Design of Photovoltaic- Wind Hybrid Source Grid - Connected System

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Abstract— ***This paper presents a hybrid solar photovoltaic (PV) and wind gird connected system. Under the varying conditions of sources and load, the proposed system is balanced by battery energy storage system (BESS). In the designed hybrid system to track the maximum power from the solar panels incremental conductance (INC) based maximum power point tracking (MPPT) technique is adapted and to track the maximum power from wind turbines, perturb and observation (P&O) based MPPT technique is adapted. The validation of designed model is verified by using MATLAB/Simulink.***

Index Terms— ***Hybrid systems, Photo-voltaic (PV), wind energy system, battery energy storage system (BESS), maximum power point tracking (MPPT).***

I. INTRODUCTION

The global warming issue is well known to developing countries across the world. The energy production fossil fuels burning in one of vital issue causing pollution leading global warming. Generation of clean energy from renewable energy (RE) sources like wind, hydro, biomass, solar etc… are the optimal solution for the cause [1]- [3]. Electric utilities and end users of electric power are becoming increasingly concerned about meeting the growing energy demand. The vitality sources, for example, sun oriented, wind, hydro and bio-fuel are the prime hopefuls of clean vitality. Next to this, the financial development has turned into a synonymous with vitality utilization progressively essential [4]-[7]. Battery energy storage system (BESS) is becoming popular in RE based systems for various advantages has been reported. Electric batteries are devices that store electric energy in electrochemical form and deliver electricity. Electrode plates, typically consisting of chemically reactive materials, are placed in an electrolyte which facilitates transfer of ions within the battery. The negative electrode, or anode, "gives up" electrons during discharge via the oxidation part of the oxidation-reduction electrochemical process. [8]- [15].

The primary design of the pv-wind hybrid system framework is made out of: a PV generator, a wind generator, a battery bank, a house load stack and an inverter between DC and AC bus. The entire framework is associated with the utility grid which is taken into consideration as a backup, as shown in Fig.1.

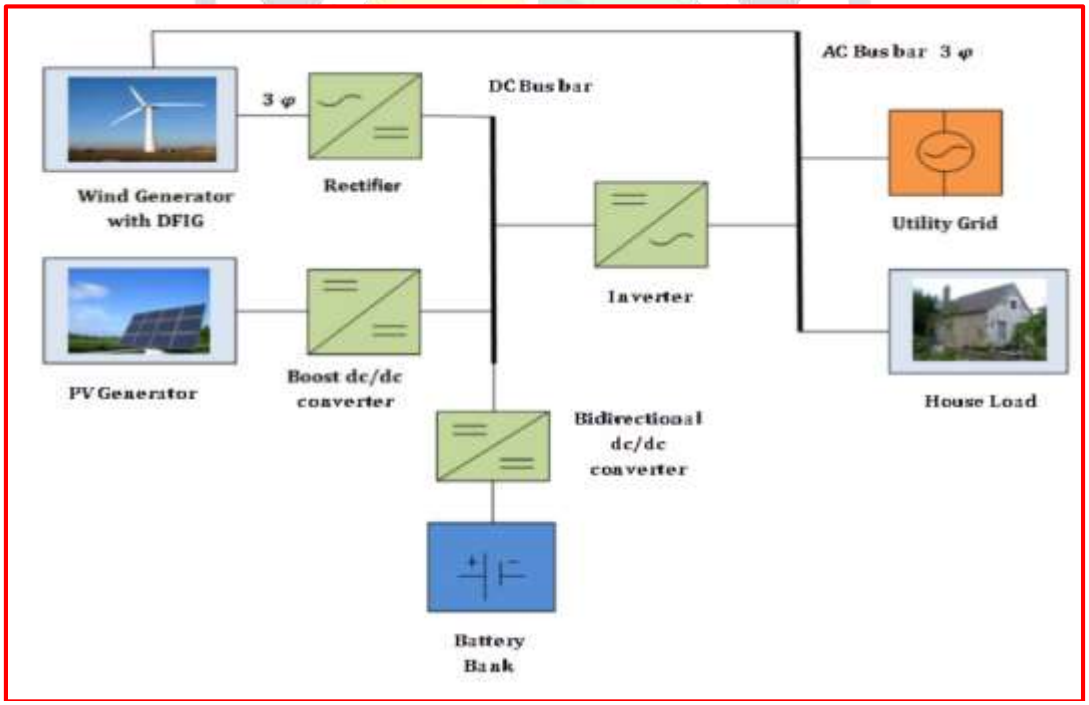

Fig.1. Hybrid Energy System Structure

This paper is organized as follows. Significance of RE based systems, hybrid grid connected systems is discussed in Section 1. PV and Wind system configurations are given in the Section 2. MATLAB/Simulink based designed models and output results are given in Section 3. Section 4 is given for the Conclusion.

II. Source System Configuration and MPPT Operation

This section converses the sources i.e., PV and Wind system design configuration along with MPPT operation.

2.1 Design Aspects of PV System with MPPT:

A photovoltaic (PV) system is a system which uses one or more solar panels to convert sunlight into electricity. Fig. 2 shows the single diode equivalent circuit model of a PV-cell [12]. In this paper, Incremental Conductance (INC) based MPPT algorithm is considered to track the maximum power from the PV panels. The operational diagram of INC algorithm is given by Fig. 3 [12].

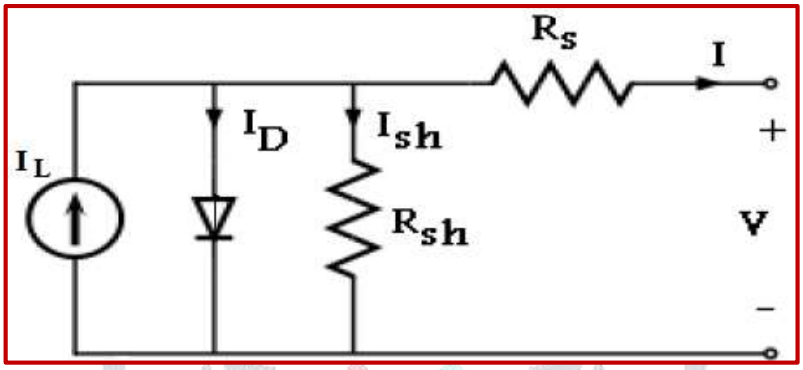

Fig.2. DC Equivalent Circuit of PV-Cell

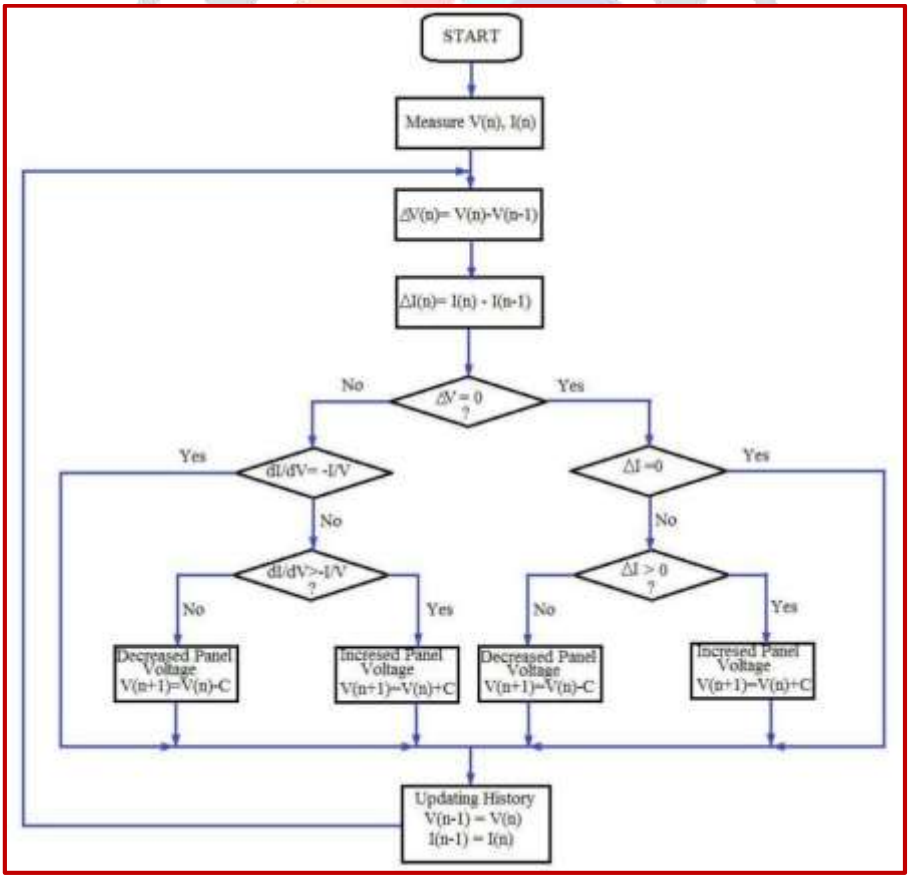

Fig.3. INC Method implementation

2.2 Design Aspects of Wind System with MPPT:

With a specific end goal to expand the efficiency, routines are to be undertaken to match the source and load appropriately. One such strategy is the Maximum Power Point Tracking (MPPT). This procedure is utilized to acquire the most extreme conceivable force from a fluctuating source. This is completed by making use of a converter whose duty cycle is differed by using a MPPT algorithm. P&O method is used in this MPPT algorithm. The P&O algorithm is as such written below programing chart.1

Programming Chart.1. P&O Algorithm

```
function D   = PO (V, I, T)

persistent Pn Po dP d dd n;

if is empty(V)
    V=20;
end
if is empty(I)
    I=5;
end
if is empty(Po)
    Po=0;
end
if is empty(Pn)
    Pn=0;
end
if is empty(dP)
    dP=0;
end
if is empty(d)
    d=1;
end
if is empty(dd)
    dd=0;
end
if is empty(n)
    n=1;
end

if (T>n*0.02)
    n=n+1;
    Po=Pn;
    Pn=V*I;
    dP=Pn-Po;

    if (dd==0)                % to avoid dP/dd=inf
        if dP>1
            dd=0.01;
            d=d+dd;
        else
            if (dP<-1)
                dd=-0.01;
                d=d+dd;
            else
                dd=0;
            end
        end
    else
        if ((dP<1)&&(dP>-1)) % leave little margin
            dd=0;
            d=d+dd;
        else
            if ((dP/dd)>0) % positive slop
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```
                dd=0.01;
                d=d+dd;
            else            % negative and zero slop
                dd=-0.01;
                d=d+dd;
            end
        end
    end
end

D=d/(d+1); % calculate duty

% code to avoid duty less than 0.1 and more than 0.9
if (D<0.1)
    D=0.1;
    d=D/(1-D);
else
    if (D>0.9)
        D=0.9;
        d=D/(1-D);
    else
    end
end
end
```

III. Conclusion MATLAB/Simulink based Model of Proposed Grid- Connected System and Results

This sections converses the MATLAB/Simulink based designed models of PV-Wind hybrid grid connected system and results of each block.

Fig.4 represents the MATLAB/Simulation based designed model of solar PV. Fig.5 represents the solar output voltage. Fig.6 represents the MATLAB/Simulation based designed model of wind system. The output current and voltage from the wind module is given by the Fig.7 & Fig.8 respectively.

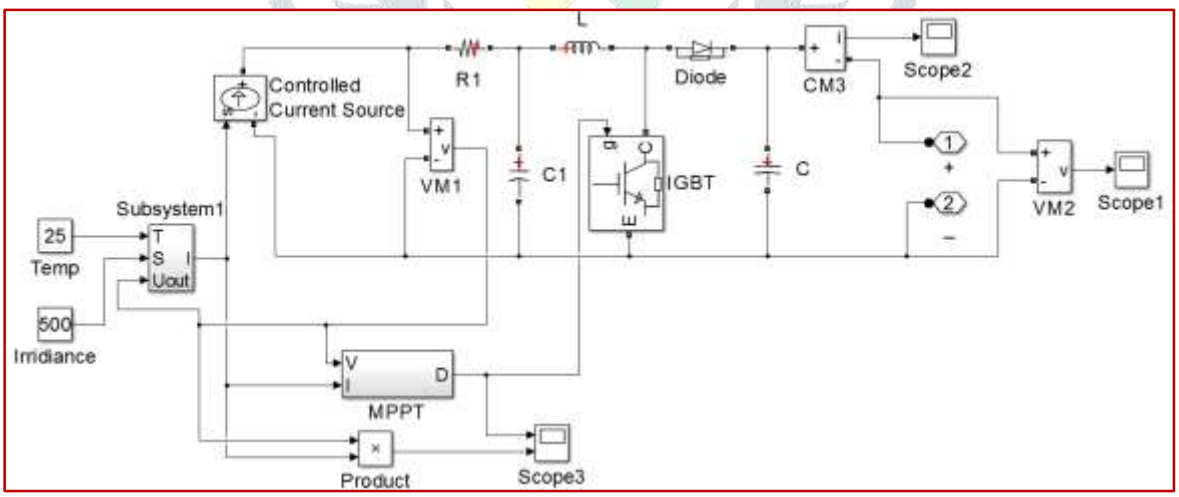

Fig.4. MATLAB/Simulation based designed model of PV System

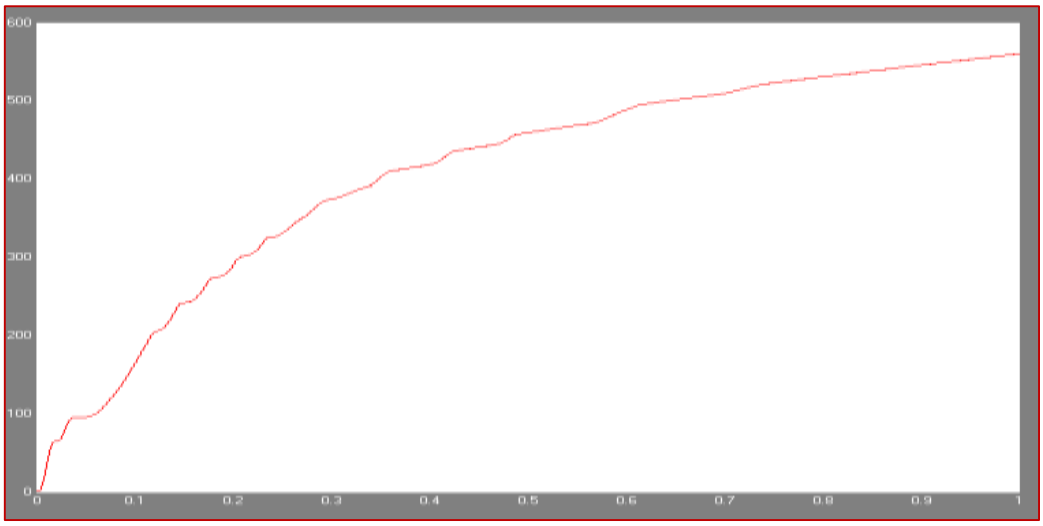

Fig.5. MATLAB/Simulation based output voltage of PV System

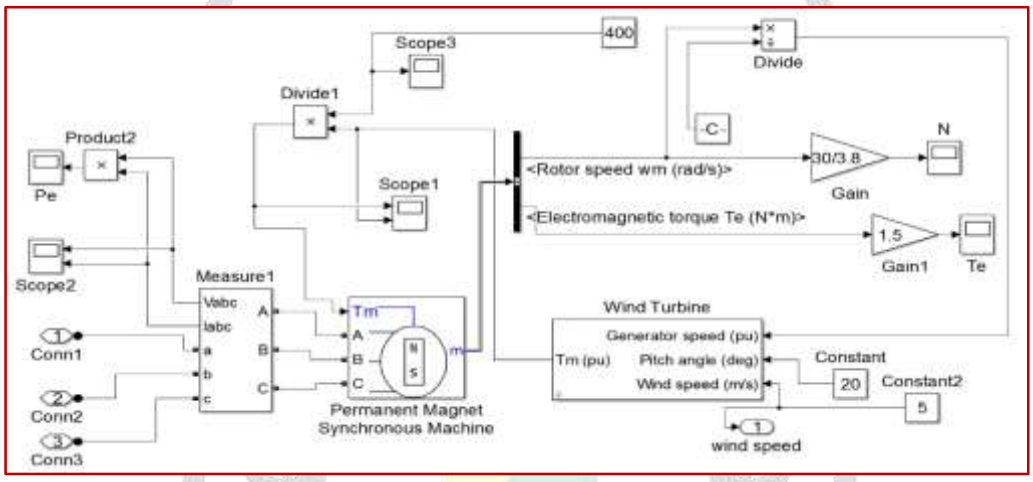

Fig.6. MATLAB/Simulation based designed model of wind system

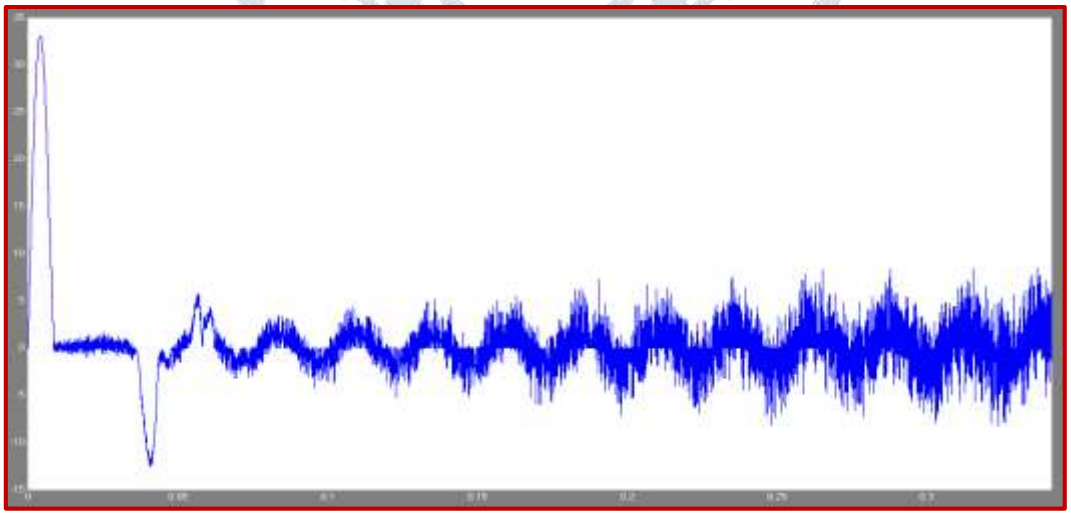

Fig.7. Output current from the wind system

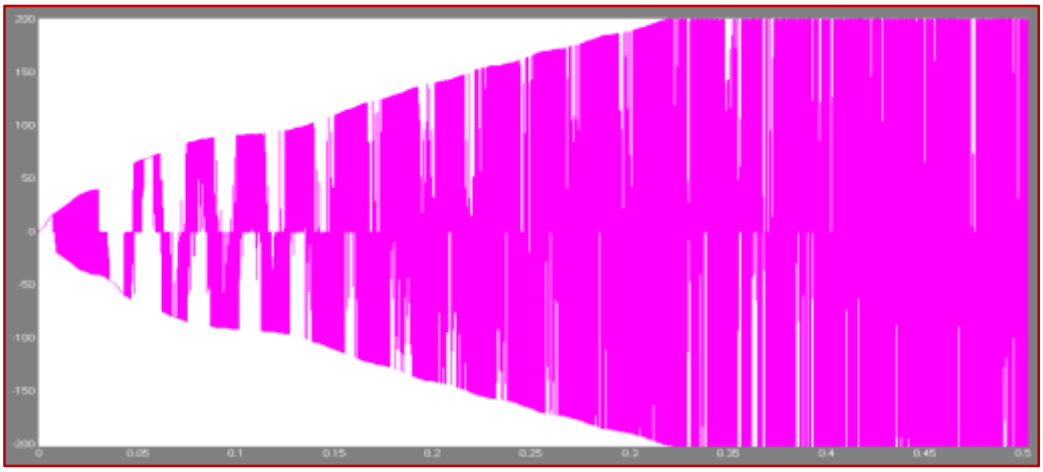

Fig.8. Output voltage from the wind system

Grid Connected Inverter (GCI) is commonly used in applications such as photovoltaic inverters to generate a regulated AC current to feed into the grid [15]. The control design of this type of inverter may be challenging as several algorithms are required to run the inverter. A typical inverter comprises of a full bridge that is constructed with four switches that are modulated using PWM, and an output filter that filters out the high frequency switching of the bridge, as shown in Fig.9. and its MATLAB/ simulation based designed model is shown in Fig.10.

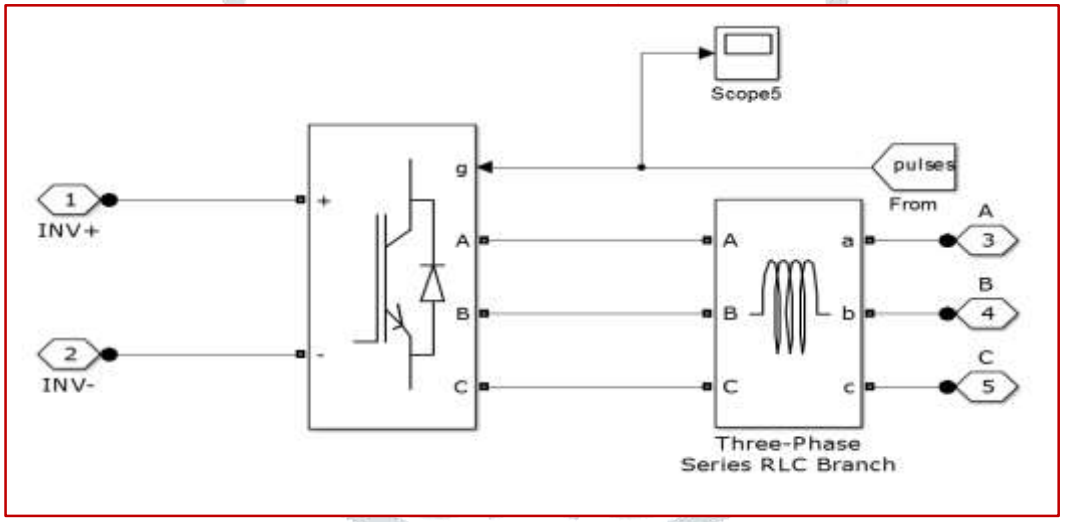

Fig.9. Grid connected inverter model

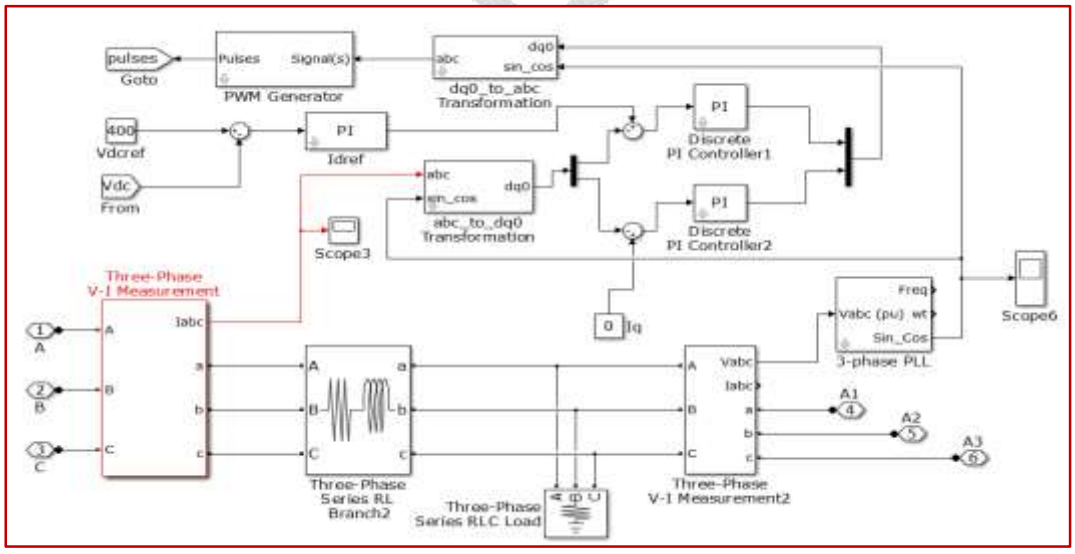

Fig.10. MATLAB/ Simulation based designed model of grid connected Inverter

Complete MATLAB/Simulation diagram of PV-Wind hybrid grid connected system with masked blocks is shown in Fig.11 and Fig.12 shows the voltage and current values of the designed PV-Wind hybrid grid system.

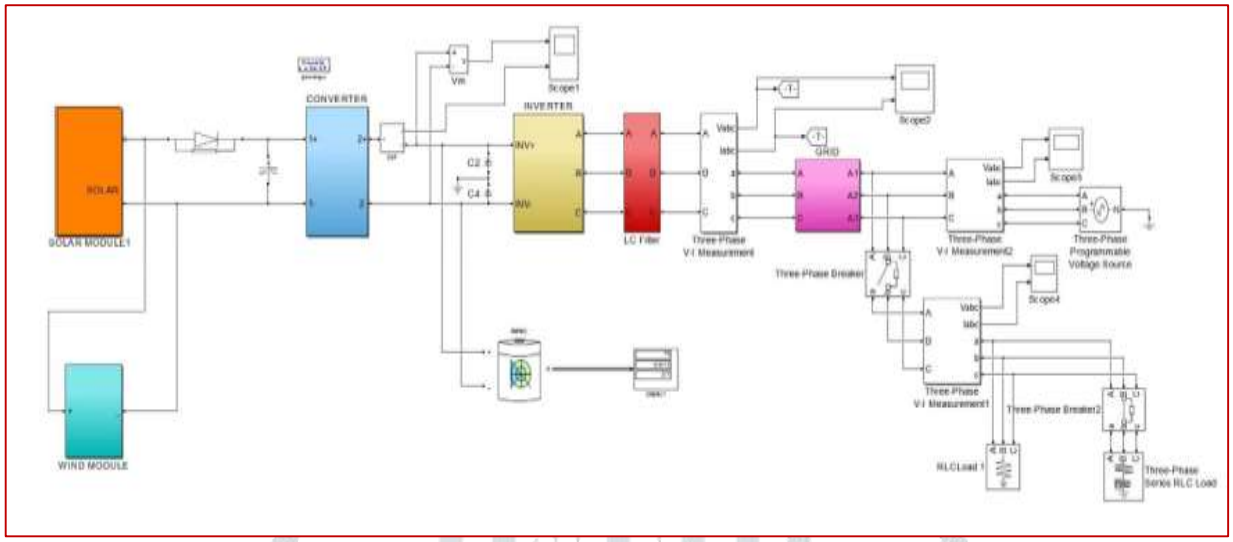

Fig.11. Simulation diagram of proposed hybrid grid connected system with masked blocks

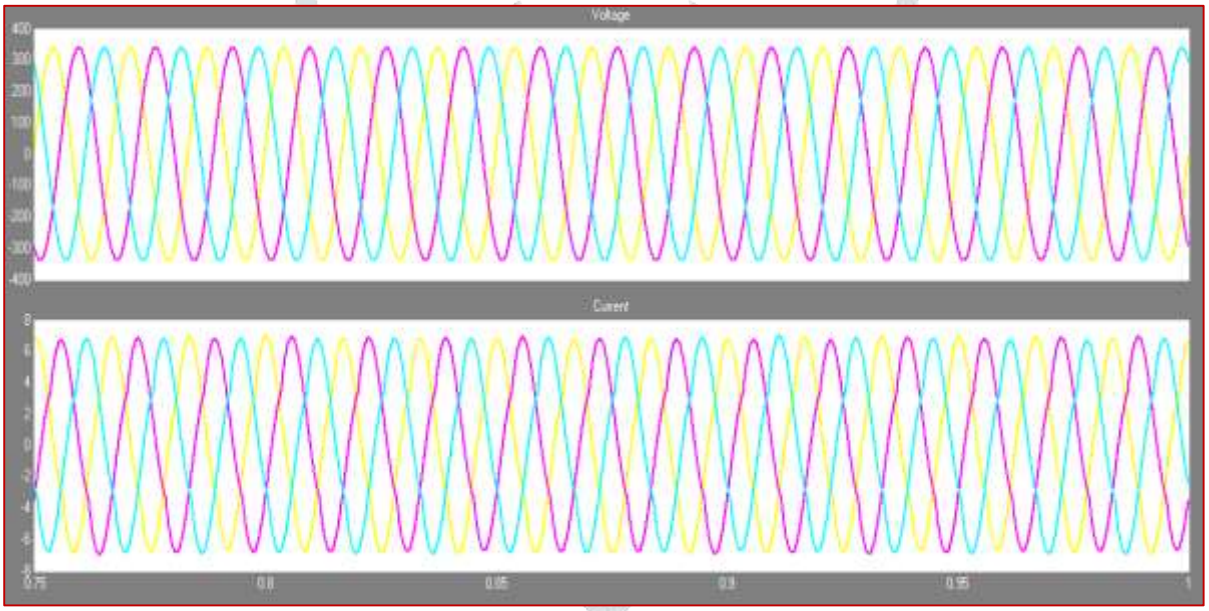

Fig.12. Voltage and current values of the designed PV-Wind hybrid grid system

IV. CONCLUSION

In this paper, PV-Wind hybrid source based grid connected system has developed using MATLAB/Simulink. Simulation results at each individual stage of the system has demonstrated. The simulation results show that the system is stable under various load and supply conditions.

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