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Modeling of a Hybrid Energy System Connected System

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Abstract- **In integrated micro-grid, PV system is usually controlled to operate in the maximum power point tracking (MPPT) mode. The battery energy storage system is operated in constant power charging or discharging mode. In order to provide an integrated energy system connected to grid Depending on individual energy requirements, the Integrated Energy System can be an add-on to an existing energy source (an integrated solution) to reduce fossil-fuel consumption or a stand-alone for complete fossil fuel displacement. Through extensive integration of energy infrastructures it is possible to enhance the sustainability, flexibility, stability, and efficiency of the overall energy system. This concept together with the cost reduction, technology development, environmental awareness, and the right incentives and regulations has unleashed the power of the sun. And all system result will be carried out by matlab simulation is proposed for isolated micro grids with renewable sources.In the presented technique, the pitch angle controller is designed for wind turbine generator (WTG) system to smooth wind power output. The proposed strategy is tested in a typical isolated integrated micro-grid with both PV and wind turbine generator.**

Keywords- **Solar, MPPT, Wind, Diesel Engine, Battery, frequency control.**

I.INTRODUCTION

The concept of microgrid is gaining lot of popularity worldwide due to their ability of working independently. The microgrid also allows the optimal utilization of available renewable energy sources (RES) in a coordinated way in order to feed remotely placed isolated locations where grid is not readily available. Thus, the microgrid is expected to work both in grid tied mode and off grid (islanded) mode. In grid tied mode, the grid voltage sets the reference for DG interfacing VSC's and chances of internal conflict among different VSC's are very rare.

However, in islanded mode of operation, the different VSC's are needed to be controlled in such a way that the load demand must be shared by all interconnected VSC's in proportion to their individual rating. Therefore, the VSC's in microgrid may either be controlled in centralized manner with dedicated communication channel between them or they may be controlled individually with droop control which may require low bandwidth communication channel or no communication channel at all.

High penetrations of renewable energy like wind and solar challenge the conventional planning/design and operation of the electricity infrastructure due to the intermittent nature of the resources. To avoid system breakdown in the electricity infrastructure, generation and demand have to be in balance on second-scale. Furthermore, the renewable energy sources displace conventional generation which today is responsible for providing many of the power system services suchas reserves,voltage control, frequency control,stability services, and black start restoration that are needed for stable and reliable operation of the electricity infrastructure.

Trading of energy through electricity and gas inter conn ects to neighboring countries is widely used to balance the system and ensure stable and reliable operation. But the ability of neighboring energy systems to interact may be limited if the neighboring systems have similar character istics like renewable energy penetration, and new inter connectors are often very difficult and take longtime to establish.The heating, cooling, gas, and transport infrastru ctures have certain intrinsic storage capability (e.g. due to the temperature of the hot water in the pipes, state-of-charge of the electric vehicle battery, or pressure of the gas in the system) and can Therefore provide some of the energy flexibility needed in the electricity infrastructure.

Also, the demand side in the electricity system in itself has someabilityif proper mechanisms(markets,commun ication etc.) are introduced.Utilizing this potential of integration of the infrastructures requires either direct coupling of the systems through energy conversion technologies or through couplings at the generation side and/or demand side. A closer integration of the energy infrastructures will not only solve some of the challenges of integration of renewable sources at the technical level. Closer integration and coordination of different energy infrastructures are a prerequisite for a cost-effective energy system with a high share of variable and somewhat difficult to predict renewable energy sources. The impending global energy

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crisis has opened up new opportunities for the automotive industry to meet the ever-increasing demand for cleaner and fuel-efficient vehicles. This has necessitated the development of drive trains that are either fully or partially electrified in the form of electric and plug-in integrated electric vehicles (EVs and HEVs), respectively, which are collectively addressed as plug-in EVs (PEVs). PEVs in general are equipped with larger on-board storage and power electronics for charging or discharging the battery, in comparison with HEVs. Semiconductor devices utilized (silicon, silicon carbide, or gallium nitride) are thoroughly reviewed.

Since grid-connected systems do not need batteries, they are more cost-effective and require less maintenance and reinvestment than stand-alone systems.This concept together with the cost reduction, technology development, environmental awareness, and the right incentives and regulations has unleashed the power of the sun.

II. EXISTING SYSTEM

The impending global energy crisis has opened up new opportunities for the automotive industry to meet the ever-increasing demand for cleaner and fuel-efficient vehicles. This has necessitated the development of drive trains that are either fully or partially electrified in the form of electric and plug inhybrid electricvehicles(EVsand HEVs), respectively, which are collectively addressed as plug-in EVs (PEVs). PEVs in general are equipped with larger on-board storage and power electronics for charging or discharging the battery, in comparison with HEVs. The extent to which PEVs are adopted significantly depends on the nature of the charging solution utilized.

In this paper, a comprehensive topological survey of the currently available PEV charging solutions is presented. PEV chargers based on the nature of charging (conductive or inductive), stages of conversion (integrated single stage or two stages), power level (level 1,2, or 3), and type of semiconductor devices utilized (silicon, silicon carbide, or gallium nitride) are thoroughly reviewed in this paper Since grid-connected systems do not need batteries, they are more cost-effective and require less maintenance and reinvestment than stand-alone systems.

This concept together with the cost reduction, technology development, environmental awareness, and the right ince ntives and regulations has unleashed the power of the sun.

III. PROPOSED WORK

Large-scale introduction of fluctuating renewable energy implies that the key to successful integration is not to focus solely on the power system, but on the entire energy system and on energy systems integration. Successful integration of large fractions of fluctuating renewable calls for complex interactions between energy production, storage,distribution,and consumption.An integrated energy system with a high share of renewable energy will utilize, and behighly reliant on,digital technology.

A novel integrated energy system is proposed for renew able sources.In the presented technique, the pitch angle controller is designed for wind turbine generator(WTG) system to smooth wind power output and diesel generator system to restore systemWind diesel hybrid systems (WD HS) are autonomous systems that use wind turbine genera tors with diesel generatorsto procure utmost contribution by the sporadic wind energy to the total power generated, while ensuring uninterruptible electric power of high quality.

As a result the fuel consumption decreases and the overall operating cost reduces while also contributing to a green environment.In integrated micro-grid,PV system is usually controlled to operate in the maximum power point track ing (MPPT) mode. The battery energy storage system is operated in constant power charging or discharging mode. In order to provide the frequency support and prevent power fluctuation,.The pitch angle controller for WTG and the load frequency controller for diesel generator sepa rately to improve the response speed and the robustness of micro-grid. This concept together with the cost reduction, technology development, environmental awareness, and the right incentives and regulations has unleashed the power of the sun. and all system result will be carried out by matlab simulation is proposed for isolated micro grids with renewable sources.In the presented technique, the pitch angle controller is designed for wind turbine generator (WTG) system to smooth wind power output.

The proposed strategy is tested in a typical integrated micro-grid with both PV and wind turbine generator.

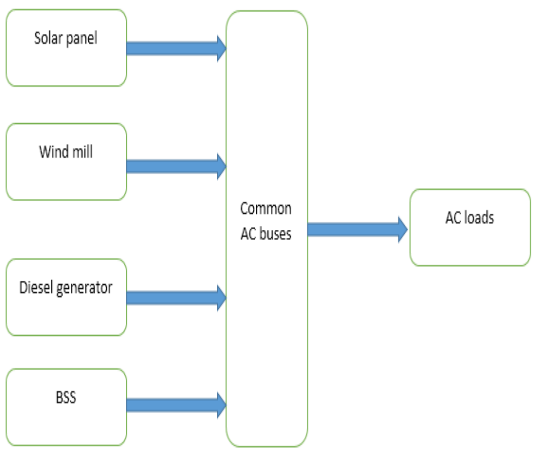

Fig 1. Proposed Integrated Energy System.

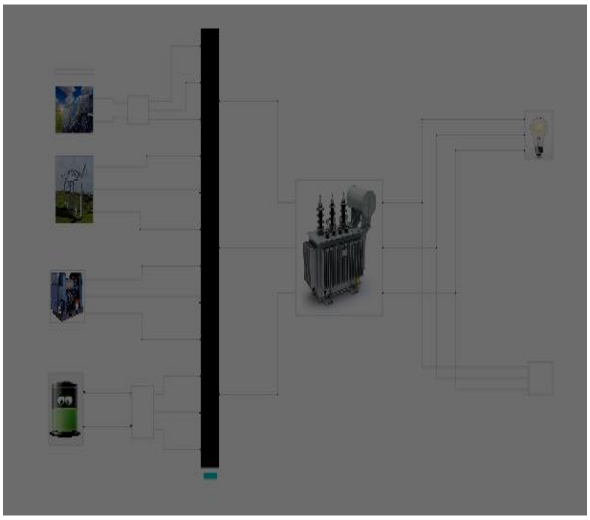

Fig 2. Simulink Model of Proposed System.

- Solar panel
- Maximum Power Point Tracking (MPPT)
- DC-DC Boost converter
- Diesel generator
- Battery
- Wind Turbine
- Linear & Non- linear Load

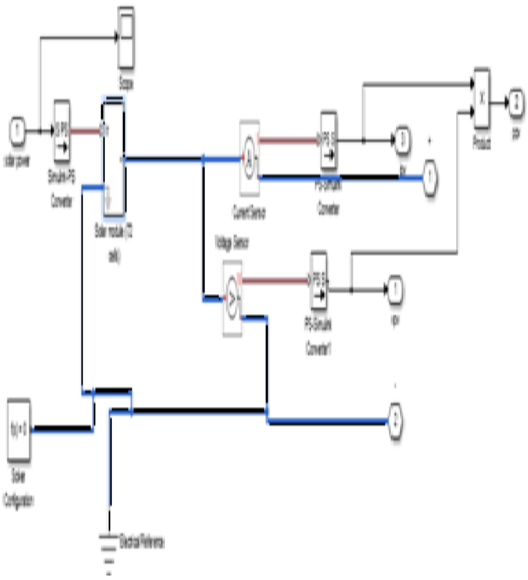

Fig 3. Solar Sub System.

1. SOLAR PANEL:The solar micro grid system is design ed to operate in two modes; Grid-Interactive and Islanded mode. In grid-interactive mode the battery system operates in parallel with the PV system. The PV system operates normally as a typical grid-tied solar PV system. During peak sun hours of the day the battery system is less active, but when the PV system is not utilizing the majority of the inverter capacity (i.e.at night) it is able to actively participate in fast response frequency regulation. The control system is designed to always prioritize the use of the inverter capacity for the solar PV generation first, and then the remainder is utilized for frequency regulation participation. In full sun the PV system will normally require approximately 325kW of AC capacity, leaving 175 kW of inversion capacity available for participation in the frequency regulation market. When there is a grid outage the micro grid system senses the loss of grid and signals the isolation breaker to open and convert to Islanded mode. The system adjusts automatically from a grid-tied current source to an islanded voltage source in a few cycles

2. MPPT: In integrated micro-grid, PV system is usually controlled to operate in the maximum power point track ing (MPPT) mode. The battery energy storage system is operated in constant power charging or discharging mode. In order to provide the frequency support and prevent power fluctuation, the novel integrated micro-grid, PV, frequency control strategy is proposed in this section. The SM control is used to design the pitch angle controller for WTG and the load frequency controller for diesel gener ator separately to improve the response speed and the robustness of micro-grid. Furthermore, the adaptive SM LFC is redesigned based on the disturbance observer and adaptive law for improving the controller precision and reducing the SM chattering. The proposed .the frequency deviation with the rated power limit of diesel generator.

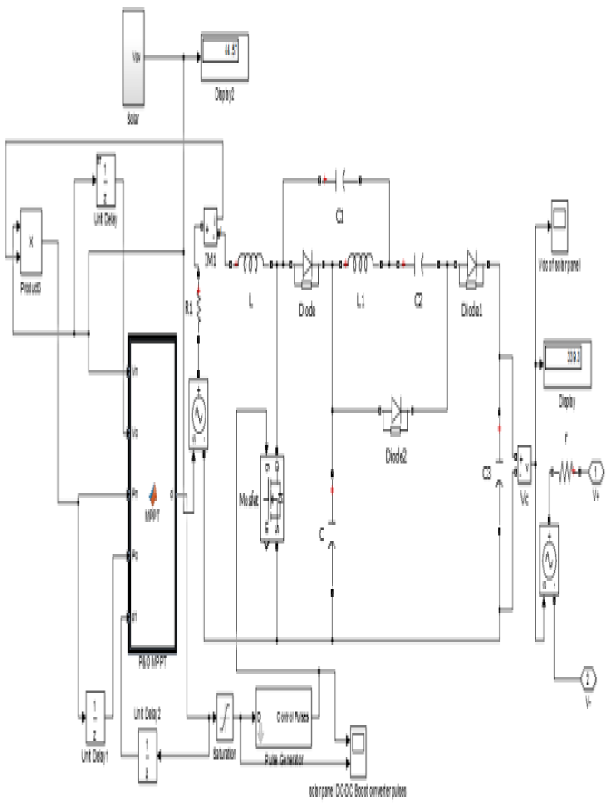

Fig 4. MPPT Model.

However, it cannot cover large-scale wind power penetr ation which is over the power limit of diesel generator. If the generation of renewable energy sources is larger than the rated power of diesel generator, other method such as load shedding has to be used to maintain system stable operation when there is large wind speed drop.

This block models a solar cell as a parallel combination of a current source, two exponential diodes and a parallel resistor, Rp that are connected in series with a resistance Rs. The output current I is given by

I=Iph-Is*(e^((V+I*Rs)/(N*Vt))-1)-
Is2*(e^((V+I*Rs)/(N2*Vt))-1) - (V+I*Rs)/Rp

Where Is and Is2 are the diode saturation currents, Vt is the thermal voltage,N and N2 are the quality factors (diode emission coefficients) and Iph is the solar-generated current. Models of reduced complexity can be specified in the mask. The quality factor varies for amorphous cells, and typically has a value in the range of1 to 2.The physical signal input Ir is the irradiance (light intensity) in W/m^2 falling on the cell. The solar-generated current Iph is given by Ir*(Iph0/Ir0)whereIph0 is the measured solar-generated current for irradiance Ir0. Short-circuit current, Isc: 7.57 Open-circuit voltage, Voc: 0.62 irst order temperature coefficient for Iph,TIPH1: Measurement temperature: First order temperature coefficient for Iph, TIPH1: Energy gap, EG: 1.12
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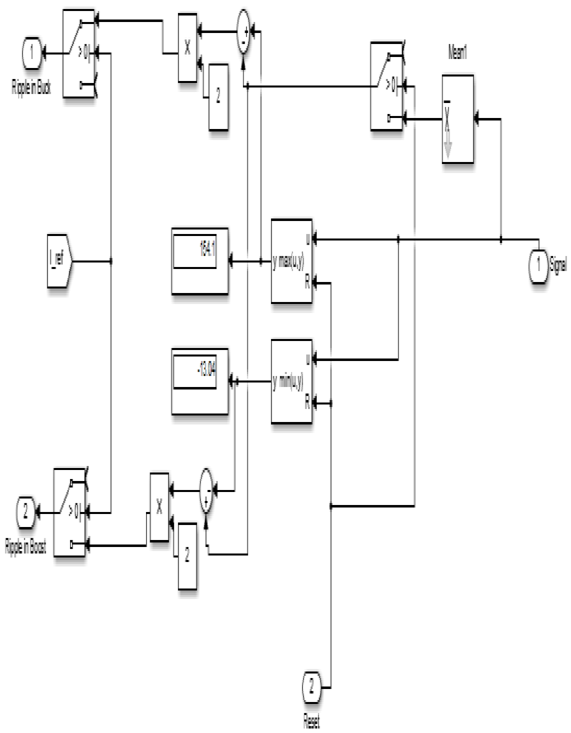

Fig 5. Buck Boost Sub System.

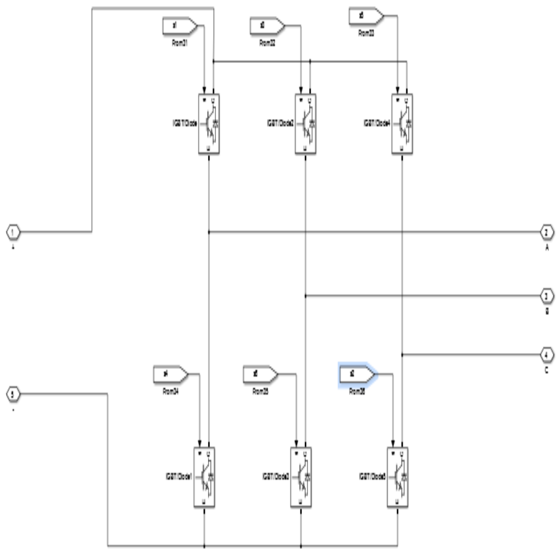

Fig 6. IGBT Circuit.

3. IGBT: The Insulated Gate Bipolar Transistor (IGBT) The IGBT is a hybrid or also known as double mechanism device. Its control port resembles a MOSFET and its output or power port resembles a BJT. Therefore, an IGBT combines the fast switching of a MOSFET and the low power conduction loss of a BJT. shows a circuit symbol that is used for an IGBT, which is slightly different from the MOSFET with similar terminal labels.

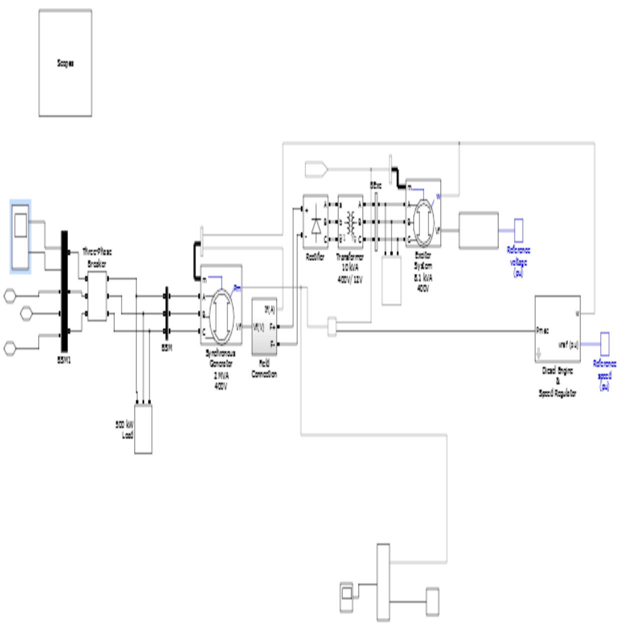

Fig 7. Diesel Generator.

The control terminal is labeled as gate (G) and the power terminals are labeled as collector(C) and emitter(E).The i-v characterist ics of a real IGBT are shown, which shows that the device operates in quadrants I and III. The ideal characteristics of the device are shown.The device can block bidirectional voltage and conduct unidirectional current. An IGBT can change to the ON-state very fast but is slower than a MOSFET device.Discharging the gate capacitance comple tes control of the IGBT to the OFF-state. IGBT's are typically used for high power switching applications such as motor controls and for medium power PV and wind PE.

4. Diesel Generator: DG set (a unit of diesel eng ine and governor) is a device which converts fuel (diesel oil) energy into mechanical energy in diesel engine and subsequently converts mechanical energy into electrical energy in a governor. A governor can be defined as a mechanical or electromechanical device for automatically controlling the speed of an engine by relating the intake of fuel. The controller for the engine is a simple speed governor that keeps the turbine operating at its designed speed. The output of the speed governor is throttle signal that controls the fuel going into the engine After a literature review, four models has selected and analysis in order to show the most efficient model which presents a dynamic study of the DG and the more flexible to be used with several technologies.

The models are implemented in Matlab/Simulink and the simulation results will not be presented here. Only models structure is presented and discuss by considering the interaction between mechanical and electrical part of DG Implements a three-phase circuit breaker. When the external switching time mode is selected, a Simulink logical signal is used to control the breaker operation.

5. Breaker resistance Ron(Ohm): 0.001Snubber resistan ce Rs(Ohm):1e6 Implements a 3-phase synchronous machine modeled in the dq rotor reference frame. Stator windings are connected in wye to an internal neutral pointed set (a unit of diesel engine and governor) is a device which converts fuel (diesel oil) energy into mechanical energy in diesel engine and subsequently converts mechanical energy into electrical energy in a governor.

A governor can be defined as a mechanical or electro mechanical device for automatically controlling the speed of an engine by relating the intake of fuel. Implements a three-phase or a five-phase permanent magnet synchro nous machine. The stator windings are connected in wye to an internal neutral point. The three-phase machine can have sinusoidal or trapezoidal back EMF waveform. The rotor can be round or salient-pole for the sinusoidal machine, it is round when the machine is trapezoidal. Preset models are available for the Sinusoidal back EMF machine.

6. Battery: Implements a generic battery that model most popular battery types. Uncheck the "Use parameters based on Battery type and nominal values" parameter to edit the discharge characteristics.Nominal Voltage(V) Rated Capa city(Ah) Initial State-Of-Charge (%)67 .Battery is acts the continuous growth and evolve of vehicle electrification causes the electric power systems to confront new challen ges, since the load profile changes

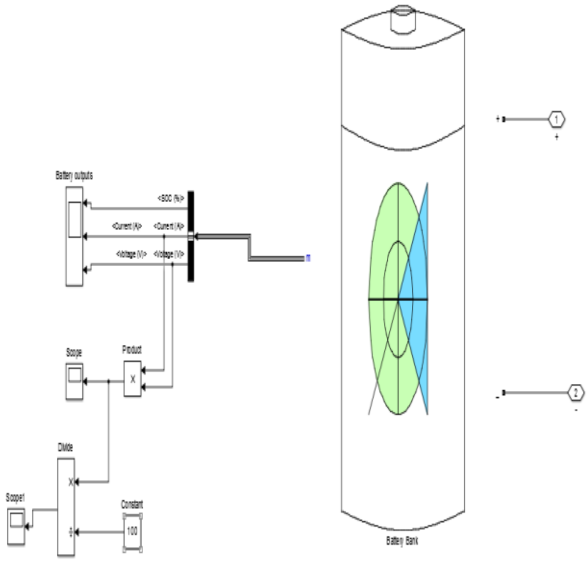

Fig 8. Battery Model.

7. Wind Turbine: This block implements a variable pitch wind turbine model. The performance coefficient Cp of the turbine is the mechanical output power of the turbine divided by wind power and a function of wind speed, rotational speed,and pitch angle (beta).Cp reaches its maxi mum value at zero beta. Select the wind-turbine power characteristics display to plot the turbine characteristics at the specified pitch angle.

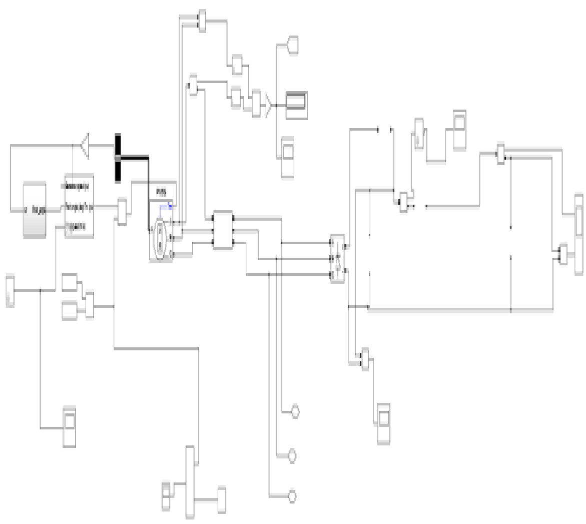

Fig 9. Wind Turbine Model.

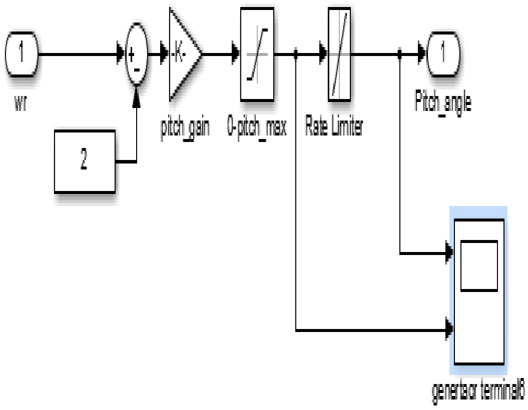

Fig 10. Pitch Angle.

Element-wise gain (y = K.*u) or matrix gain (y = K*u or y = u*K).gain 500Nominal mechanical output power (W): 8.5e3 Base power of the electrical generator (VA): 8.5e 3/0.9 Base wind speed (m/s): 12 Maximum power at base wind speed (pu of nominal mechanical power Rotational speed (p.u. of base generator speed): Pitch angle beta to display wind-turbine power characteristics(beta>=0) (deg): 0The first input is the generator speed in per unit of the generator base speed. For a synchronous or asynchronous generator, the base speed is the synchronous speed. For a permanent-magnet generator, the base speed is defined as the speed producing nominal voltage at no load. The second input is the blade pitch angle (beta) in degrees. The third input is the wind speed in m/s.The output is the torque applied to the generator shaft in per unit of the generator ratings.

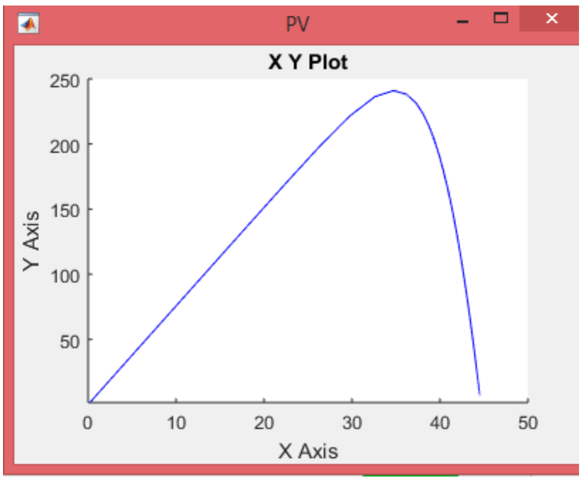

Fig 11. PV Characteristics Waveform.

The turbine inertia must be added to the generator inertia. The five-phase machine has a sinusoidal back EMF waveform and round rotor. Preset models are not available for this type of machine. This block implements a bridge of selected power electronics devices. Series RC snubber circuits are connected in parallel with each switch device. Press Help for suggested snubber values when the model is discredited. For most applications the internal induc tance Lon of diodes and thyristors should be set to zero.

In figure11 show PV characteristics and there are X-Y coordinates voltageVs current plotted. The maximum pow er is generated 230 Kw by the solar cell at point of the current-voltage characteristic where product of V and I is maximum shown in fig 11 Y Axis plotted 230Kw and x-axis point maximum 44I

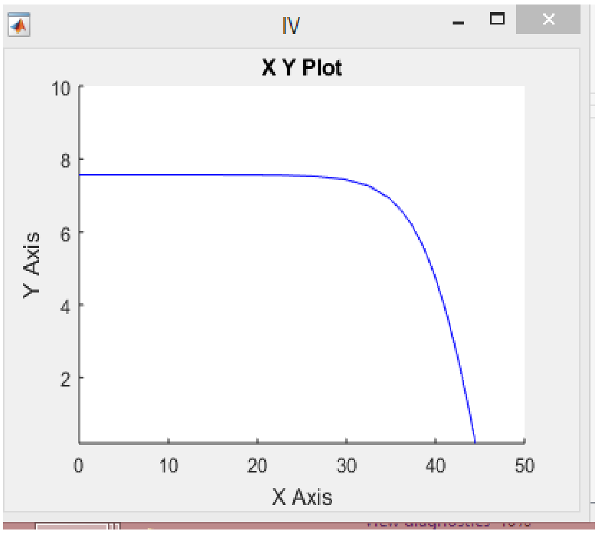

Fig 12. PV Characteristics Waveform.

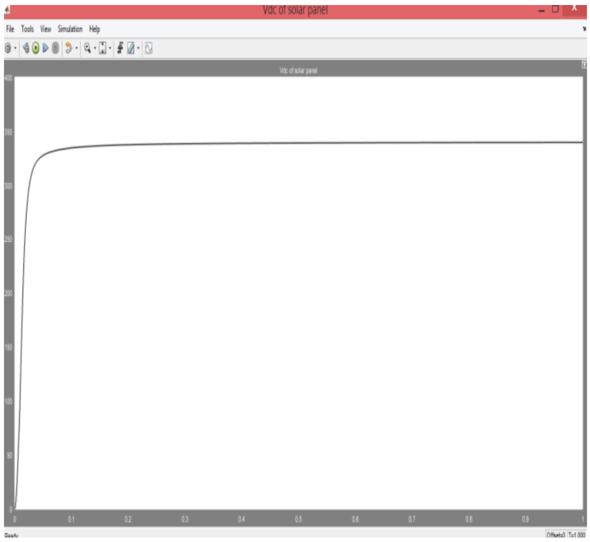

Fig 13. VdcFrom Solar Panel.

The power delivered by a PV cell attains a maximum value at the points.The short circuit current is measured by shorting the output terminals and measuring the terminal current PV cells are made of semiconductor materials with crystalline and thin films being the dominant materials. The majority future other thin film materials are likely going to surpass siliconPV cells in terms of cost and per formance following classes:crystalline, thin film, amorp hous, multi-junction, organic or photochemical .in figure 12 show PV characteristics and there are X-Y coordinates voltage Vs current plotted.The maximum power is generated 230 Kw by the solar cell at point of the current-voltage characteristic where product ofV andI is maximum shown in fig 12.

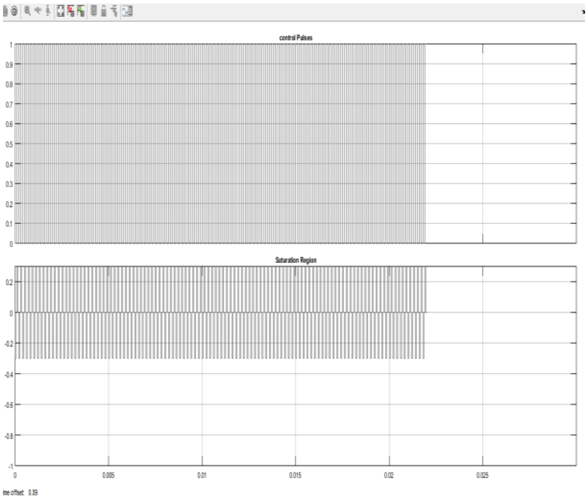

Fig 14. Solar Panel DC-DC Boost Converter Pulses.

8. Stator phase resistance Rs(ohm):0.425Armature induc tance (H):0.000835nertia, viscous damping, pole pairs, static friction [J(kg.m^2) F(N.m.s) p() Tf(N.m)]: [0.01197 0.001189 5] initial conditions [wm(rad/s) thetam(deg) ia,ib (A)]:Implements a three-phase parallel RLC load. Nomi nal phase-to-phase voltage400Vn(Vrms Nominal frequ ency fn (Hz):50 Inductive reactive Power QL (positive var): Implements a three-phase circuit breaker. When the external switching time mode is selected, a Simulink logical signal is used to control the breaker operation. Switching times (s): [4/60 10/60] Breaker resistance Ron (Ohm) 0.001 fig 15 showing saturation region and control pulse on y axis with respect to time on a axis

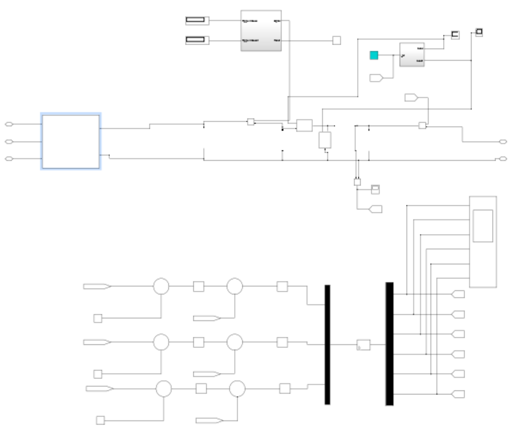

Fig 15. Dc-Dc Bidirectional Converter.

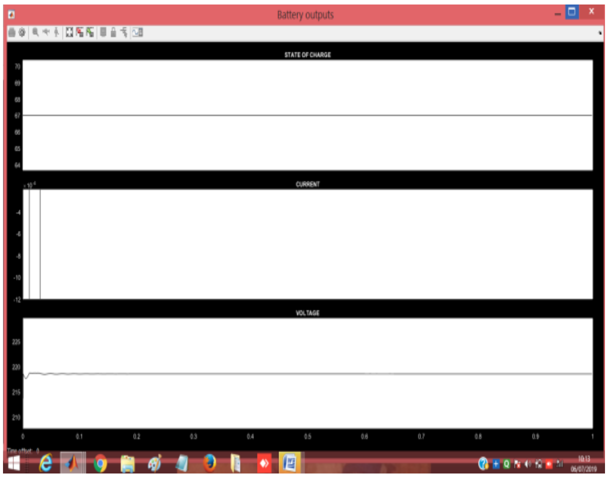

Fig 16. Charging Voltage and Current of Battery.

Fig 17 y axis showing Charging Voltage and Current of Battery with respect to time on x axis

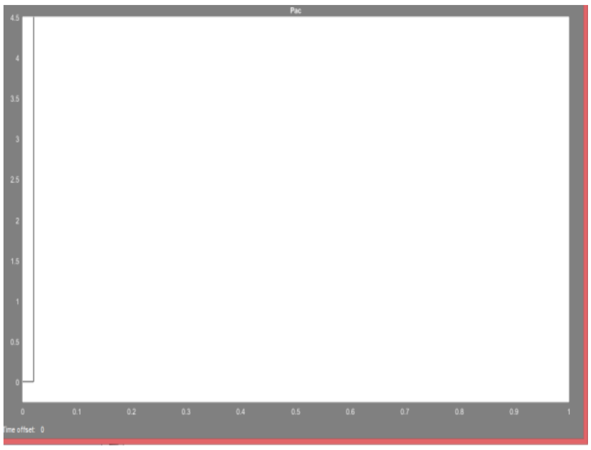

Fig 17. Wind Power.

Nominal mechanical output power (W) Showing Y Axis 4.5W 8.5e3 Base power of the electrical generator (VA): Base wind speed (m/s):Nominal mechanical output power (W): showing y axis Multiply or divide inputs. Choose element-wise or matrix product and specify one of the following:

- or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.
- Scalar specifies the number of input ports to be multiplied.

If there is only one input port and the Multiplication parameter is set to Element-wise(.*),a single*or / collapses the input signal using the specified operation. However, if the Multiplication parameter is set to Matrix (*), a single * causes the block to output the matrix unchanged, and a single / causes the block to output the matrix inverse.in fig.16 wind power show 16Receive signals from the Goto block with the specified tag. If the tag is defined as 'scoped' in the Goto block, then a Goto Tag Visibility

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block must be used to define the visibility of the tag. After 'Update

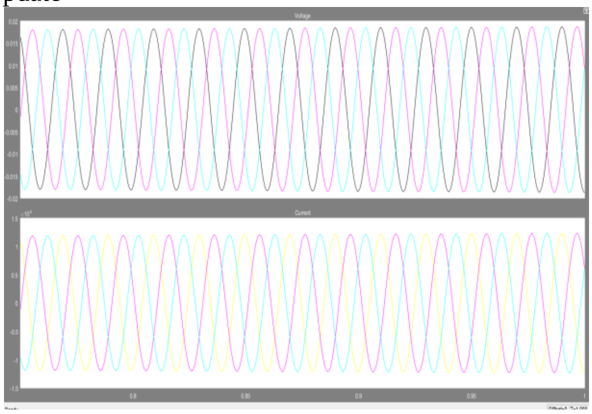

Fig 18. Diesel Generator.

Diagram', the block icon displays the selected tag name (local tags are enclosed in brackets and scoped tag names are enclosed in braces,{}).Multiplyordivide inputs. Choose element-wise or matrix product and specify one of the following: a) * or / for each input port. For example, **/* performs the operation 'u1*u2/u3*u4'.b) Scalar specifies the number of input ports to be multiplied. If there is only one input port and the Multiplication parameter is set to Element-wise(.*), a single * or / collapses the input signal using the specified operation.

However, if the Multiplication parameter is set to Matrix (*), a single* causes the block to output the matrix unch anged, and a single / causes the block to output the matrix inverse.fig 19 y axix showing voltage and current with respect to time on x axis

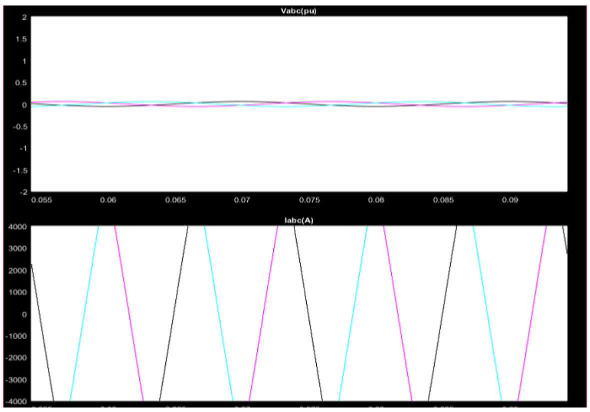

Fig 19. BSM Output Of Diesel Generator.

Diesel engine and governor system. The input1 is the meas ured speed, in rad/s. The input 2 is the reference speed, in pu. The output is the mechanical power. Controller transfer function:Hc=K.(1+T1.s)/(1+T2.s)Throttle actuator transfer function :

Ha= (1+T3.s) / [(s (1+T4.s)(1+T5.s)]

9. Motor: Time delay Td Inertia and viscous friction are modelled in the Synchronous generator. The base power used to specify the initial mechanical power (Pm0 in pu) is the nominal power of the driven generator showing y axis and x axis showing time

10. Linear and Non- Linear Load: A non-linear load is considered linear if its impedance changes with the applied voltage. The changing impedance means that the current drawn by the non-linear load will not be sinusoidal even when it is connected to a sinusoidal voltage. on-linear loads occur when the resistance is not a constant and changes during each sine wave of the applied voltage waveform, resulting in a series of positive and negative pulses.

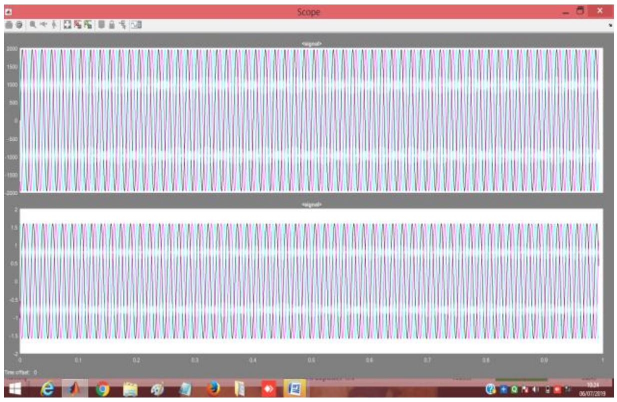

Fig 20. Nonlinear Voltage and Current.

Implements a three-phase parallel RLC load. The block can output the voltages and currents in per unit values or in volts and amperes. Inductive reactive Power QL (positive var): Active power P (W):100 Inductive reactive Power QL (positive var): where voltage x axis show voltage and current with respect to time

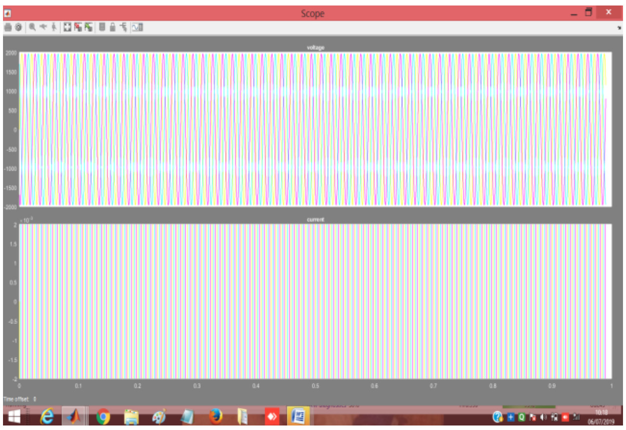

Fig 21. Linear Voltage and Current.

Where voltage x axis show voltage and current with respect to time.

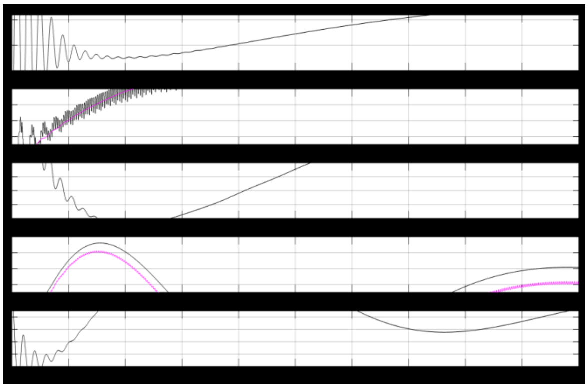
Fig 22. Output Synchronous Generator.

Diesel engine and governor system. The input 1 is the measured speed, in rad/s.The input 2 is the reference speed, input.The output is the mechanical function: Hc =K.(1+T1.s)/(1+T2.s)Throttle actuator transfer function Ha= (1+T3.s) / [(s (1+T4.s)(1+T5.s)] Motor Time delay Td Inertia and viscous friction are modelled in the Synchronous generator. The base power used to specify the initial mechanical power (Pm0 in pu) is the nominal power of the driven generator showing y axis and x axis showing time constants Regulator time constants [T1 T2](s)-[0.01 0.02 0.05] Actuator time constants [T3 T4 T5](s)-[0.25 0.009 0.0384]Torque limits [TminTmax](pu) [0.0 1.1] Engine time delay Td(s)-0.024 Initial value of mechan ical power Pm0(pu)-0.25 Regulator gain-40 Showing Y Axis

IV. CONCLUSION

This concept together with the cost reduction, technology development, environmental awareness, and the right ince ntives and regulations has unleashed the power of the sun. and all system result will be carried out by matlab simula tion is proposed for integrated energy system with renew able sourcesfor integrated isolated micro-grid. Considering the load variation and the fluctuation output power of wind and PV systems, the proposed of this system proposed to further improve the efficiency of the system.The use of the solar-wind with diesel backup system for the power supply of remote areas may give an economically attractive alternative for mobile telecom sector over the use of conventional diesel generators in near future.

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