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Simulation and Modeling of PV and Wind Hybrid Power System.

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Abstract:
In the contemporary framework where the depletion of fossil fuel resources and environmental pollution with dramatic climate changes leading to the depletion of constrain alternate energy resources. Renewable energy sources have been arising as a popular alternative resource, the construction of these renewable energy as solar and wind energy has developed as a reliable source of renewable energy supplies. The paper mainly objects to the hybridized model that generates wind power hybrid with the solar. For the hybridized model the primary component is the power generating system which includes the MPPT technique to obtain the maximum and constant output. Further the solar power generating system have been combined with the wind power generating system and then attached to the grid. And the whole hybridized system has being developed in MATLAB/Simulink and the output characteristics of the hybridized structure is presented.

Keywords: Solar energy, wind energy, MPPT Technique, Hybridized System, Nominal voltage, Utility grid.

1.INTRODUCTION

In the present days scenario where the oil prices rising and global warming with a drastic climatic change's technologies like the solar energy, wind energy, hydro thermal energy and geothermal energy has come as a safe way to power over future. In this field of renewable energy technologies, the wind and solar energies holds a successful key towards the green powered future. A new trend of hybridization of renewable technologies has been emerged and this hybridization technology basically provides the solar and wind a good platform to work. The new trend of hybridization is becoming more popular because they are complementing each other, by dispensing higher quality and definite power supply [1]. With the interests of electrification particularly in the rural areas a review of power standalone system; solar and hybrid ,solar –wind , solar-hydro etc [1]. Solar energy being the suitable and environment friendly and more efficient [3]. Standalone solar power system is being the best choice for continuous feeding of power supply in rural areas. In this system MPPT method is habitually used in photovoltaic (PV) systems mainly to accelerate the power [4]. The main purpose of using MPPT in hybrid system which mainly helps to attain a stable and reliable power generation basically for the load land utility grid, thus improves the steady and dynamic behavior of the whole system [5]. Also in the other hand wind energy is the fastest growing renewable energy, Having such great behavior like easily available for true non-polluting and

more convenient it become a good source of the hybridization technology [6]. The main motive of this combined system to provide a great substitutes of electric power generation. [7]. In this paper both the energy sources are modeled using MATLAB software tool to analyze the output power and its behaviour.12K wind system is being used in the model with solar PV array represent the main block for solar power system is given with 10000 irradiation with temperature 25 degree Celsius and it is mainly varying in nature because of the climate changes the irradiance and temperature varies from morning to the evening time. The whole system in hybrid condition is being connected to utility grid and the power output from the system is 91.29 watt further all the functions and simulation results has been shown in the paper.

2. DETAILED DESCRIPTION OF THE RENEWABLE SOURCES

Demand of electricity is increasing day by day and it wouldn't be met by non - renewable resources of energy. In an effort to meet the rising energy demand while lowering greenhouse gas emission renewable resources are being used as an alternative to fossil fuels. Solar and wind energy are popularly known as one of the best renewable energy resources and many governments throughout the world are investing in them, causing their launched capacity to increase. Through both the sources are fluctuating and partly complex in nature. But increase use of solar and wind power in existing power system may used to many technological challenges due to their intermittent and unpredictable characteristics and a result it leads to many unwanted issues in the system. Solar and wind power system as a hybrid system provides one of the best combinations. By the merging of the two renewable natural resources into top-notch mingling, the effort of fluctuating nature of the solar and wind energy resources can be partly set on, and the whole system becomes more reliable and economical. This paper mainly provides an overview of the HYBRID SOLAR AND WIND SYSTEM power generated and further used for grid.

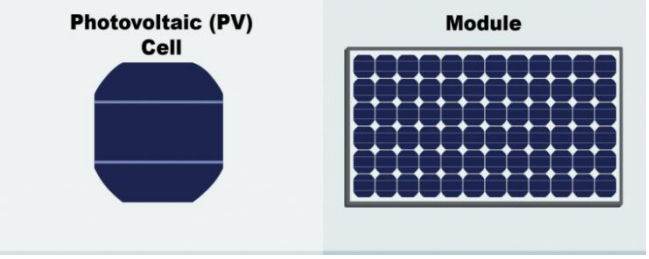
2.1. WIND SYSTEM

Wind power generating system mainly consists the wind turbine that transforms the kinetic energy of the air into mechanical force i.e. rotary motion. The consumed by the rotor blades of a wind turbine is according to blade shape pitch angle and speed of the air. The generator is connected to the using shaft which transforms mechanical energy into electrical energy. Depending on the type there are two types - the VERTICLE AXIS WIND TURBINE[7]and HORIZONTAL AXIS WIND TURBINE[7]. The power yielded by the wind turbine depending up on the speed of wind.

Figure.1: Vertical Axis Wind Turbine

Figure.2: Horizontal Axial Wind Turbine

2.2. SOLAR PV SYSTEM



The solar power system which mainly consists of PV modules or PV ARRAY which mainly converts the solar energy are mainly in the structure of solar irradiation and this irradiation are being absorbed by the PV array or PV modules. This solar PV modules are mainly consisting of solar cells. A typical solar module consisting of an assembly of 60 solar cells converter is being used to rival the voltage level commonly the dc-dc converter acclimated to match the voltage level with the electrical gadgets given to the system. The dc-dc converter can be a BUCK CONVETER or a BOOST CONVERTER depending upon the system requirements. The basic theory related to the operation of an single PV cell is the photoelectric outcome whereby when a photons hit a photovoltaic cell, after collecting energy from the sunlight, the semiconductor electrons are excited and jump to the conduction band from the value band and becomes free to move. The motion of electron fabricate the positive and negative terminal and leading to a potential difference between the terminals. This solar PV system are generally designed for small area production as its energy production vary depending upon the weather changes. But it can also be used for large area distribution system by increasing quantity and size. Application of suitable methods such as maximum power point techniques are also used to get constant supply. As in solar and wind hybrid system from both the sources constant contribution of energy is being required for that MPPT method is being considered as one of the best and this paper also uses the MPPT method.

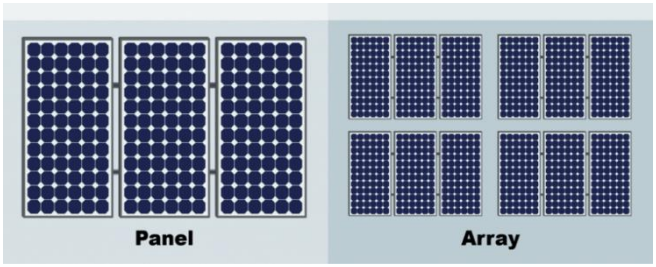


Figure.3: PV cell, module, panel and array

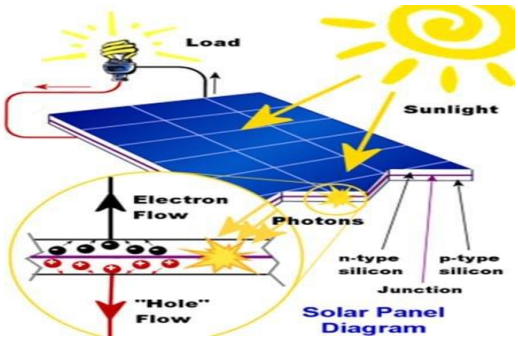


Figure.4: Photovoltaic Effect

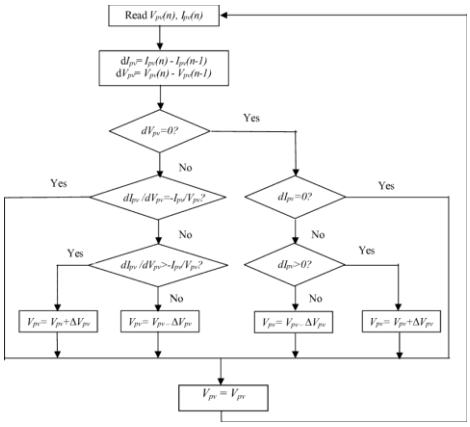


Figure.5: Diagram of incremental conductance MPPT algorithm

3.MPPT METHOD

MPPT the full form stands for maximum power point tracking method with varying power sources. MAXIMUM POWER POINT TRACKING (MPPT) also known as power point tracking is a process that enhances energy outcome, under changing conditions. This procedure can be carried out to thermos photovoltaic, optical power transmission, wind turbine, and photovoltaic (PV) solar system. The efficiency of wind generator and solar panel improves by maximum power point tracking if configured to operate at maximum capacity. There are several approach of MPPT. The most common techniques are incremental conductivity method, perturbation and observation, Fuzzy Logic, Neural Network. For first photovoltaic system reference voltage and initial rotor reference, the wind turbine are coordinate when the two system are working. If the two-system output power does not match to their maximum power then we need to adjust the direction of the initial references value in order boost the manner of the output power. Until wind and solar power systems makes it happen to reach the point of the maximum power. The same process goes not repeat. In this paper, incremental conductance algorithm of MPPT has been used. The incremental conductor defects when the MPPT reaches the MPP and steps interfering. operating point. If this condition is no satisfied, the direction that must perturb the MPPT operating point may change. Calculation has been done from the relationship between dl/dV and –I/V. This relationship is derived from the fact ;dP/dV. It is negative if the MPPT is placed right to the MPP and positive if it is placed left to the MPPT. This algorithm has the advantage over the P and O is that we can determine when the MPPT reaches the MPP and at that point the P and Q fluctuates around it. MPPs. Additionally, increasing conductivity can track the increasing and decreasing isolation conditions at maximum values.

4. SIMULATION AND RESULTS

The complete system designed i.e. hybrid energy system is being buildup and designed using simulink. Here the 12KW wind power system is being considered throughout the whole paper hybrid system along with its parameters is being studied.

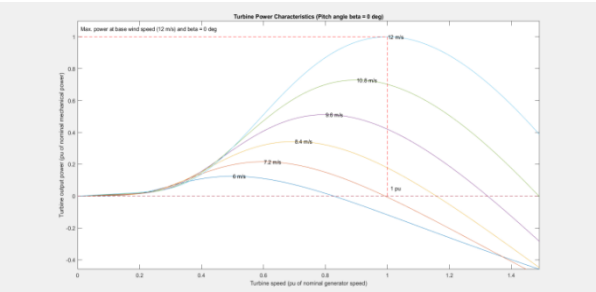
4.1. SIMULATED COMPONENTS PARAMETERS AND THE CONNECTIONS

(a) 50Hz wind turbine block has been used in the wind power system

b) Nominal power of the turbine has been selected as 12 Kw with base wind speed at 12 m/s.

(c) The momentum(speed) of the wind is 8>12 m/s .Varries which is further plotted in the simulation block.

(d) The three-phase voltage supply which is supplying 25KV at the grid at 50Hz frequency.
(e) The three phase two winding transformer with Y-Y arran argument. It has grading of 50 KVA with main side at 25KV and secondary side at 400V.
(f) Further the capacitor bank introducing 4K Var to the induction generator of Wind Turbine.
(g) From the figure we can see the wind power characteristics.



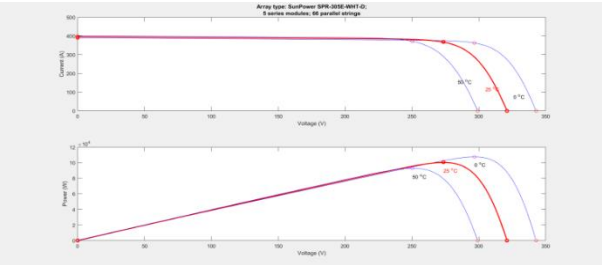


Figure 6: Wind turbine power characteristics

Figure 7: PV Block parameters

h) In the solar power system it consisting of 66 parallel strings and 5 series strings in the PV array model from which we can have a theoretical idea about the power output that we are getting from the PV system.

Calculations

We have taken parallel string 66 and series string 5. As we all know voltage add on in series and current add on in parallel. The voltage at utmost power point of selected panel is 54.7 and current at that point is 5.58 A.

V_m=54.7

I_m=5.58 A

Total voltages of PV array

=54.7 *5

=273.5 v

Total current of PV array

=5.58 A *5

=368.28 A

i) We can see the power and current outputs of the PV array from the PV array characteristics graph from the

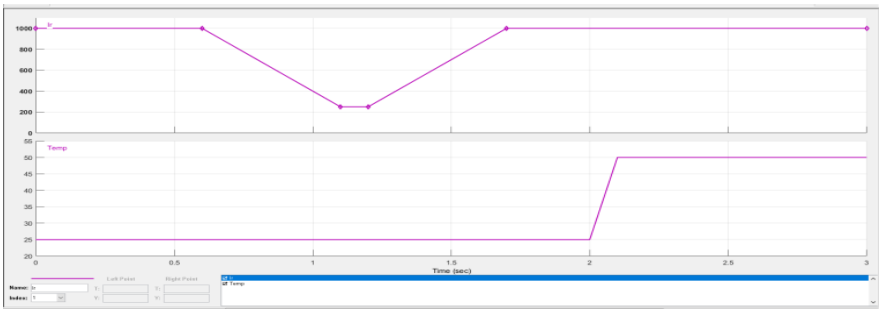


Figure 8: Temperature and irradiance ramp block parameters

(j) As from irradiance the ramp-up/down block has been used which is being connected with PV array block in the simulink module. From the Ramp-up /down block we can see the temperature end irradiance graphs which mainly varies throughout the day as accordingly the temperature and the irradiance changes it will work accordingly.

(k) And the main purpose of this Ramp block is that at the grid connection remains throughout the time changes further help for the wind turbine to work in a synchronized way in the hybrid model.
(l) As a minimum voltage is required for running the system and also we are getting DC from the PV array due to which in order to has a boost up voltage, here boost converter is seing used i,e 5HZ-500V Boost converter.
(m) With the help of block IGBT block and inductor which consist of a small amount of resistance along. with diode the boost converter block is made. In the IGBT it also contains a gate port/ gate pulse. This gate pulse is mainly being connected to the MPPT controller.
(n) Boost converter which is used to maintain DC voltages at 500V to track minimum power point. Also there is inverter which gets DC input connected in AC so, that it could be fed into grid. A three-level universal bridge is been used as an inverter.
(o) The VSC control gives pulses to the inverter. After inverter there is filter or capacitor bank which is making the output sinusoids smooth.
(p) In this hybrid module the wind turbine is being integrated to the system through the subsystem named as VSC block is connected into the hybrid system. Once the solar PV array output has been converted into system AC after boosting up. The whole has been shown in the figure
(q) The MPPT is being connect in the PV array block through the m port and m-PV block.

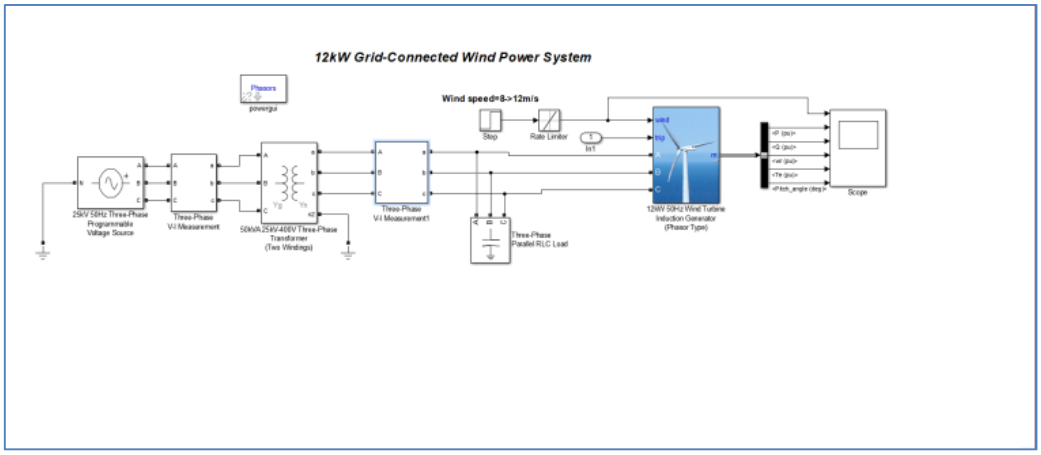


Figure 9 : 12kw Grid- connected wind power system

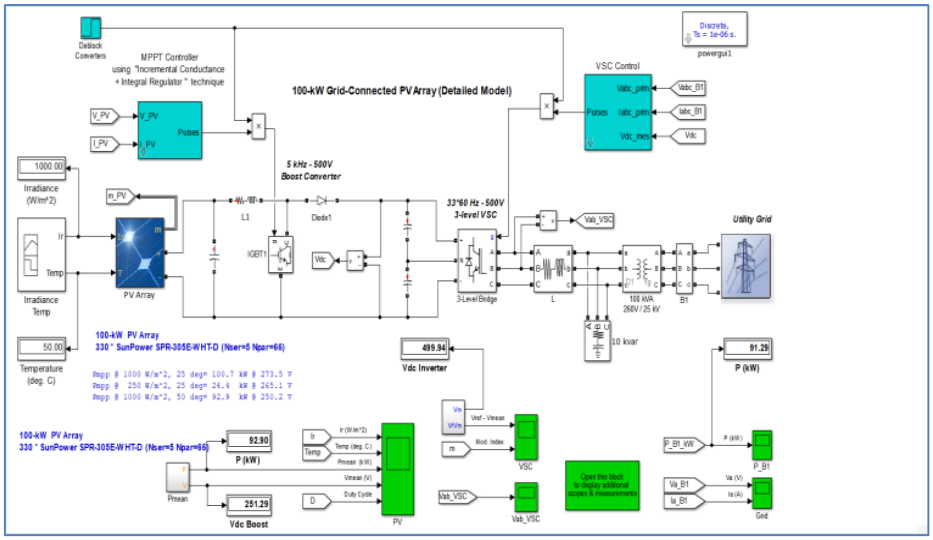


Figure 10: Hybrid Model Of Solar PV and Wind Turbine Connected With The Grid

4.2. OUTPUT GRAPHS

(a) From the wind turbine graphs revealing **wind momentum(speed)** increasing from 8m/s to 12 m/s.
(b) 2nd graph is of **P,** which is providing the information that when wind proceeds towards to 12m/s, it gives the output power of 1 pu or 12 kW.
(c) 3rd graph is providing value of **reactive power** when wind speed changing.
(d) In 4th graph, the rate of rotor is more than 1 pu since it is connected to induction generator and having speed more than 1 pu.
(e) Correspondingly, the 5th graph is providing information about the torque.
(f) In the 6th the pitch angle remaining the same.
(g) In the hybrid system model as mentioned in the calculation the maximum power of the PV array is 100.72 kv and the temperature varies from 0 to 50.
(h) The irradiance value is changes from 1000 to 250 and also the temperature value rises from 25 to 50-degree calculus.
(i) From the V_dc boost converter the dc voltage remains 500 after some time of settlement.
(j)Vab_VSC the block shows voltages after inverter.
(k) In the PV block the first output graph is of irradiance changing as expected from 1000->250->1000.
(l) Second graph is of temperature and its changing from 25->50.
(m) The third graph is of Pmean in which till t=0.05s, there is no controller in working due to Deblocking. But after that the power goes up towards 12kW. Then it went down and as duty cycle changes the power again rises up towards 12kW. When irradiance value goes down to 250W/m^2, the Pmean also drops and when Ir rises to 1000W/m2, Pmean again rises.
(n) Fourth graph is of Vmean which changes according to the change in duty cycle graph (fifth graph).
(o) After running the whole hybrid system, the output graph been displayed through the P(kw) block.
(p) From the power output graph, it shows the power is fluctuating in the initial and then we have a steady power output graph.

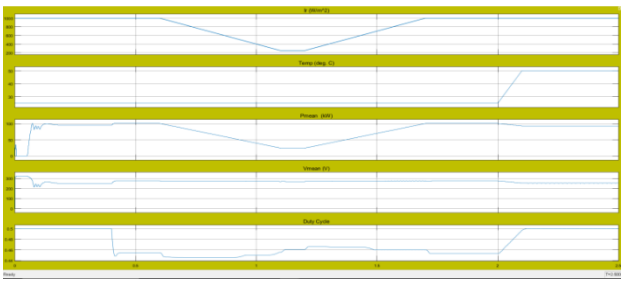


Figure 11: PV Mean

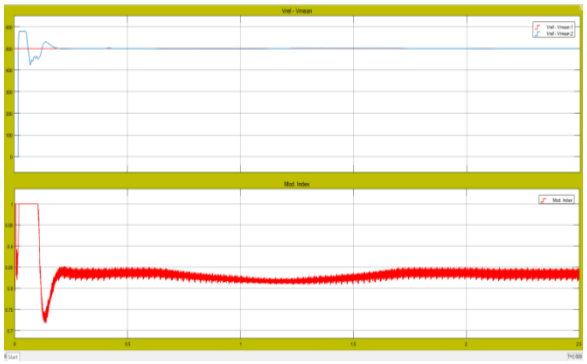


Figure 12: voltage and current output from the passing through the filter.

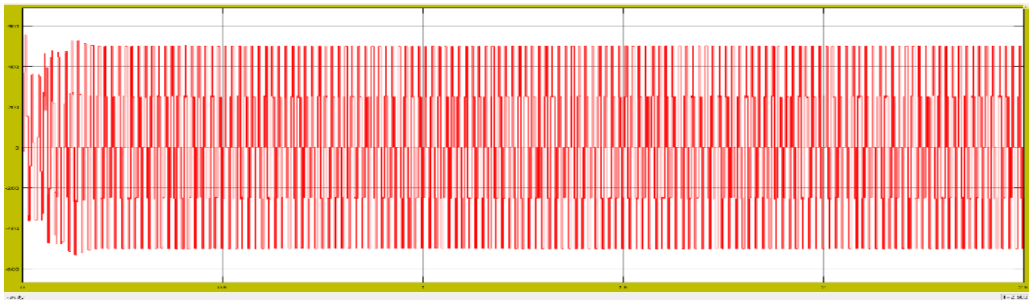


Figure 13 : voltage curve output after inverter

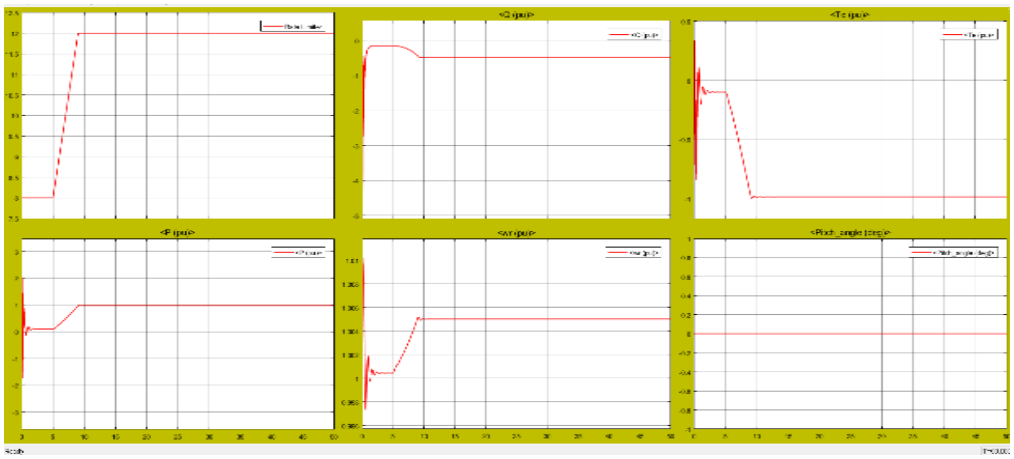


Figure 14: P, Q, wr, Te, Pitch Angle, Wind Turbine

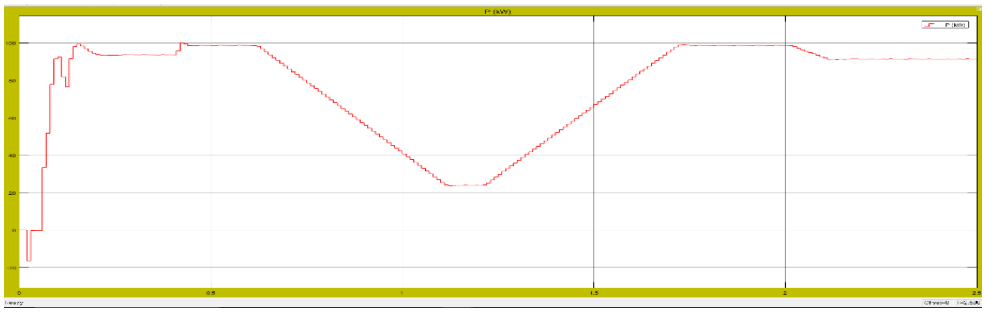


Figure 15: Power Output of the Hybrid Model

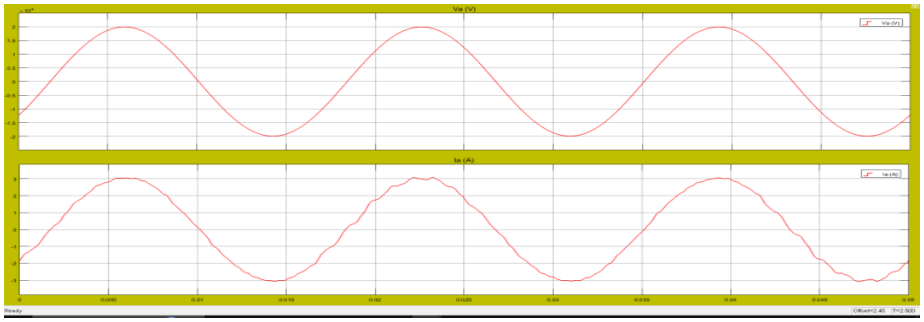


Figure 16: Current and voltage graph of the hybrid system

5.CONCLUSION

Output from the hybridized system of solar and wind is more versatile. This model is more effective also it can further be modulated as a hardware project. Under all running conditions to fulfill the requirement at the grid load, the hybridized system is managed to give maximum power output. The wind turbine system used is of 12KW and the solar PV array model/system is consisting of 100KW as power output. In this paper with the operation of MPPT the output from the hybrid system is 91.29 KW which is more compatible and steadier for the utility grid rather than single renewable systems. And gives a perfect layout of the compatibility of the hybridized system. The entire system is being simulated by using MATLAB/SIMULINK.

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