

DESIGN AND CONTROL OF MICRO GRID FED BY RENEWABLE ENERGY GENERATING SOURCES

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Abstract:

This paper provides with an idea of design and the various control techniques to be used to design a micro grid effectively. It gives the concept of distributed generation and the micro grid. There are various techniques used to determine the best design of micro grid in order to effectively utilise the resources to provide quality electrical supply which is the main motive of every generation. Micro grid refers to the operation in connection with the utility grid but it also has a special feature of operating in the standby mode which is called as islanding mode. The primary purpose of micro grid designing is to enable continuous and quality supply.

Key Words:

DFIG, Vector control, Wind Energy, Power Quality, Solar PV energy, Micro grid, Battery Energy Storage System, Renewable Energy Generating System.

Introduction:

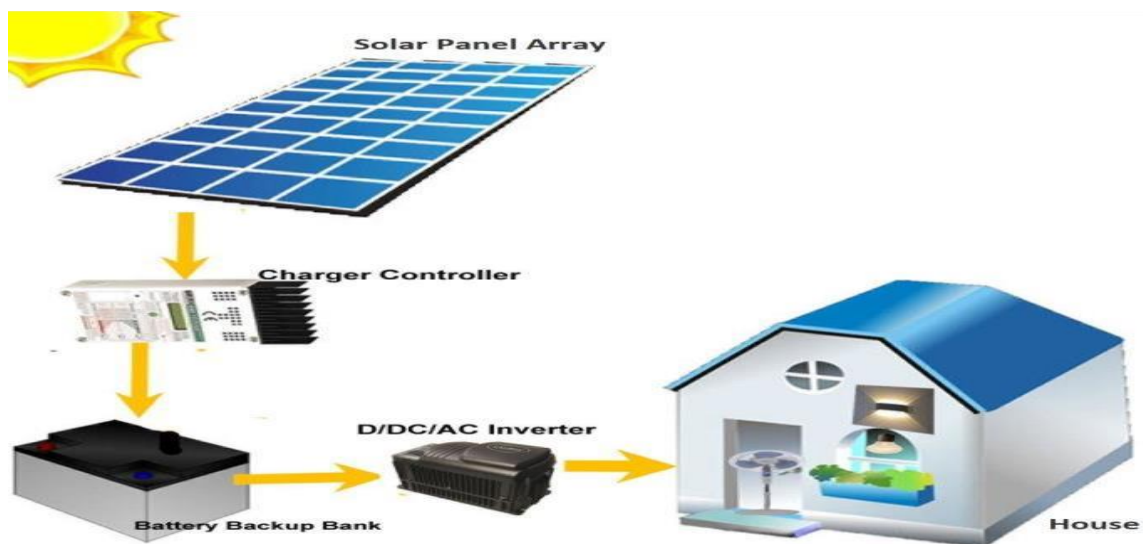
The fast evolving world came with plenty of inventions which altered the world's living greatly. This change impacted the way of living in every aspect. One of them is the consumption of electrical energy. With the increasing population the necessity to improve the energy generation became an utmost important issue. But not just increasing the energy generation would suffice but the quality of the supply would play just an equal role both on the consumer and producer sides. But the current production of electrical energy is greatly through the non-renewable resources which are in the danger of extinction due to excessive usage. This created the necessity of searching for alternating resources for energy generation.

Renewable Energy Generating System:

The usage of conventional or non-renewable resources for electricity generation must be reduced so that the resources can be used furthermore in the future as they are decreasing in their resources. The alternate to this issue is the utilisation of non-conventional or renewable resources which are restocked even after their usage. These resources importantly produce almost zero to very little amount of pollution which is very desirable. These resources are dependent on environment and can be used for electrical generation. The various and highly used renewable sources are solar and wind energy.

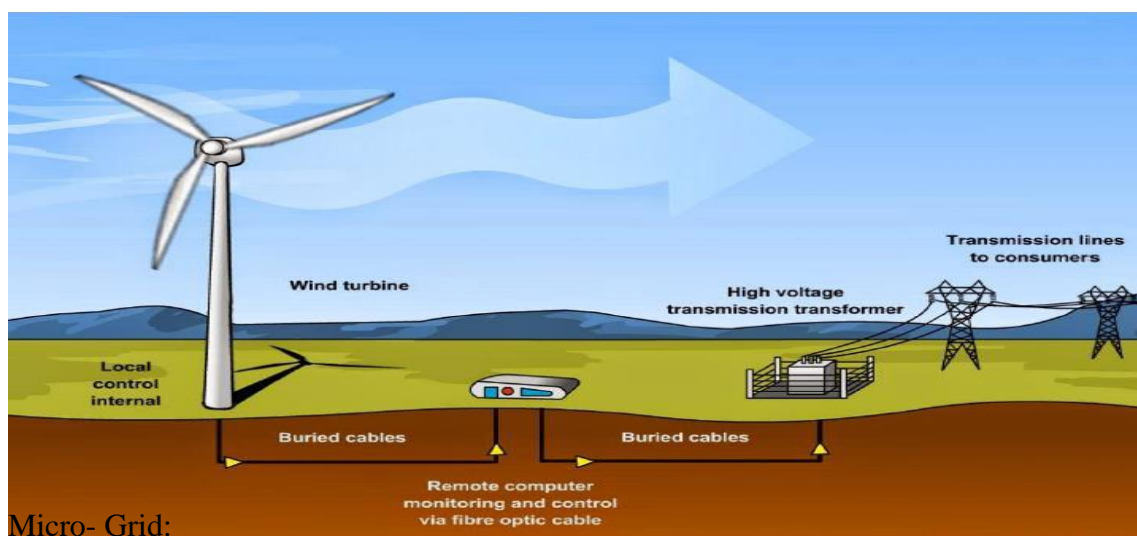
Solar PV Energy:

Sun is the primary source of heat and light to earth. The energy contained by the solar radiation is of enormous which can produce a high amount of electrical energy if trapped properly. The energy through the sun is utilised for energy generation through PV (photovoltaic) cells. When the solar radiation strikes the semiconductor PV cells, it generates electron-hole pairs which when closed or connected to load produces current. This can be used directly or stored in a battery for further usage.



Wind Energy:

Wind is one of the abundant, pollution free renewable resources which can be utilised for the generation of electricity. Wind is an indirect form of solar energy which is the movement of air due to unequal solar heating which causes the air to move from hot to cold area. A wind mill is used for energy generation in which when wind strikes the blades of the wind mill, the blades rotate which are connected to the rotor of the turbine. When this turbine rotor rotates, the alternator connected to it also rotates and electricity is produced.

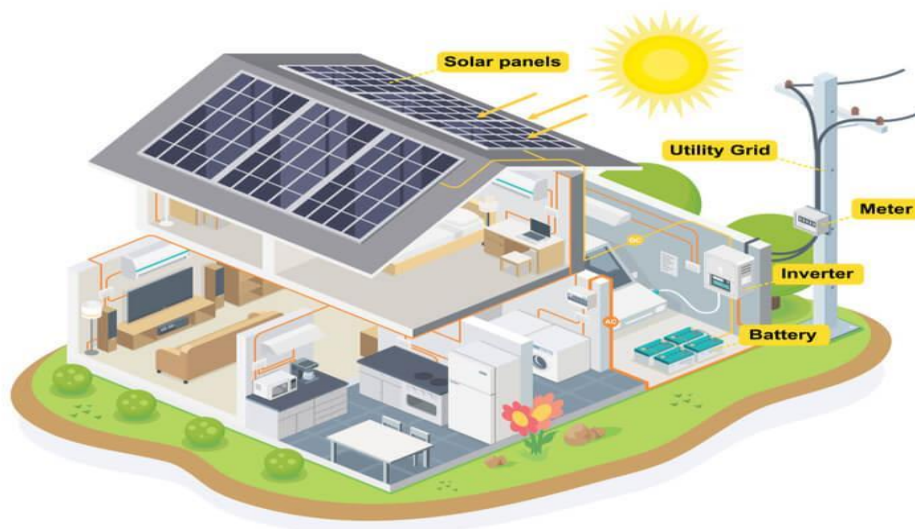


Micro- Grid:

The only usage of non-renewable resources for electricity generation is becoming extremely difficult as they are depleting in their quantities. The generation through the renewable resources is now being used widely at domestic and industrial levels. But the energy produced by them alone may not be sufficient for the total requirement. Usage of battery banks for storage is only helpful for a short period of time. The output of wind and solar energies are environment dependent and they may be high at some point and low at some point. This can be utilised effectively by establishing a contact with the grid through which when there is energy deficiency, energy can be taken from the utility grid and when there is excess

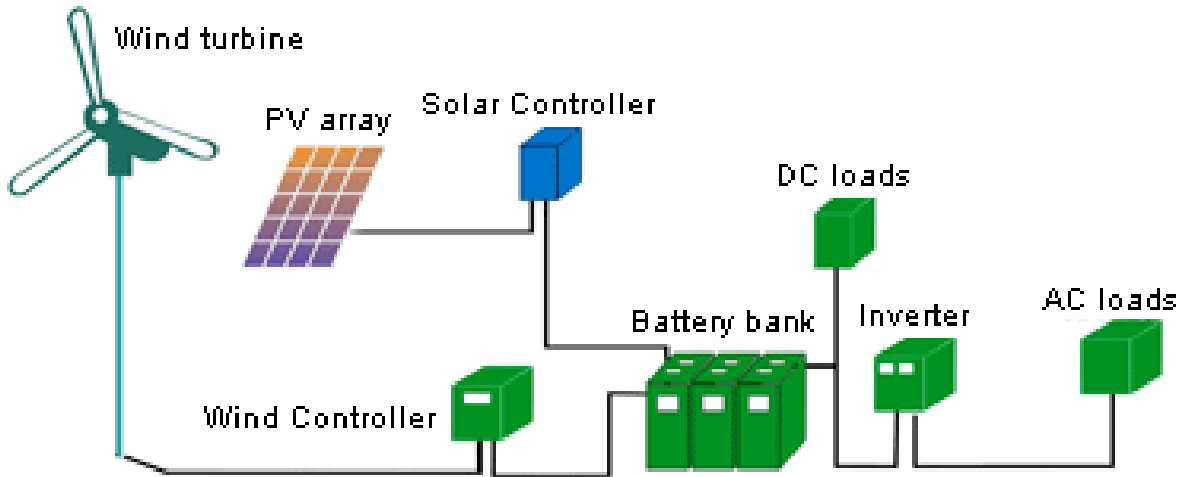
energy, it can be given to utility grid. This form of generation is known as micro grid. Micro grid operates in two modes:

- 1) In contact with grid where exchange of energy takes place
- 2) Islanded mode where micro grid operates alone without any contact with grid and feeds its loads itself.



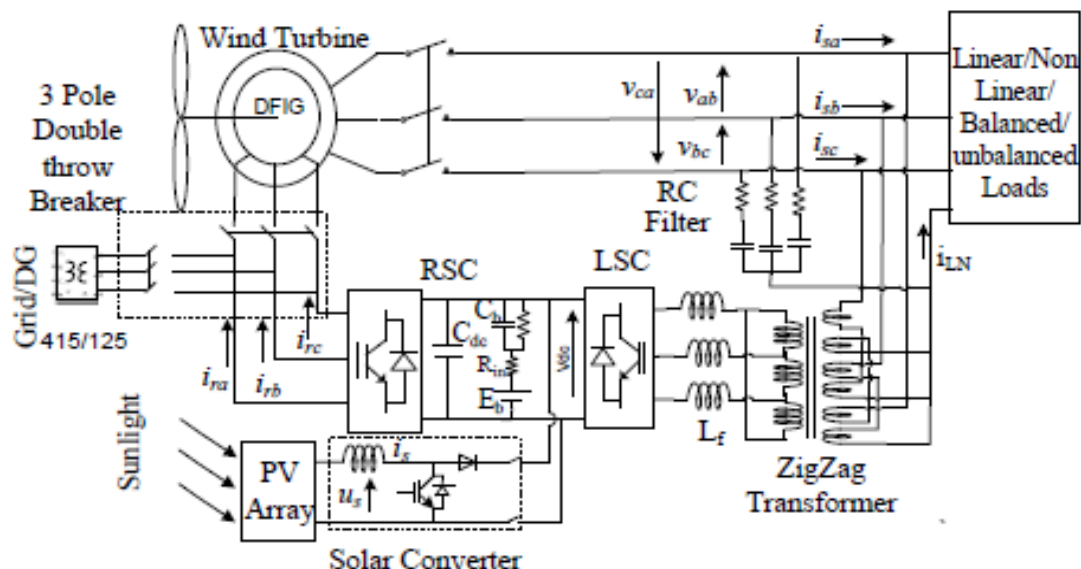
Existing Method:

The micro grid mainly focuses on the renewable resources which are environment dependent. The energy captured through them may not be the fullest of their capacity. This makes that the energy output of micro grid uncontrolled so the micro grid will be unreliable. Often, when the battery bank is highly depended on these cases, there is a need of load shedding so that the battery is not deeply exhausted and the supply to critical load is continued to ensure reliable supply. This also introduces some power quality issues because when the grid operates in islanded mode, the frequency varies from that of the utility grid supply and also the voltage which effect the delivered power quality which is highly undesirable. The existing method can be shown as:

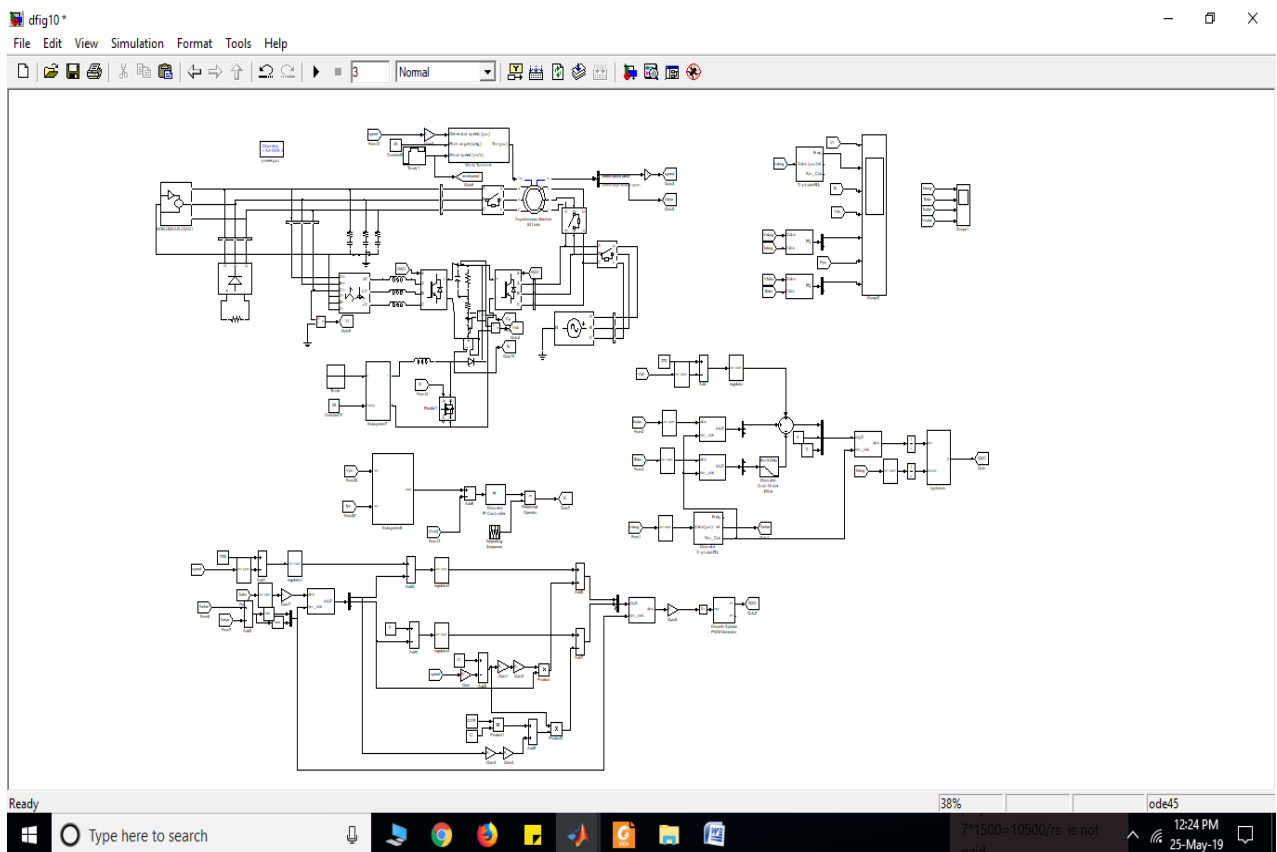


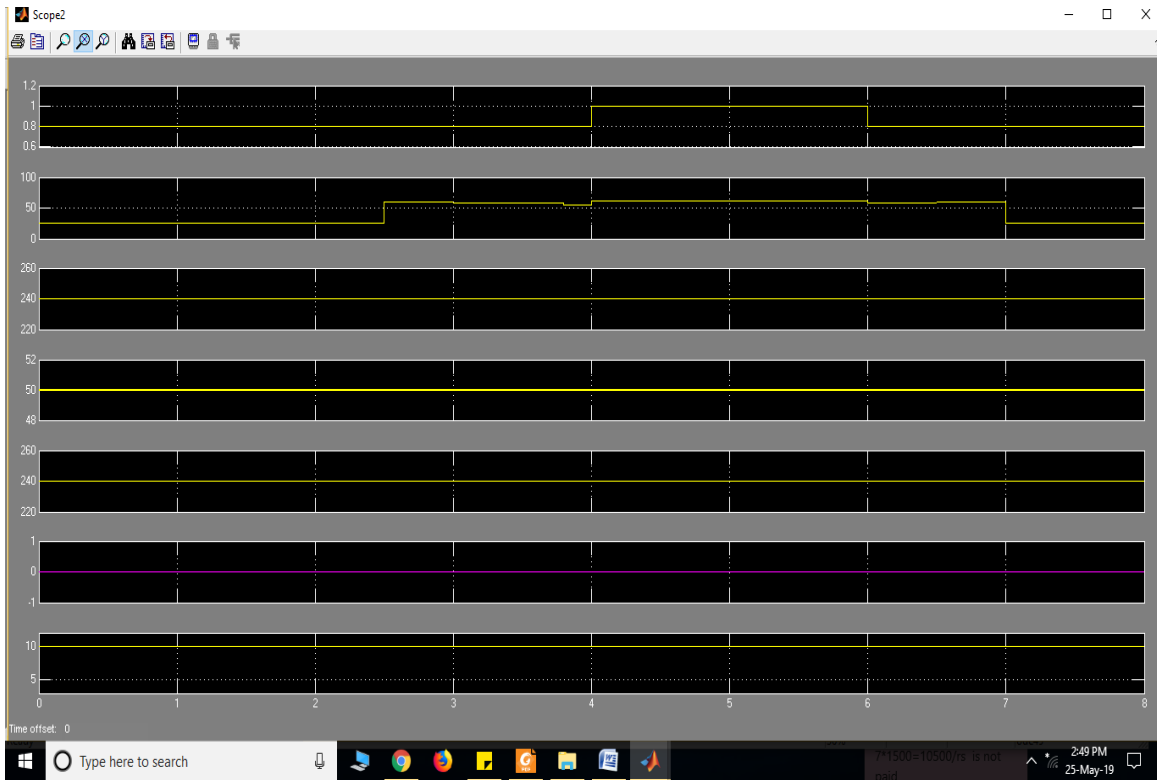
Design and Control of Micro Grid:

As the renewable resources output is unpredictable, to obtain maximum output from them the utilization of these resources is modified as per the variation of the factors. Solar energy varies with the rotation of sun throughout the day. If the energy captured from it is varied according to the direction of sun, maximum amount of energy can be obtained. The wind direction and speed is highly varied and is dependent on the global conditions. When the blades are moved in the direction of wind, maximum amount of energy can be harnessed from it. This is the designing of the micro grid with various controls to obtain maximum energy. The system proposed is a hybrid system in which two or more renewable sources are combined for energy generation.

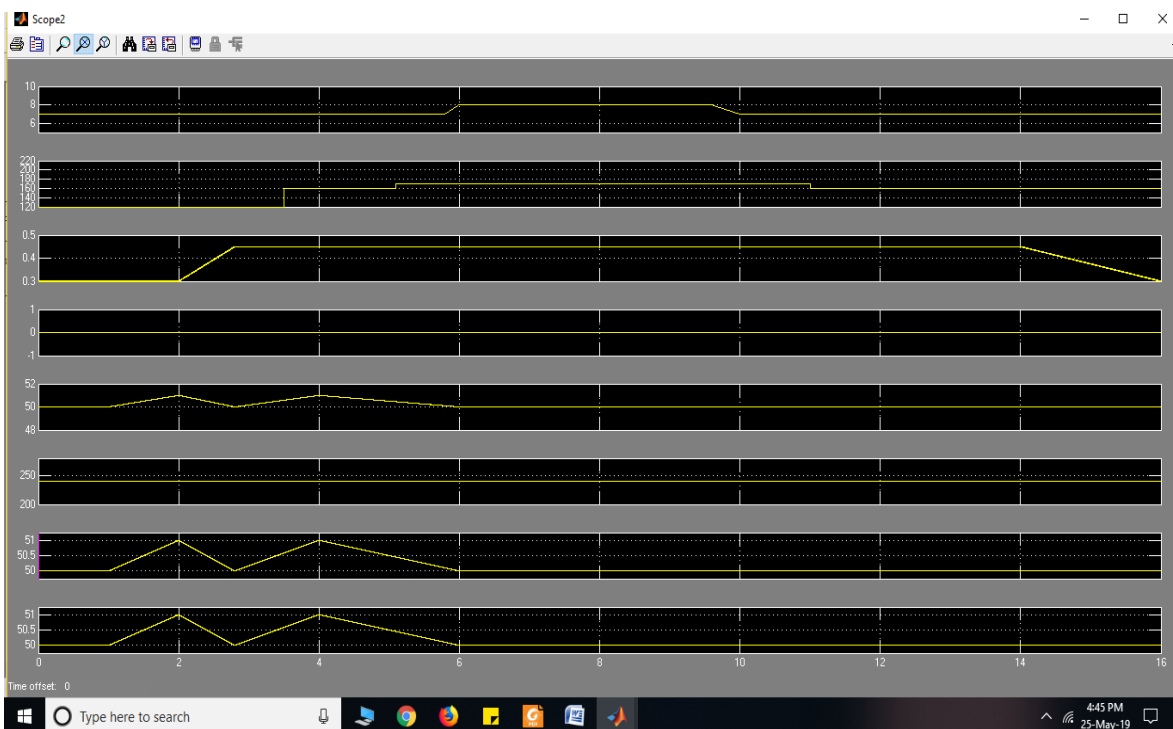


In this system, MPPT algorithm is utilised in order to obtain the maximum output energy from the solar and wind energy. In this two controls are employed which are LSC (load side control) and RSC (rotor side control). The RSC controls the turbine so that it rotates in the direction of the wind to obtain maximum power. The power from the PV array is stepped up through a boost converter. LSC is used so as to control the load side parameters in order for them to always match with the grid and also to meet the requirement. A battery bank is utilised in order to store the energy and supply to the load when there is a lack of energy from wind power. A switch is used in order to connect or disconnect with utility grid and wind energy. The transformer is utilised for electrical isolation as well as to match the voltage of the load. In this a special alternator is used which is DFIG (doubly fed induction generator). This is used because the variable speed of wind makes it difficult to capture the maximum energy with other generators. But this helps in capturing maximum energy of variable wind. The simulated diagram can be shown as:

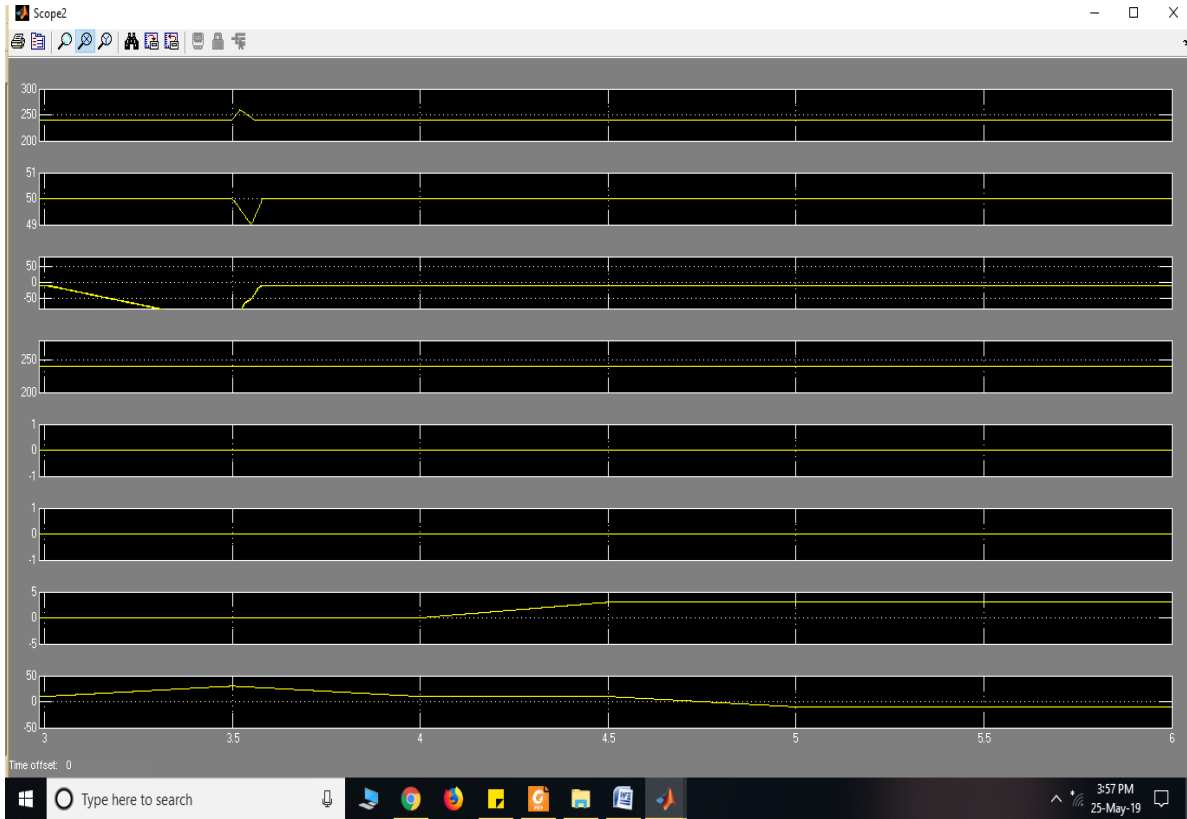




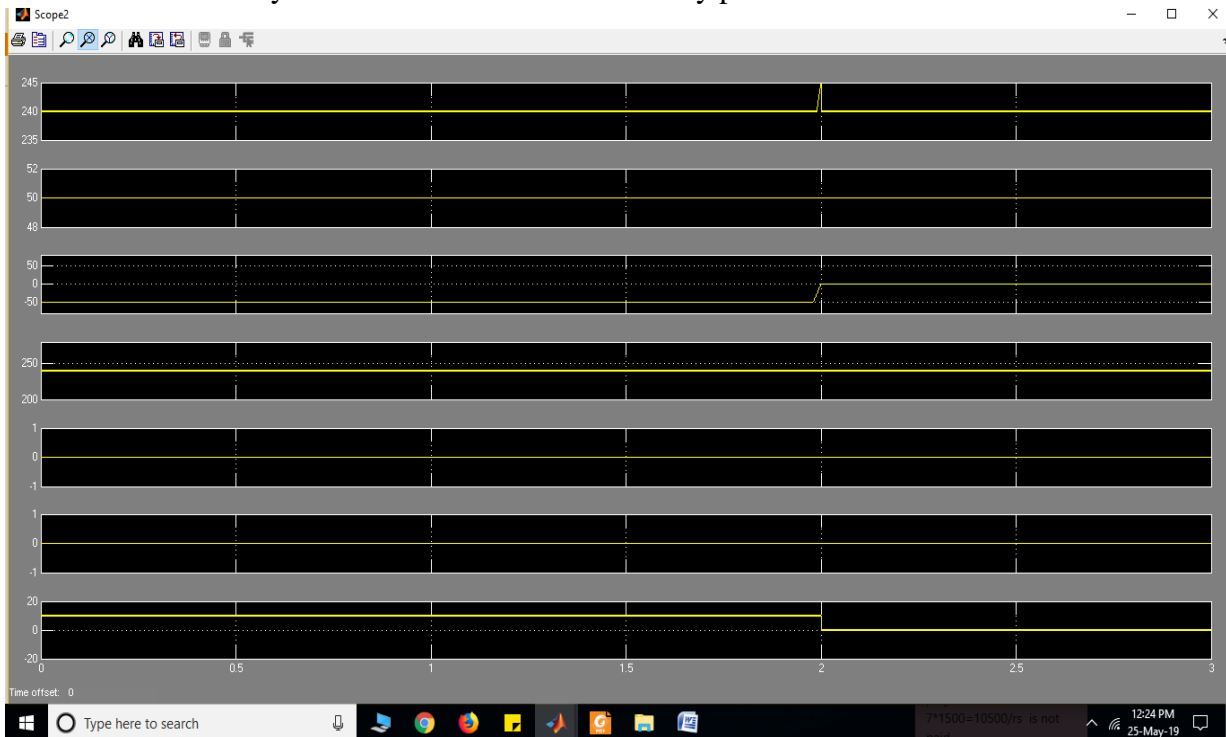
Results:Performance of REGS fed micro-grid with wind energy source



Performance of the system without generating source and solar system is taken in the service



Performance of the system under loss of load at battery power



Performance of system through external charging

Conclusion:

The operation of electrical utility as micro grid helps in reduced usage of non-renewable resources as it promotes the usage of renewable resources. But improper designing of micro grid does not yield maximum output which makes the proper designing of micro grid necessary. The controlling of micro grid helps in maximising the output to the load and also governs the power delivered to the load thus improving the output as well as power quality.

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