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Research Article

Modelling and Simulation of Hybrid Power System for Mains Subsidization

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A B S T R A C T

This paper deals with the hybrid power systems with renewable energy sources (HSRES).

This paper proposes operation and control strategy for a hybrid power system for a Subsidization of the main power. The proposed wind solar hybrid system consists of a wind turbine, a solar power unit, main power supply and a set of loads. The proposed hybrid system model is implemented with MATLAB with its library function and its block and tested for various wind and load conditions. Results are presented and discussed. The necessary analysis has been done also. In conclusion, it has been made a summary of the future trends for research and development.

Keywords: Renewable Energy, Hybrid Power Systems

Introduction

Form the past many attempt have been made in recent years to address issues surrounding the use of fossil fuels for energy. However, it must be conceded that world's dependence on fossil fuels cannot cease overnight. Truth is that we are very slow migrating towards the technology form many decades. Over this time period world need bridging technology to aid the transition to alternate source of energy. From the various technologies, one technology promise in boosting the energy efficiency while it is reducing emission and cost. This technology is the hybrid power system. This paper gives the seeking alternating energy source and discuss our future needs to move away from the conventional energy sources and the role of hybrid power system will definitely play an important role in future electricity needs. Hybrid power system is more popular as alternative source of energy in remote and island area where grid connection in not economically or technically viable. Harnessing ample supply of wind and solar energy can play an very important role in ensuring an environmental friendly and clean energy generation for remote and isolated areas. When we see from power generation point of view, due the intermittent nature of the renewable energy sources many time they not even match the load demands. In that case more systems is required and these systems or Hybrid system with renewable energy sources can give the better efficiency. Better reliability and very good security and they are reducing the operational cost also. To satisfying the load requirements or demands under constraints this is the main challenge of hybrid power system application.

Hybrid System

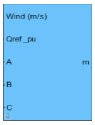
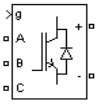
In the 21 Century the end of cheap and ample of source of energy, we know and believe that is the major challenges humankind will face. By 2030 the world energy consumption is estimated is double from the present time. In present major energy is obtained from the fossil fuel only and these fossil fuels are utilize in electricity or power generation, industries and transport sector. As estimated that the production of world oil is at peak between the present time and 2040. This impending reduction in oil production will most likely see the cost of energy increase to unprecedented levels. Greenhouse gas emissions from the use of fossil fuels since the industrial revolution have been linked to temperature

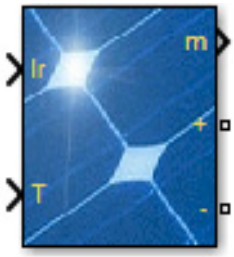
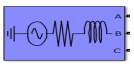
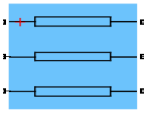
rise and global climate change, furthermore, it is widely believed that if greenhouse gas emissions such as CO2 are not reduced, the world's climate will be irrecoverably damaged leading to disastrous consequences for life on earth. Many efforts have been made in recent years to address these issues on both international and national fronts across many countries worldwide. When we discuss about the transport sector, the well establish technology which we use is combustion engine and these are consume the fossil fuel to run. It's time for reduction in worldwide fuel utilization and gas emission, so a new alternative is also needed for this technology also. In electricity of power generation there we have technology that gives a promising sign of moving away from the fossil fuel build power generation technologies. These technologies are predominantly in the form of de-carbonization of electricity grids by using renewable energy sources and various campaigns to lower energy consumption by means of more efficient electrical appliances and processing technologies. Countries such as the United States, France and Japan have chosen to invest in nuclear power; others such as China, Canada and Brazil have made use of their geographical locations and natural features by using hydro power. Another noteworthy trend is the harnessing of wind energy, particularly in the USA; Germany and Spain. Many advances have been made in current alternate energy production technologies; however there are many limitations and technological challenges to be overcome before they can compete with fossil fuel based energy production. Furthermore, it is worth noting that currently all these alternate sources of energy amount to less than 15% of global energy requirement. It is acknowledge that the world's fossil fuel dependency is not come to an end in a very short time period. Actually the switchover is expected a very slow resettling of technologies over decades. In this time duration world will need to unite technologies to surplus in the switchover, meanwhile avoiding economical and climatological problems. There is one technology is available which shows very encouraging in cost reduction as well as energy saving, it's indirectly reducing emission and help the environment, it is the adoption of the Hybrid Power System. Hybrid Power System is the combination of two or more types of electricity generation concomitantly, in general make use of renewable technologies. These systems are not only independent of large and centralized electricity grid but also they provide higher level of energy security by multiple generation methods and some time it contain a storage system also it will increase the supply reliability and security.

Why a Hybrid System?

Over the past years solar-wind hybrid technologies has developed and upgraded its role in renewable energy sources while the benefits it produces for standalone power generation are unchallenged. Presently many houses in remote, rural and urban areas use these hybrid systems. Many isolated islands try to adopt this technology because of the benefits which can be received in comparison with a single renewable system. Therefore it can generate electricity during the day using the energy from the sun and after the sun has set it utilize the potential wind energy to generate electricity and pursue its function. For that reason solar and wind work simultaneously in a hybrid power system together they provide much consistent power output rather than the individual standalone system. Hybrid system is too much economizing and gives plenty of benefits towards use of renewable energy sources. These systems are the very good solution and the perfect response to switch in energy market.

Table 1.Blocks Used in Modelling and Simulation

S. No.	Block Used	Block Design
1.	Constant Block	
2.	Step Function	
3.	Sum Block	
4.	Wind Turbine	
5.	Universal Bridge	

6.	Voltage Measurement Block	
7.	PV Array *Parallel strings* Number of strings of series-connected modules that are connected in parallel. The default value is 40. *Series-connected modules per string* Number of PV modules connected in series in each string. The default value is10.	
8.	Controller	
9.	PWM Generator	
10.	Transformer Block	
11.	Three Phase Voltage Source	
12.	Distributed Parameters Line	
13.	Demux	
14.	Mux	
15.	Load Flow Bus	
16.	Three Phase Voltage Measurement	
17.	Three Phase Circuit Breaker	
18.	RLC Load	
19.	Scope	

Hybrid Power System: Modelling and Simulation

Model Blocks

For design the complete model of hybrid power system for mains subsidization Matlab 2015 is used which contain the various blocks. With the help of these block complete model is designed. Some of the main blocks are used are as follows: Table 1.

Hybrid System Model

With the help of various blocks of Matlab and by the adjust their parameters the following Model of Hybrid Power System for Mains Subsidization is developed, Figure 1.

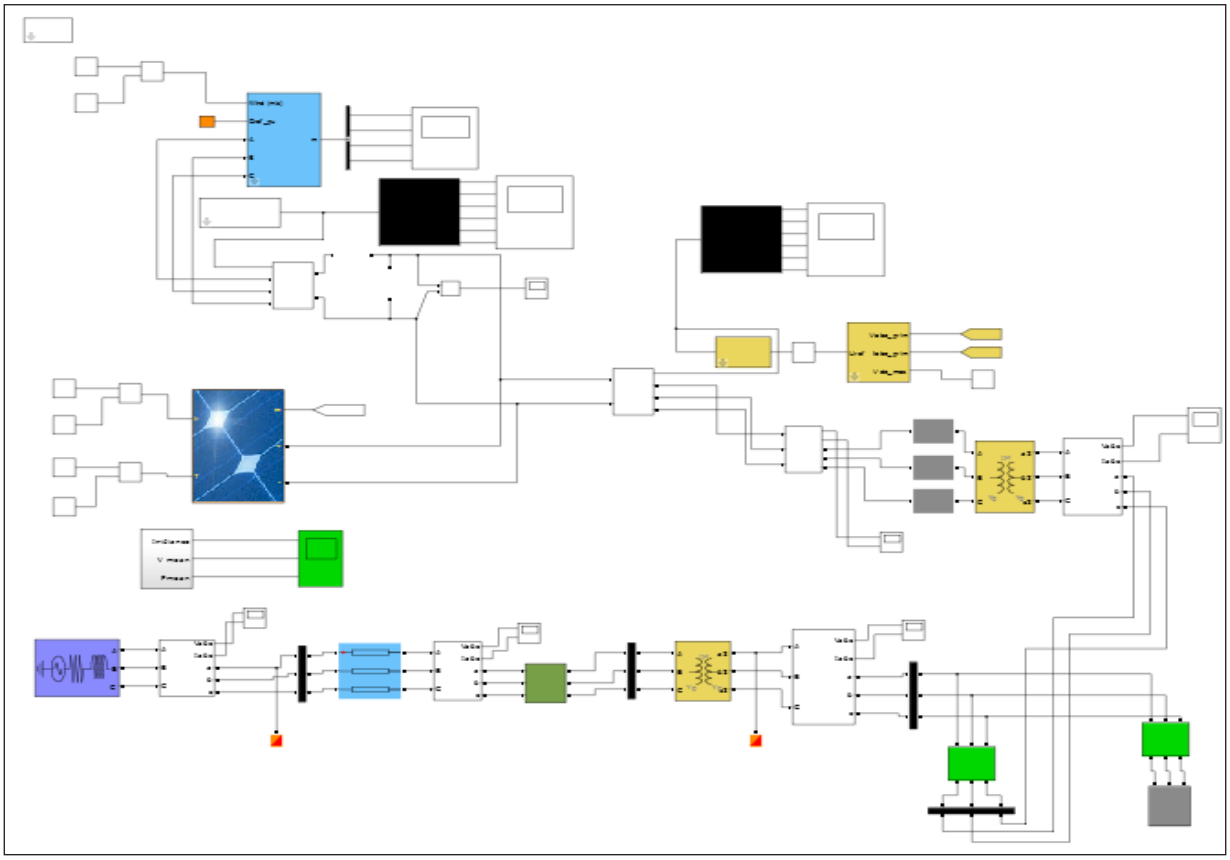


Figure 1.Matlab Model of Hybrid Power System for Mains Subsidization

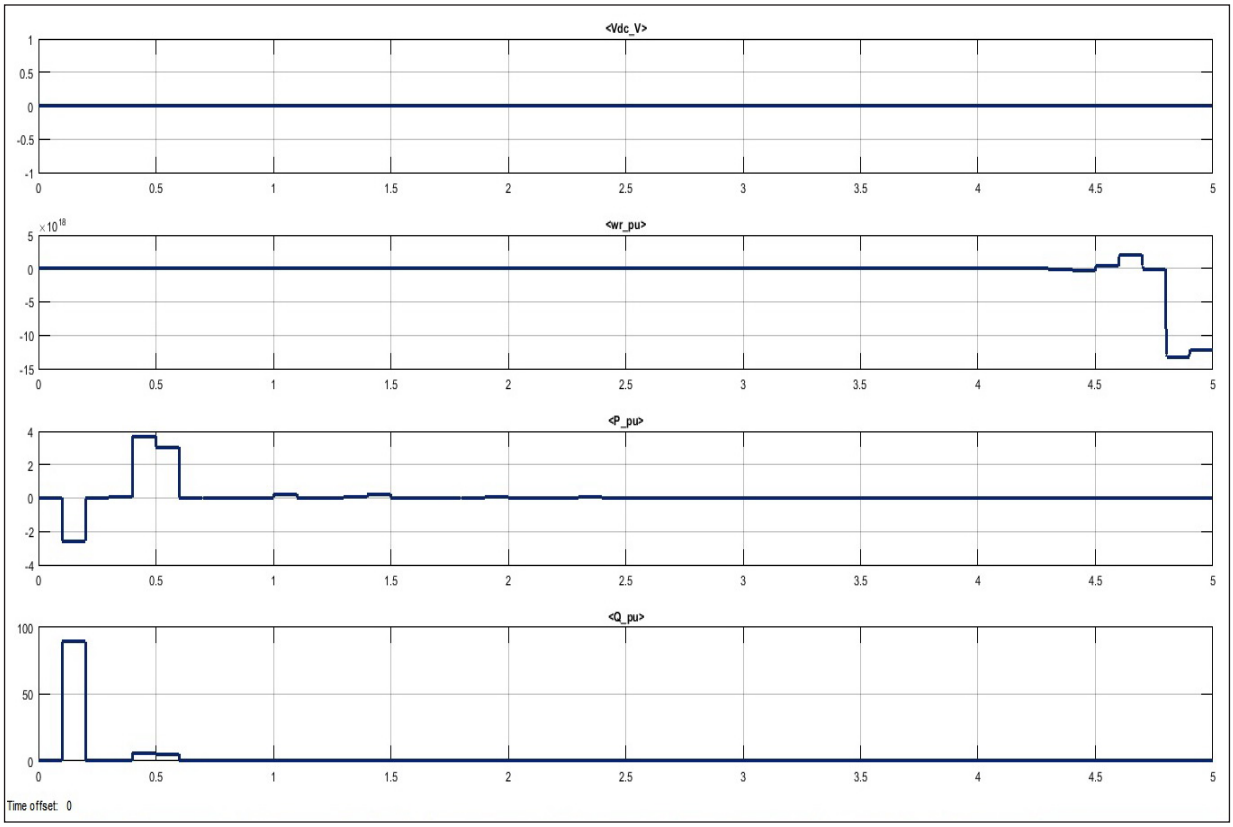


Figure 2.Wind Turbine output

Wind Power Model

To prepare the wind power model first take the model of wind turbine from the matlab simcape library.

The Inputs of this block are:

- Wind Velocity
- Reference power parameter

Outputs of this block are:

- Three phase power
- Measurement output

Initially we give the reference power zero (for actual data and voltage). Now let the wind speed of 15 m/sec and set this in the constant block. With this we take the step function which is varies from 0 to 8 in every 3 seconds. Now this total will give to the subtraction block where wind speed is varies and this varied wind input is feed to the wind turbine. The output of the wind power is shown on to the graph, Figure 2.

Now the output power of wind turbine is feed to the universal bridge. This bridge is the three leg bridge. Now PWM generator block is taken to provide 6 bit pulse to the universal bridge. Input of the PWM generator is shown on to the scope, Figure 3.

The main purpose of using universal bridge is to convert our ac supply into the DC supply. The output of the universal bridge is the fluctuating DC, so to improve the DC we connect the Inductor and the capacitor in the model. These are working as a filter component to remove the AC component in the DC supply. Now the pure DC supply is feed to the DC bus for further process.

Solar Power Model

To design the solar power model first take the PV array block from the simcape library of the Matlab. The special about of this block it is only available in the latest version of Matlab. This block has two inputs Irradiance and temperature.

Initially we assume the Irradiance at 1000 by put the input in the constant block and then take the step function. This step function is varies from 0 to 200 in 3 seconds. Now both inputs are sending to the subtraction block and then feed to the PV array. This input of PV array is variable Irradiance to the panel.

For the temperature the first initially set the 25ºC by setting it in the constant block and then take the step function. This step function is varies from 0 to 5 in 2 seconds. Now both inputs are sending to the subtraction block and then feed to the PV array. This input of PV array is variable temperature to the panel.

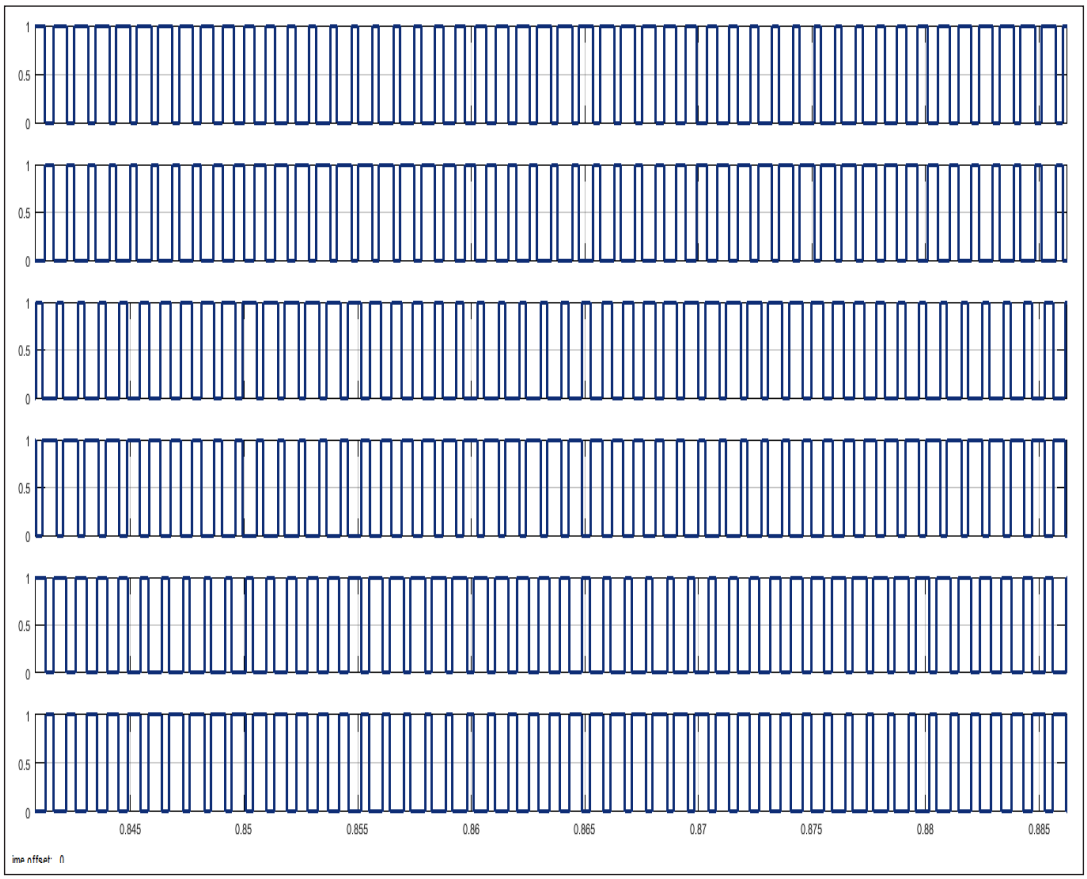


Figure 3.Input of PWM Generator

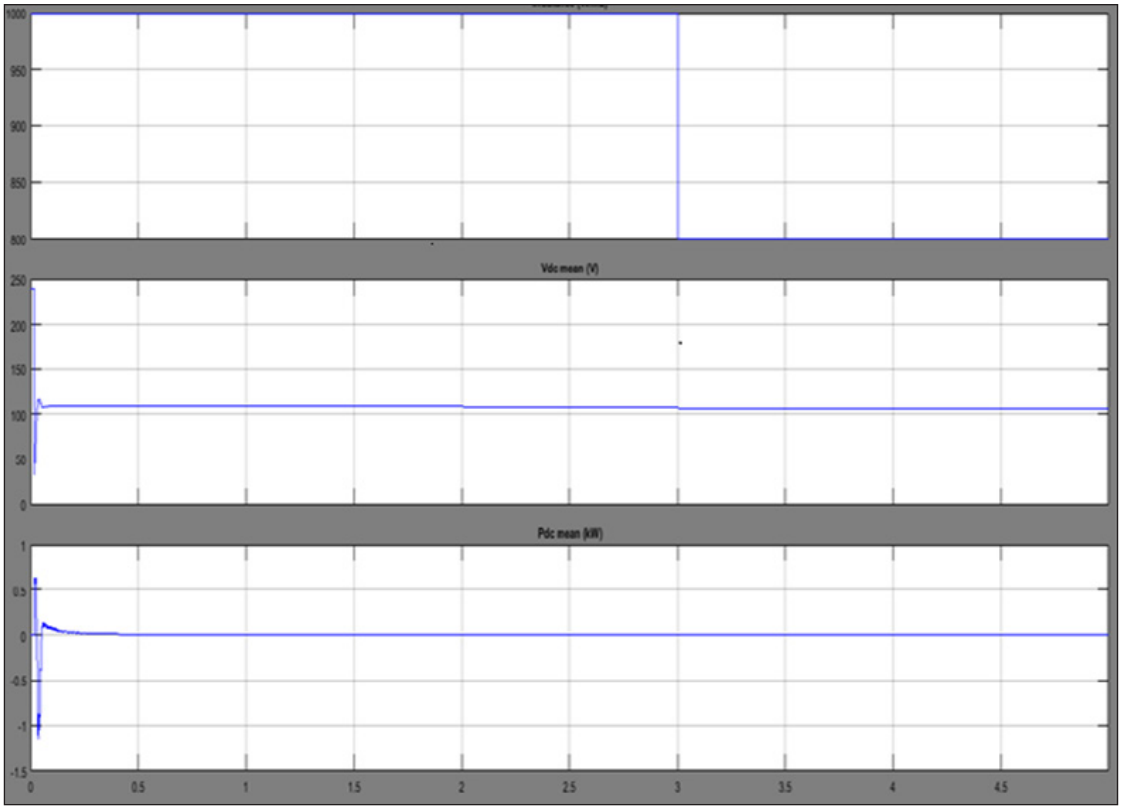


Figure 4.PV Array Output

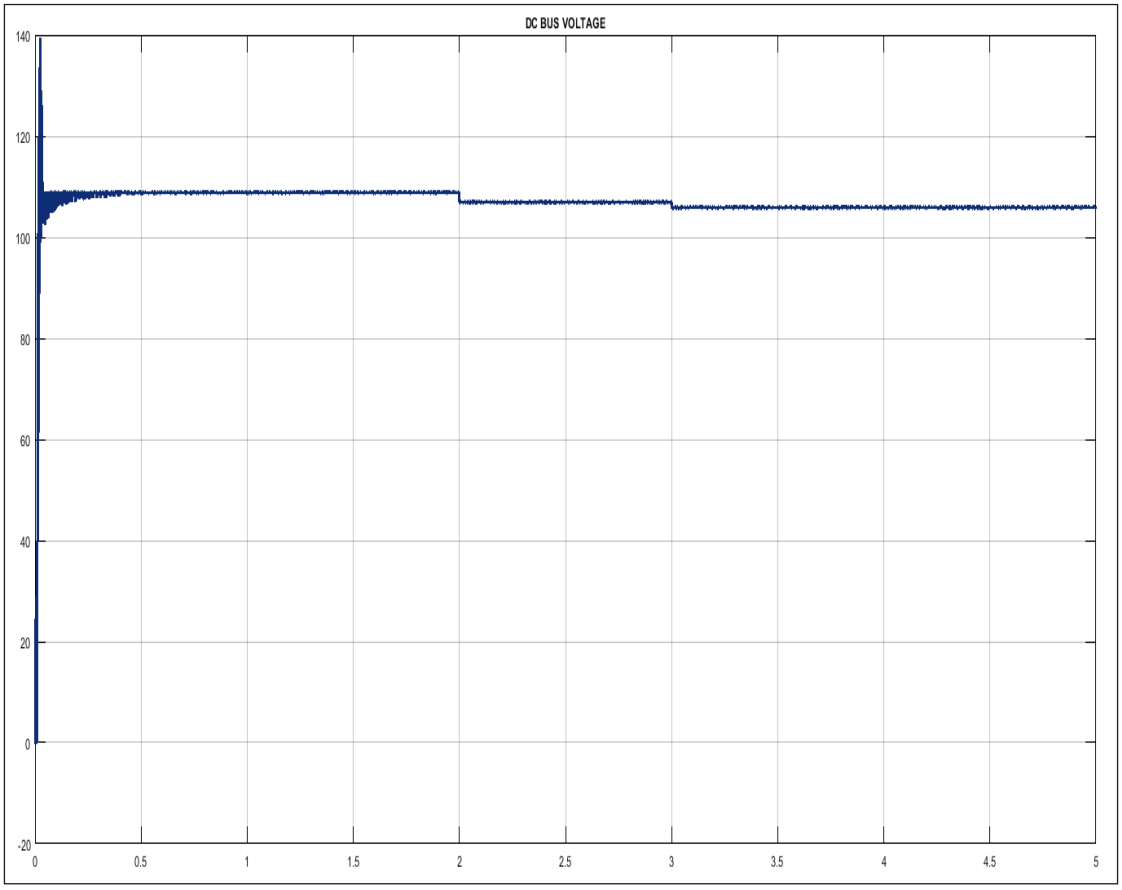


Figure 5.DC Voltage from Hybrid System

The output of the PV array is shown on the graph, Figure 4.

The output voltage of the PV array is send to the DC bus where it gets in contact with the wind turbine DC voltage. The total output of the Dc voltage is shown on the scope whis is almost constant, Figure 5.

Now again a universal bridge is connected to the system to convert this Dc voltage into the AC system. This universal bridge is also connected to the pulse generator which is connected to the voltage controller which is working on the feedback system of the main supply. If the main supply is available the only it sends signal to the pulse generator. If main supply is cut off then no signal is provide to the system then our Ac waveform is not be able to generate. After feedback from the main supply the signal (Voltage and Current) voltage controller is provide the signal to the pulse generator then universal bridge is working and it will convert DC supply in to the Chopped AC. Now a diode is connected to the system to reduce the noise from the system. Now the three phase transformer is connected to the system and the output of the hybrid system is measure by apply the three phase V-I measurement block the output of the three phase course is shown on the scope. This the final output of the Hybrid System which is almost constant and it is work until main supply is on, Figure 6.

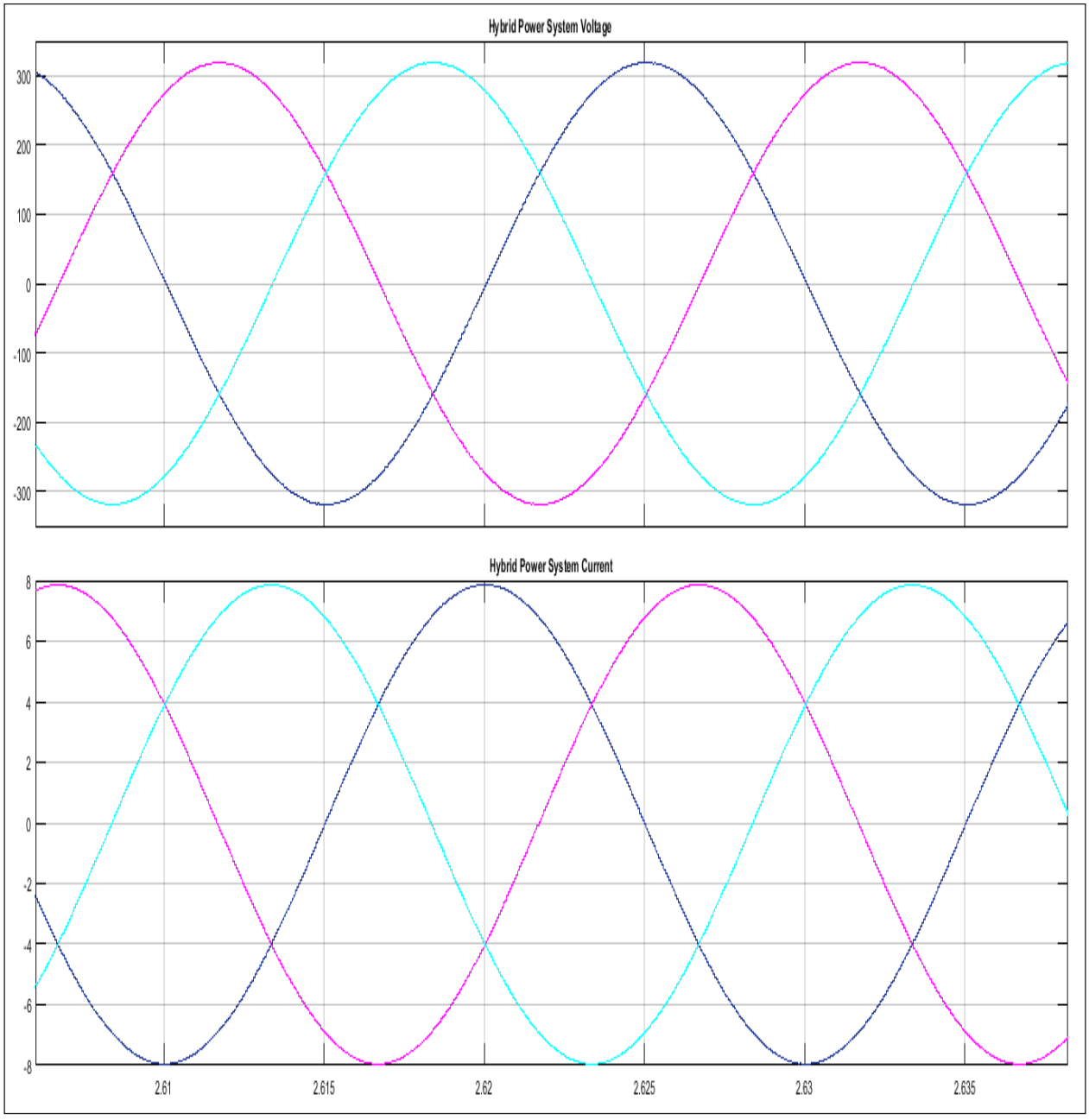


Figure 6.Hybrid System Output

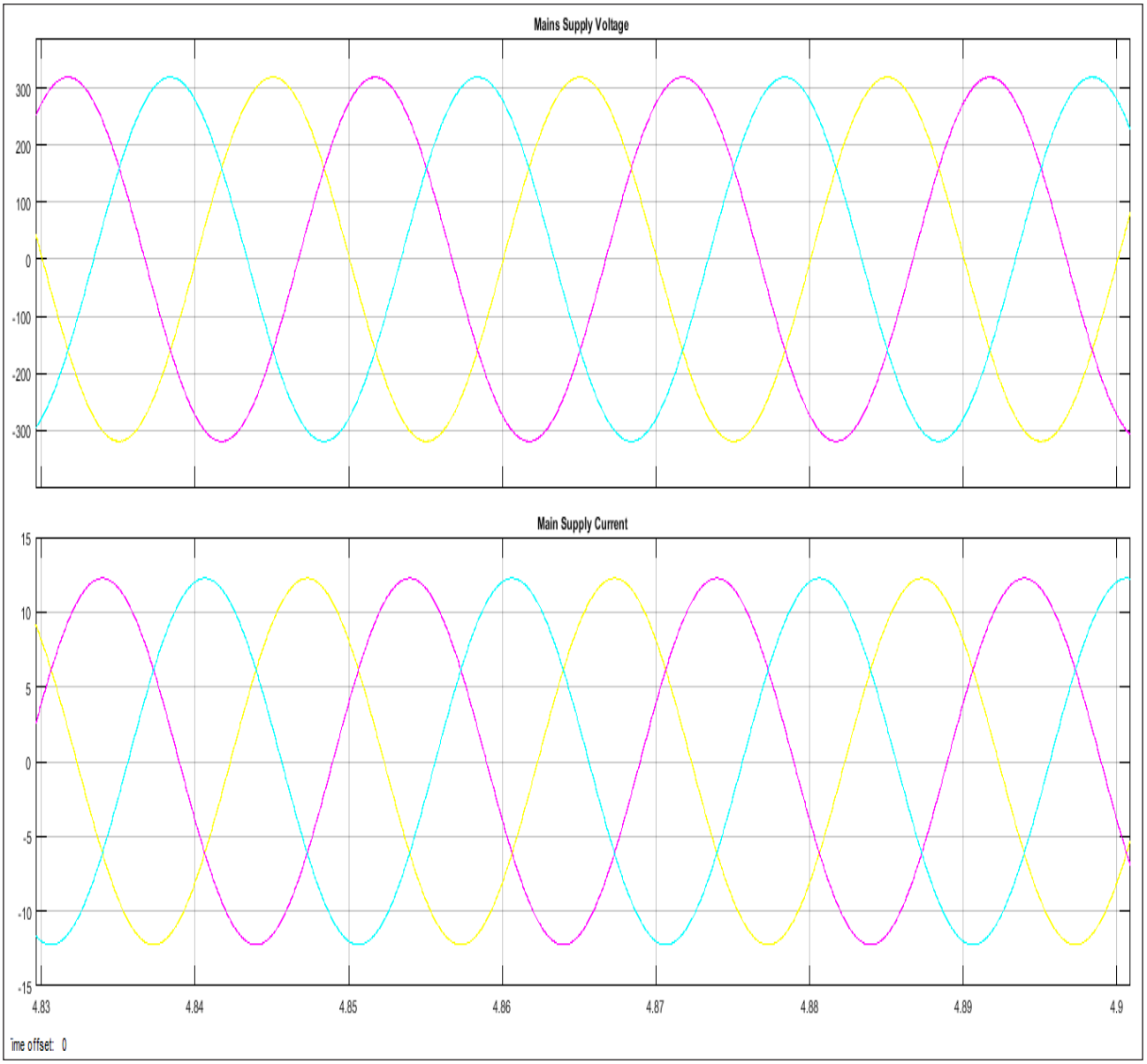


Figure 7.Three Phase Output at load End

Main Supply Model

Now take the three phase source block and measure the voltage and current by adding the three phase V-I measurement block the output of the three phase course is shown on the scope. Now output of the three phase source is feed to the distributed line parameters which is the model of the 100 km line and its output is feed to the transformer and the load side. The output of this transformer is measured by adding the three phase V-I measurement block the output of the three phase course is shown on the scope, Figure 7.

The combine power is to be calculated by the waveform of the both (Mains and Hybrid) power system and this will feed to the load. The load is varying as per our requirement and the total power load gets as per its requirement.

Simulation Parameters

For Solar

S. No.	Parameter	Values
1.	Irradiance	800 – 1000 W/m2
2.	Temperature	18-25ºC
3.	Open Circuit Voltage	36.6 V DC
4.	Parallel Module	2
5.	Series Module	3
6.	Total Module	6
7.	No of Cells Per Module	60

For Wind

Wind Speed varying between 8 to 15 m/sec^2.

Result

Simulation is run for 5 seconds.

S. No.	Set Load in Watts	Mains Power by Calculation in Watts	Hybrid System Power by Calculation in Watts	Total Power at Load End in Watt
1.	3000	2732.26	1268.5	4000.76
2.	4000	34640.11	1268.5	4732.61
3.	5000	4195.97	1268.5	5464.47
4.	6000	4879.03	1268.5	6147.53
5.	7000	5692.6	1268.5	6961.1
6.	8000	6505.3	1268.5	7773.8
7.	9000	7188.8	1268.5	8451.3
8.	10000	7936.9	1268.5	9205.4

Conclusion

This paper provides the hybrid power system for mains subsidization which is play an important role in the power generation at the remote and island or remote location and where the generation is possible from solar and wind power to subsidize the main power. We can easily see from the result the total power at the load end which is actually more than the load requirements, so it easily subsidizes the main power. In fact we can connect multiple or 'n' number of renewable energy sources to subsidize the main power as per our load requirements. In the present scenario houses in many areas using hybrid power system, there are many isolated island are also try to adopt this kind of power system technology due to its benefits which can be it have in comparison with a single renewable system. This hybrid system presents many benefits, more specifically for a wind/solar hybrid system the assessment is focused on the wind and solar potential of the region. Therefore it can be operated during the day using the energy from the sun and wind both and after the sun has set it can utilize the potential wind energy alone to continue its function. For this reason, solar and wind system work together in a hybrid system and they provide a more consistent year-round output than either wind-only or PV-only systems. Moreover with the usage of suitable auxiliary system like batteries you can store energy, which may be useful in compensating demand of electricity used by the consumers for periods where there is no sun or wind. At last, it is economically better and we have many advantages to use of renewable energy resources in-spite of conventional sources of energy that is solar and wind or combine both of them that are hybrid. The investment financially and environmentally in modern technologies will win through the generations to come in the fight for energy efficiency and effectiveness. The main reason behind to adopt the solar wind hybrid is that they are easily available and power may be easily generated. The main feature of this system is to subsidization of the main power with the help of the hybrid system which is shown in the result. The main key benefit of this system is that if we want to more subsidization of the power more then we have to increase the power of our hybrid system by increasing the capacity of the system or by adding new sources or we can say that by adding the number of more Renewable source we can subsidize more power.

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