Pakistan Journal of Engineering and Technology, PakJET
Multidisciplinary | Peer Reviewed | Open Access
Volume: SI, Number: 01, Pages: 01- 05, Year: 2020

Power Quality Enhancement & Optimization of Renewable Hybrid System

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Abstract- **Wind and photovoltaic hybrid renewable energy resources for power generation due to their low environmental impacts have an attraction for lots of groups and countries, which will take part to adjust energy layout and secure environments. But there are many other factors such as non-linear behaviour, various objectives and various extreme values, need to determine. It is challenging to deal with them through orthodox techniques. Dynamic Voltage Restorer (DVR) is a method and electronic device to restore voltage during any disturbance in voltage supply. This research offers an Artificial Neural Network (ANN) based non-linear controller for built-up restoration capacity of DVR. ANN is a productive tool for a highly non-linear system. This paper further presents the optimization technique Particle Swarm Optimization (PSO) for tracking Maximum Power Point (MPPT) of wind/photovoltaic based hybrid power systems. Through this optimization technique can trace the wind speed and level of irradiation of solar to track the maximum point of power output for generation, due to its tracking ability generation from the hybrid system can get at their maximum rate which is economical too. In this work, we will compare the prediction with the help of PSO and Artificial Neural Network so that to show the more robustness and comparison between these two algorithms by implementing these two techniques on hybrid energies, i.e. photovoltaic and wind power energies.**

Index Terms—**Artificial neural network (ANN), dynamic voltage restorer (DVR), photovoltaic, particle swarm optimization (PSO), Wind power.**

I. INTRODUCTION

With the growing global power sector in electrical engineering and industrialization, the need for power inside the international organizations is attaining deviant stages. As stated in the arena power council [1], in line with capita worldwide electricity need for will spike in upcoming ten years, and energy need for is predicted to double by using 2060; ultimately necessitating more massive investments in smart utility grids.

Renewable natural resources are considered to be clean and safe energy, many industries and countries are interested in Wind/Photovoltaic hybrid power system and go through many types of research on renewable energy resources based hybrid system [1-6]. Nowadays, many researchers have been taken out about the renewable-based hybrid systems for control of these resources generation and optimum their output as much as possible. The DVR can reduce voltage distortion. It injects the required voltage in the main voltage with the help of a transformer for quickly support the distribution system. This research defines a simulation-based study to describe the advantages of the DVR to alleviate voltage disturbances by employing ANN control strategy for different voltage problems. ANN is a mathematical and scientific model-based controller that is persuaded by the structure or functional characteristics of biological neural networks [7-12].

The DVR mechanism relies upon the control strategy used in it. Analog conventional control techniques have been considered as the finest control techniques for any Industrial purpose. So, the controllers like PI and PID are used for increasing their performances. But requirements of these Controllers are accurate mathematical model and are highly sensitive to any variation in the parameter. Nevertheless, the artificial intelligent methods describe the rapid reaction. In the past, the researchers are interested in biological behaviour human brain research and used this intelligent based behaviour in ANNs [13-18].

The unpredictable these resources, like wind and photovoltaic, are non-linear. It is tough to deal with them through previous optimization techniques. Nevertheless, there are many optimization techniques available, i.e. ant colony algorithms, genetic algorithms, immune algorithms, and PSO which are not required any accurate mathematical model and also have less analytic demands which make them easy to solve nonlinearity behaviour of renewable energy resources and get the best result from them. [2]. PSO is a unique optimization technique which is particle swarm-based intelligent optimization algorithm as compared with other smart optimization techniques. These Hybrid energy systems can operate in parallel with different grids and can work as a standalone. The purpose is to lower the load on power grids stations. So .the main aim of us is to get maximum output power whenever they are working as solo power grid their power output should be economical and meet their demand [19-22].

The primary goal of this study is to predict the optimized and accurate values for attaining good quality of energy. It

additionally must assist in putting into effect system with precise load stability. This research emphasizes on the prediction through the usage of the system-studying mechanism at the side of optimization techniques. For this purpose, we have proposed research use in a hybrid system based on wind/solar resources and a combination of PSO and ANN. It will show the best-optimized solutions by PSO and NN to offer better and accurate results to make a better quality of power which may not cause any dissipation.

We aim to give a comparison study between PSO and ANNs separately for making expectations for smart lattices energy utilization. In PSO the loads and bias values for training are improved utilizing the PSO algorithm. PSO is a very attracting technique for optimization problems; it has a variety of different forms to tackle these issues which have many applications w.r.t. Issues. In [20-21], an adjustable PSO algorithm is introduced based on the defined particles position and their personal best position and global best position and the distance between them. In [22-23], a different technique present by predefined values of velocities for learning factors. Some other modifications of PSO are present in [24-25]. For prediction requirements, other learning algorithms are used [26-32].

II. MATERIALS AND METHODS

Before implementation we will start to define the techniques we use with a brief introduction below:

A. Particle Swarm Optimization

Basic factors of the PSO algorithm are population which is called a swarm and number of particles of the swarm. A search space is introduced in PSO algorithm where these particles are moving according to a set of basic formulas [8]. These particles find the best position concerning each other by defining their personal best work and the global best position of the whole swarm. The point at which they found their best work they come to direct the development of the multitude. The procedure of finding the best position is continuous but yet not accurate.

Let f: Fn → F is a cost work for which we found its minimum value. The capacity takes a swarmed space as an argument in a vector form of real numbers and gives a whole number as yield, which indicates the target work value of the shared swarm space arrangement. The gradient off isn't known. The problem is to find a minimum value for which d (a) ≤ d (b) for all b in the search space, which is known as global minima.

Let N is the numbers of particles in the swarm, each particle having its own position of which is Yi in the search space and having a velocity Vi in Fn. Let particle Pb alone the best position of particle S and let Gb is the global best position of the whole swarm. A basic structure of PSO algorithm is [9];

Every particle i = 1... N *do*,
Now unif Yi ~ R
From the initial position, value initialize the particle's personal best position: Pb ← Yi

If (Pb) < f (Gb), →,

Update the personal best position to global best position: Gb ← Pb
Initialize the particle's velocity: ui ~ R
While a termination criterion is not met:
For every particle i = 1... N;
For every dimension d = 1... N; do
Pick any random numbers: rp, rg ~ S (0, 1)
Update the particle's velocity:
ui, l ← ω ui, l + φp rp (Pb, l-Yi, l) + φg rg (Gb,l-Yi, l)
Update the particle's position:
Yi ← Yi + ui
Iff (Yi) < f (Pb)
Then
Update the particle's personal best position: Pb ← Yi
Iff (Pb) < f (Gb) then
Update the swarm's best personal position to global best position: Gb ← Pb

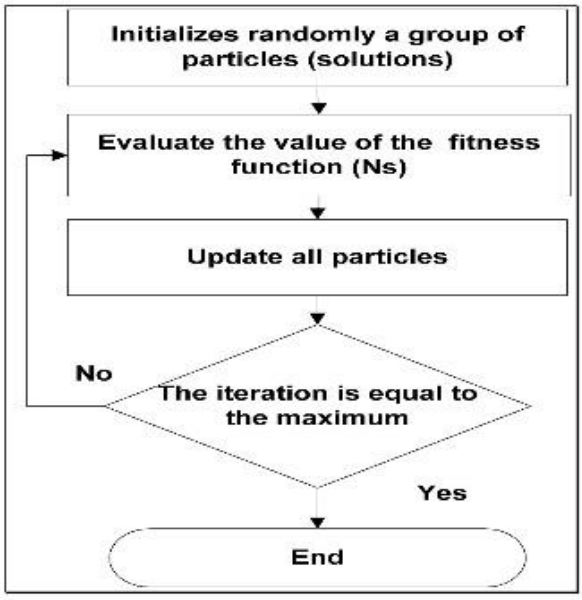

FIGURE 1: Basic Flowchart of PSO Algorithm

Power Quality improvement of Hybrid Renewable Energies using PSO with DVR. The DVR can provide an effective solution to restore the voltage of its previous value by adding the required voltage level. DVR can provide the best quality of power to check the load side to avoid power disrupt. In addition to this PSO will search out the best local and global optimal solution to make it better in quality. All results are recorded in MATLAB/Simulink

B. Artificial Neural Networks

Researcher McCulloch and Pitts introduced a computational model of artificial intelligence-based neural networks in 1943 [19]. Literature [20] proposed the research of artificial based neural networks. Improvement in the field of computer processing power enhances the artificial neural networks because the computation processing power was the main challenge in the progress of ANNs at the beginning [21].

In literature [21] the results closed to prediction are yield by biologically ANNs. There are basically two modes of operations in Artificial Neural networks training and testing. The ANNs learning procedure has three main layers input layer, hidden layers and a set of the output layer. In training mode, the neurons are linked to inputs, hidden layers and many outputs. For a definite pattern, the neuron determines whether to fire an output or not in training mode.

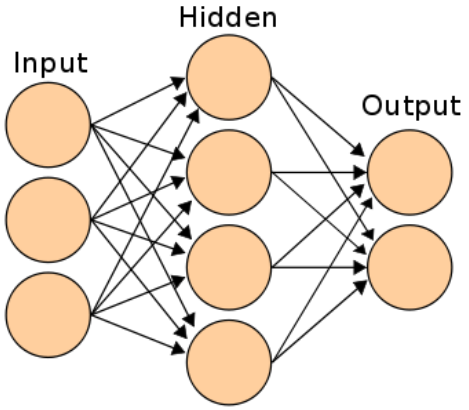

FIGURE 2: Basic Structure of ANN

For the improvement of power quality of hybrid renewable energies, ANN as a controller with DVR is preferred. DVR provides the productive solution to lessen voltage sag through maintaining the desired voltage quality level, necessary. To avoid any disturbance in power quality DVR give the best solution. In addition to this PSO technique will predict out the best value to locate the point at which maximum power will get to make it better in quality. All results are recorded in MATLAB/Simulink

III. RESULTS AND DISCUSSION

Due to intermittent and nonlinearity in nature of renewable energy resources of solar and wind power. There is a very high possibility of creating problems and could cause many technical issues in the renewable energy-based hybrid power system. Our results, as shown in Figs. 3-10, is to improve power quality by using ANN controller-based DVR and get maximum output power from renewable hybrid system through PSO. Firstly we will state the cases of Power Quality Problems.

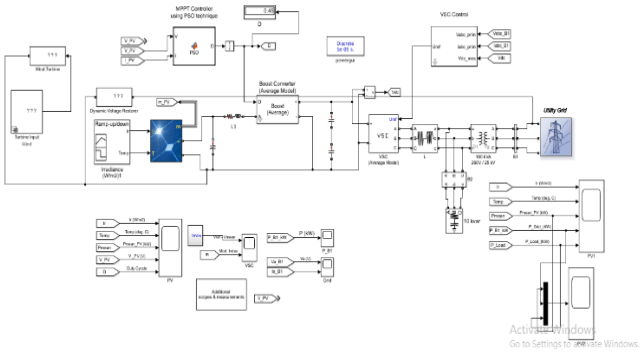

FIGURE 3: Complete Simulink Model

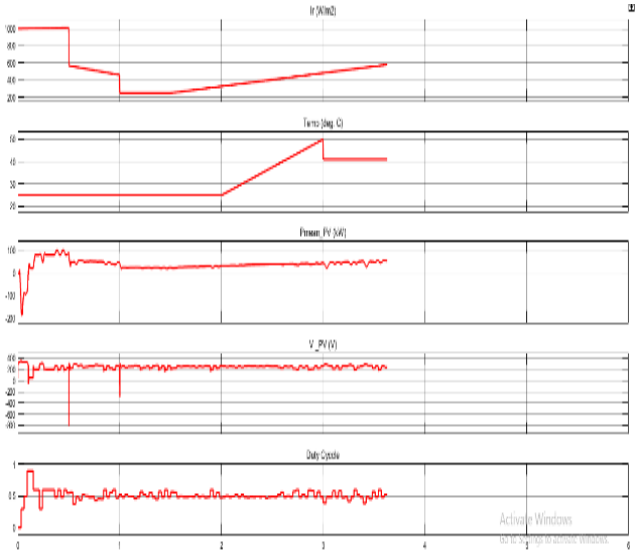

FIGURE 4: Wind Power DC Source Voltages waveform

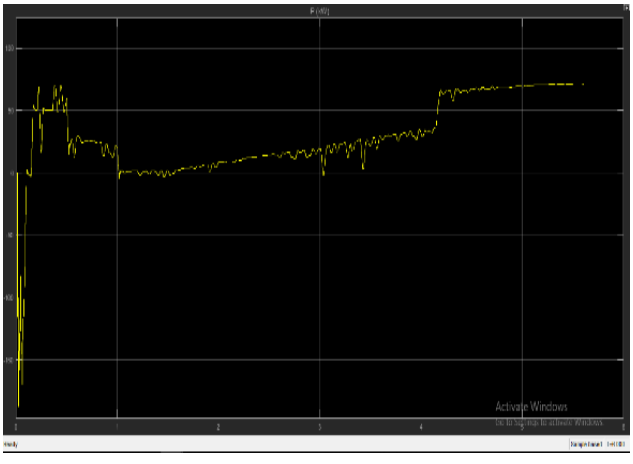

FIGURE 5: Short circuit, Control failure, (trying to remove electrical problem) which are maintained by DVR.

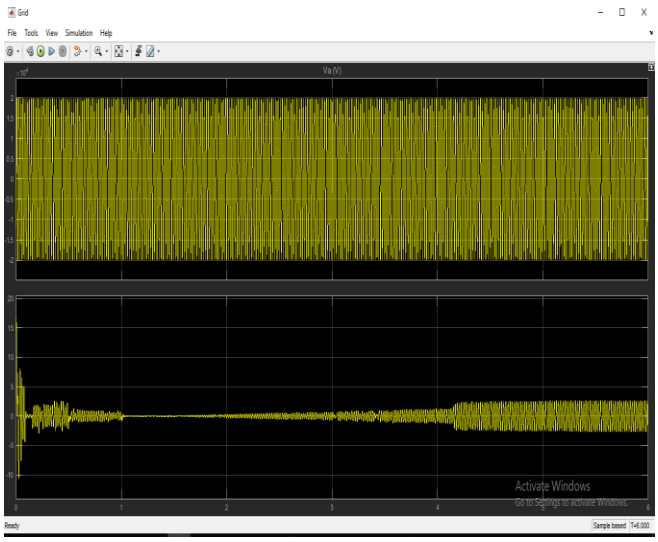

FIGURE 6: Due to Lightning effect, equipment turning on or off, causing making capacitor energization and re-energization. The waveform is dissipating the quality of power

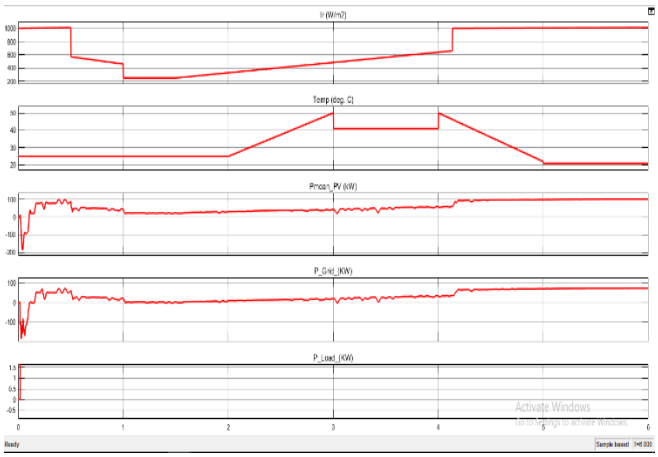

FIGURE 7: voltage source of solar panels waveform energizing a large capacitor bank, Switch off a big load, incorrect VAR compensation

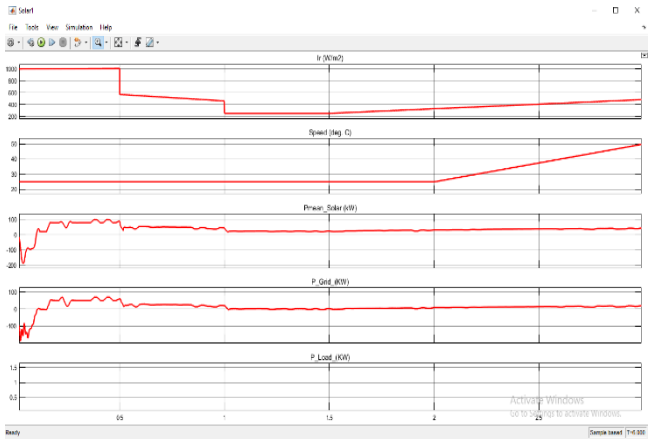

FIGURE 8: PSO optimized waveforms for Solar Panel voltage source waveform energizing a large capacitor bank, Switching off a large load, incorrect VAR compensation

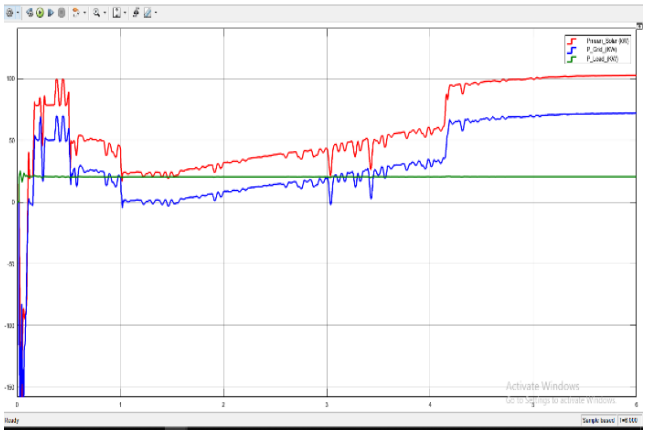

FIGURE 9: Voltage Sags occure because of starting a large Motor incorrect VAR compensation but stabilized and optimized by PSO

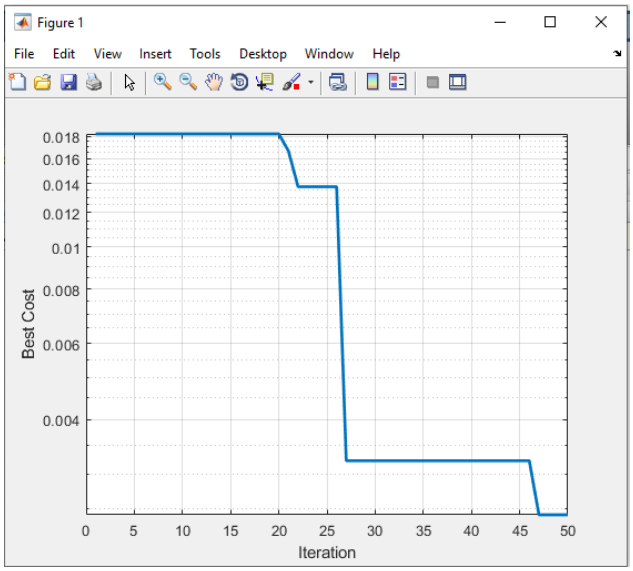

FIGURE 10: Artificial Neural Network (ANN) based controller for improving restoration capabilities of DVR.

IV. CONCLUSION

Wind/photovoltaic hybrid power system has non-linear behaviour in their nature so, making their accurate mathematical and analytic model is very difficult and to deal with them through classical methods. By applying different faults in the system, as shown in results, analyze the behaviour of DVR with artificial neural network control technique for improvement of quality of power. A non-linear ANN control scheme is implementing in input to the inverter to take their control decision. The proposed method of using ANN controller gives a greater response of power quality in comparison to other previous controllers, which takes decisions, based on the system parameters. PSO can track the optimum value of solar irradiation and wind speed to get the maximum amount from these resources. The use of these techniques makes the hybrid power systems steady, and by improving the power, quality protects power devices from any damages to makes power

systems run safely and economically. By using both PSO and ANN hybrid system get maximum and controlled output power which makes the hybrid system highly reliable.

V. ACKNOWLEDGMENT

First and foremost, I offer my sincerest and countless gratitude to The Almighty ALLAH, the one and only, the Most Beneficent and the Most Merciful, for making me what I am today and for giving me the ability and opportunity to learn and progress. I am indebted & grateful to my Holy Prophet whose blessings are all time with me; Indeed He is with me. I would also like to thank my parents, who are the reason behind my every success. My Mother has always been inspiring and encouraging me to progress.

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