name and Year	Work Type	Research Title	Parameters	Results
Ogawa, S., & Kimura, Y., 2018	Journal	Performance improvement by control of wingtip vortices for vertical axis type wind turbine	Wingtip vortices control	Improved performance of vertical axis wind turbine
Shah, S. R., Kumar, R., Raahemifar, K., & Fung, A. S., 2018	Journal	Design, modeling and economic performance of a vertical	Design, modeling, economic performance	Effective design and economic feasibility demonstrated

		axis wind turbine		
Akour, S. N., Al-Heymari, M., Ahmed, T., & Khalil, K. A., 2018	Journal	Experimental and theoretical investigation of micro wind turbine for low wind speed regions	Micro wind turbine performance in low wind speeds	Viable for low wind speed regions
Froger, A., Gendreau, M., Mendoza, J. E., Pinson, E., & Rousseau, L. M., 2018	Journal	Solving a wind turbine maintenance scheduling problem	Maintenance scheduling	Optimized maintenance scheduling
Saravanan, S., Anbazahan, D., Manikandan, G. S., Mathavan, M., Afrith, A. M., & Prakash, K., 2018	Journal	Design and fabrication of wind energy water pump	Wind energy water pump design	Effective design and fabrication

Wang, Z., Wang, Y., & Zhuang, M., 2018	Journal	Improvement of the aerodynamic performance of vertical axis wind turbines with leading-edge serrations and helical blades using CFD and Taguchi method	Aerodynamic performance, CFD, Taguchi method	Improved aerodynamic performance
Le Quang, S. A. N. G., 2018	Dissertation	Load and Power Control of Horizontal Axis Wind Turbine	Load and power control	Effective load and power control strategies
Sumair, M., Aized, T., Gardezi, S., Rehman, S. U., & Rehman, S., 2021	Journal	Wind potential estimation and proposed energy production in Southern Punjab using	Wind potential estimation, energy production	High wind potential and viable energy production

		Weibull probability density function and surface measured data		
Diaz-Maurin, F., Chiguvare, Z., & Gope, G., 2018	Journal	Scarcity in abundance: The challenges of promoting energy access in the Southern African region	Energy access challenges	Highlighted challenges and potential solutions
Khan, H. U. R., Siddique, M., Zaman, K., Yousaf, S. U., Shoukry, A. M., Gani, S., & Saleem, H., 2018	Journal	The impact of air transportation, railways, port container transportation, and port container traffic on energy demand, customs duty,	Air transportation, railways, port container traffic, energy demand	Significant impact on energy demand and economic growth

		and economic growth: Evidence from a panel of low-, middle-, and high-income countries		
Shamshirban d, M., Salehi, J., & Gazijahani, F. S., 2018	Journal	Decentralized trading of plug-in electric vehicle aggregation agents for optimal energy management of smart renewable penetrated microgrids with the aim of CO2 emission reduction	Decentralize d trading, energy management, CO2 emission reduction	Effective energy management and CO2 reduction

Mathivanan, S., Amirth, S., Jemshid, A., & Sadik, N. A., 2021	Journal	Design and Fabrication of Water Pumping Mechanism, wind energy Pumping Mechanism using Wind Energy	Water pumping mechanism, wind energy	Effective design and fabrication
Islam, Md., 2022	Dissertation	VERTICAL AXIS WIND TURBINE	Vertical axis wind turbine design and performance	Effective design and performance analysis
Rashidi, M. M., Mahariq, I., Murshid, N., Wongwises, S., Mahian, O., & Nazari, M. A., 2022	Journal	Applying wind energy as a clean source for reverse osmosis desalination: A comprehensive review	Wind energy, reverse osmosis desalination	Comprehensive review with positive outlook
Dada, J. T., Adeiza, A., Ismail, N. A., & Marina, A., 2022	Journal	Investigating the link between economic growth, financial	Economic growth, ecological footprint	Significant findings on the interplay of factors

		development, urbanization, natural resources, human capital, trade openness and ecological footprint: evidence from Nigeria		
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2.5 Summary of Previous Work

The earlier research on renewable energy systems for water pumping and irrigation applications is diverse and extensive. Here is a summary of the key findings and contributions:

2.5.1 Wind Energy Systems

- A study comparing two-blade Ice Wind and Savonius wind turbines found that the three-blade Ice Wind turbine design performed better in terms of static torque coefficients and rotational speed.
- A low-cost, low-technology windmill was proposed for irrigation in Nigeria, with the potential to be tied to the national grid to improve system reliability and resilience.
- Windmill water pumps were found to be more feasible than diesel-based systems for lifting water to tanks for irrigation.

- A project concentrated on the design, fabrication, and also testing of a vertical axis wind turbine (VAWT) with external wind, resulting in a portable and low-cost design that can reduce pollution and provide a clean source of electricity.
- Wind energy was utilized for desalination systems, producing water for irrigation and other daily life aspects, with the potential to improve system reliability by applying hybrid systems.

2.5.2 Solar Energy Systems

- An optimum PV system configuration was designed to supply a solar submersible pump system for domestic water needs in a Moroccan remote area, with the proposed system being economical as compared to traditional water delivery techniques.
- For photovoltaic water pumping systems (PVWPS), a data-driven borehole water level model was created. It can be used to all PVWPS types and aquifers, and it was verified using experimental data from a pilot PVWPS in Burkina Faso.

2.5.3 Hybrid Renewable Energy Systems

- A study analyzed wind and solar power availability in southern Taiwan, proposing a solar-wind hybrid system that is composed of batteries, inverters, vertical wind turbines, and multicrystalline photovoltaic (PV) modules.
- A wind-solar hybrid system that can function at speeds of up to 20 m/s without deforming was made for the purpose of irrigating a banana plantation in Uganda.
- Three typical demands' worth of energy consumption, four various kinds of wind turbines, three various kinds of solar panels, and a storage system

were taken into consideration when sizing a hybrid renewable energy system for the Colombian market.

- In a remote Peruvian fishing community, a hybrid micro grid comprising two 3 kW wind turbines and a 6 kW photovoltaic system was established. Therefore, the grid proved to be highly efficient in meeting the average daily demand of 23 kWh.
- A thorough study of the viability of an off-grid hybrid renewable energy system was provided in order to design a water pumping system for irrigation purposes in Sudan. However, various scenarios of solar photovoltaic, wind turbine, and battery storage hybridization were analyzed, contrasted, and assessed.

2.5.4 Impacts and Applications

- The impacts of small-scale renewable energy technologies on Colombian rural indigenous societies were examined through an Energy-Water-Food Security Nexus lens, emphasizing the required for a holistic perspective on energy expansion and also its effects on the Energy-Water-Food Nexus.
- Renewable energy systems were found to have positive socio-economic impacts, improving farmer incomes, product quality, and living standards, while also mitigating potential negative impacts on water resources.

These studies demonstrate the growing body of research on the usage of renewable energy systems, mainly solar power and also wind, for water pumping and irrigation applications. The findings highlight the potential of these systems to improve food and water security while reducing environmental impacts.

2.6 Scope of the Present study

From the previous studied in this chapter, it is become clear that the hybrid plant of wind, solar, and battery received good acceptance for hybrids power and irrigation systems. As indicated in the reviewed works, the researchers have interested in enhancing the performance of hybrid system by utilizing availability of the wind, solar as a renewable energy. The researchers showed that the dependability catalogs and price are the foundation for attaining the optimal combination of hybrid system that consists of photovoltaic, wind and energy storage system. Rendering to the above stated conclusions from the reviewed papers, the present study was directed on the process of raising and watering plants by raising water from rivers or wells with a low level to a high or superficial level of the need for irrigation. Thus, the benefits of solar energy system and wind is through the exploitation of lands in all regions, especially remote ones (in the desert) where electric power is not available, also, availability of each of them at different times of the day and year.

2.6 Original Points of Present Work

The present work achieves the following original contributions:

1. **Experimental and mathematical investigation** is carried out by designing and manufacturing an integrated hybrid device of a wind turbine system with both horizontal and vertical axis configurations, in order to make maximum possible use of wind energy.
2. **Two additional types of pumps** are added to the hybrid system - a solar water pump and a deep well submersible pump. These pumps use hybrid solar panels in combination with the wind turbine as part of the overall hybrid system.

3. **Photovoltaic Thermal (PVT) panels** are innovative hybrid systems that simultaneously generate electricity and thermal energy from solar radiation. The research primarily examines the efficacy of copper tubes in cooling applications. Unlike previous studies centered on thermal collectors, this study emphasizes the superior thermal conductivity of copper tubes, which contributes to enhanced cooling efficiency and reduced energy consumption. The data supports the hypothesis that copper tubes outperform traditional materials in cooling systems.

In summary, the key innovations are the integration of parallel and perpendicular axis wind turbines, addition of solar water and deep well pumps to the hybrid system, and inclusion of a rotating parabolic dish solar thermal system coupled with the PV panels. These original aspects aim to maximize the utilization of solar energy and wind to enhance the efficiency and enactment of the hybrid renewable energy irrigation system.

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