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ANALYSIS OF PV-WIND HYBRID ENERGYSYSTEM PERFORMANCE USING MATLAB/SIMULINK

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ABSTRACT:

Applications of solar wind hybrid energy systems and their efficient usage (SWHES). Solar energy, the most plentiful natural source of energy, is essential for the creation of energy in the future. Due to the lack of coal, conventional power generation will become increasingly challenging in the future. The thermal power plant's increasing cost per unit of generation. Another factor is the loss of transmission power. Environmental damage will result from traditional power generation's emission of pollutants. To overcome these difficulties in future we have to depend on solar power generation. It is clean source of energy and it can transform to any source of energy with no effect on the environment. To get continuous power supply we should operate wind and solar power plants together as a single unit. By this combined mode of operation, the overall efficiency of the system increases. The combined power generation will give the continuity power supply for household applications with battery as a storage element. SWHES are more reliable to small power application. This configuration also reduces the load on the conventional power generating system with no effect on the environment. It is a stand-alone hybrid Solar PV Wind energy system for applications in isolated area. The wind and solar PV system are connected to the common load through DC/DC Boost converter. The performance of the hybrid system is evaluated under different wind speeds and different irradiation levels. In the last few years the photovoltaic and wind power generation have been increased significantly. A hybrid energy system which combines both solar panel and wind turbine generator it is an alternative for conventional source of electrical energy like thermal and hydro power generation. A simple control technique which is also cost effective has been proposed to track the operating point at which maximum power can be coerced from the PV system and wind turbine generator system under continuously changing environmental conditions. The entire hybrid system is described given along with comprehensive simulation results that discover the feasibility of the system. The modeling and simulation of hybrid system is done using MATLAB/SIMULINK.

INTRODUCTION

According to many renewable energy experts, a small "hybrid" electric system that combines home wind electric and home solar electric (photovoltaic or PV) technologies offers several advantages over either single system. In much of the United States, wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available. Because the peak operating times for wind and solar systems occur at different times of the day and year, hybrid systems are more likely to produce power when you need it. Many hybrid systems are stand-alone systems, which operate "off-grid" -- that is, not connected to an electricity distribution system. For the times when neither the wind nor the solar system are producing, most hybrid systems provide power through batteries and/or an engine generator powered by conventional fuels, such as diesel. If the batteries run low, the engine generator can provide power and recharge the batteries. Adding an engine generator makes the system more complex, but modern electronic controllers can operate these systems automatically. An engine generator can also reduce the size of the other components needed for the system. Keep in mind that the storage capacity must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for one to three days. Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. Many renewable energy sources like solar, wind, hydro and tidal are there. Among these renewable sources solar and wind are the world’s fastest growing energy sources.

SURVEY OF RESEARCH

The permanent increase in the energy demand is considered as one of the most critical issue nowadays. Besides, as conventional power sources are limited and have adverse effects on the planet, has necessitated an imperative search for renewable energy which cause no pollution of the earth. Between these sustainable energy sources, wind and photovoltaic can be considered as the most promising technologies to produce electricity. Wind power can be utilized using large generators to generate great power capacity. Also, solar irradiation can be utilized as Photovoltaic power. Both photovoltaic and wind have their own demerits as they are intermittent in nature and immensely depend on the climate conditions, besides photovoltaic energy can be utilized only during daylight. Therefore, integration of these renewable energy resources as hybrid system can be used for overcoming intermittency and provide high reliability to maintain continuous output power to electrical grid or rural areas. Over recent years several investment and research have been investigated in PV/wind hybrid power system, such as Benadli [1-3], introduced sliding mode control for standalone PV/wind hybrid system. Oskouei [4], proposed quinary asymmetric inverter used in PV/wind hybrid power system with backup battery. Laabidi [5], presented modelling and control strategy of gridconnected PV/wind hybrid power system. Since, the extracted power from hybrid system is immensely dependent on the variations of environmental conditions such as solar irradiation and wind speed. Therefore, the maximum power point tracking (MPPT) strategies are essential to capture maximum power under varying climatic conditions. Several literatures deal with the MPPT control algorithms [1, 3, 6, 7], such as Abbassi [6], investigated fuzzy logic control for extracting maximum power from hybrid power system. The doubly fed induction generator (DFIG) is the most commonly utilized in the wind energy conversion systems [8-10]. Several surveys have been carried out in PV and DFIG based-wind hybrid power system [11, 12]. Among them, Rajesh [11], presented PV and DFIG based-wind hybrid power system to supply continuous power for rural places. Kumar [12], proposed the connection of PV and DFIG based-wind hybrid power system with the electrical grid. Recently, more challenges on the grid-connected PV/wind hybrid power system occur. Among these challenges, enhancement of the injected power quality, extraction of maximum power, and the problems related to the connection of hybrid power system with the electrical grid under any conditions [13-15]. This study investigates detailed dynamic modeling, design and control of PV and wind as hybrid system interconnected to the electrical grid and supply large plant with critical variable loads. The proposed hybrid system consists of two Photovoltaic (PV) stations placed at different locations and one wind farm are integrated into main AC bus to enhance the system effectiveness. The technique of extracting maximum power point is applied for both photovoltaic stations and wind farm to capture maximum power under varying climatic conditions. The objective of this paper is to analyze hybrid system performance under various environmental conditions like variations of sun irradiance and wind speed. Moreover, power flow control method is proposed to supply critical load demand of large plant. The validation and effectiveness of the proposed power flow are evaluated under variation of the critical load demand.

WORKING METHODOLOGY

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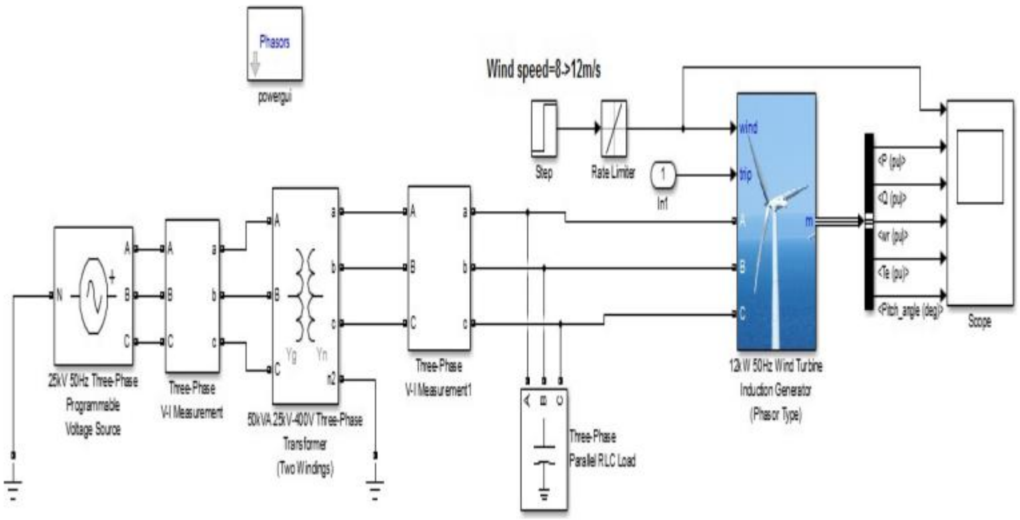

Figure 1 depicts proposed hybrid power system. The proposed hybrid system consists of two Photovoltaic (PV) stations placed at different locations and one wind farm are integrated into main AC bus (25 kV-bus bar). Wind farm equipped with Doubly Fed Induction Generator (DFIG). Also, the wind farm includes Rotor Side Converter (RSC) for extracting maximum wind power, and Grid Side Converter (GSC) to adjust DC bus voltage at specified value. PV stations (A, B) are subjected to different solar irradiations, where they are installed at different locations. The PV station is integrated into the Point of Common Coupling (PCC) bus through DC-DC converter and DC/AC converter. Incremental conductance MPPT technique is used for extracting maximum output power from PV array. PV/wind hybrid power system feeds a large plant with critical variable loads and the electrical utility grid. The plant is composed of 6 production lines. Each production line contains induction machine having rating of 2 MVA. When hybrid system injects power larger than plant demand (load), surplus power will be supplied to the electrical grid. Otherwise, when the injected power from hybrid system is lower than plant demand (load), electrical grid will feed load demand in cooperation with hybrid power system. In addition, when the injected power from hybrid system is unavailable, plant is entirely fed by electrical utility.

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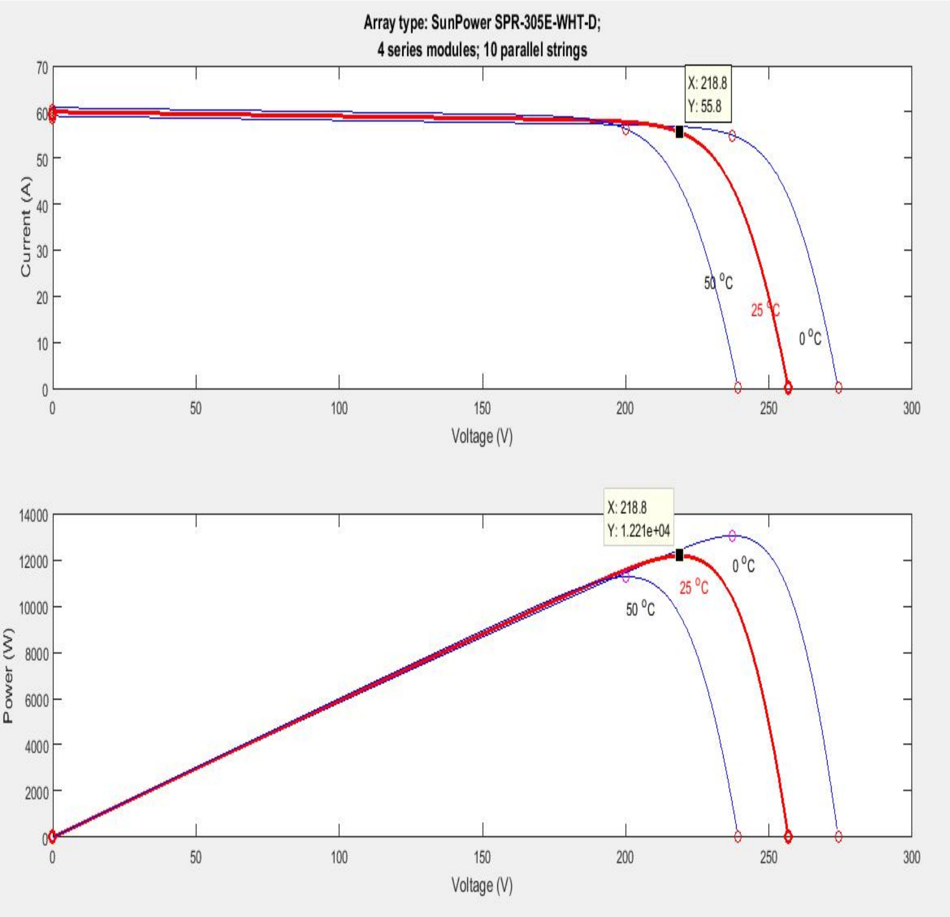

GRAPH 1:VI&PV CURVES

As mentioned in calculations, the maximum power is12.21kWa temperature of 25.Also, notice that as temperature varies from 0to50,the power decreases as voltage decreases.

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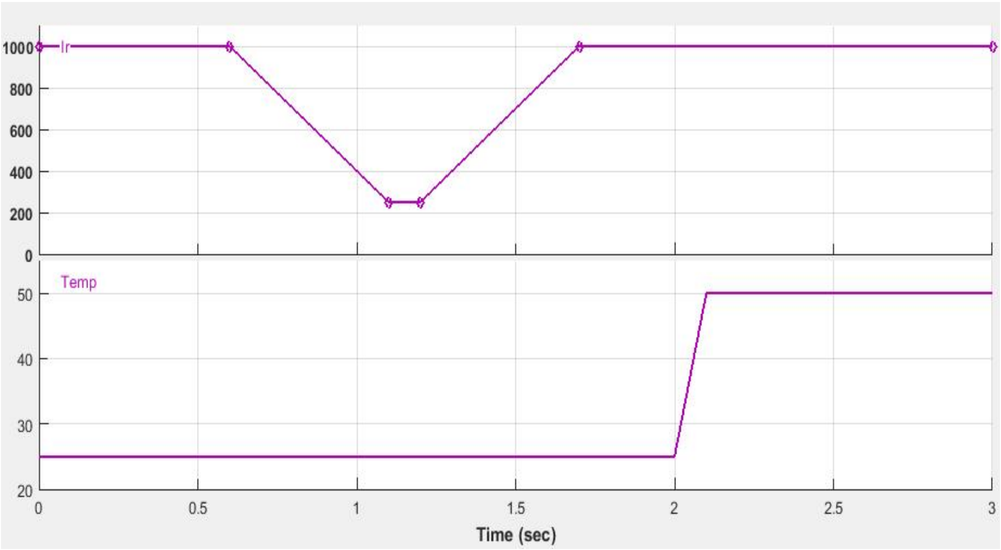
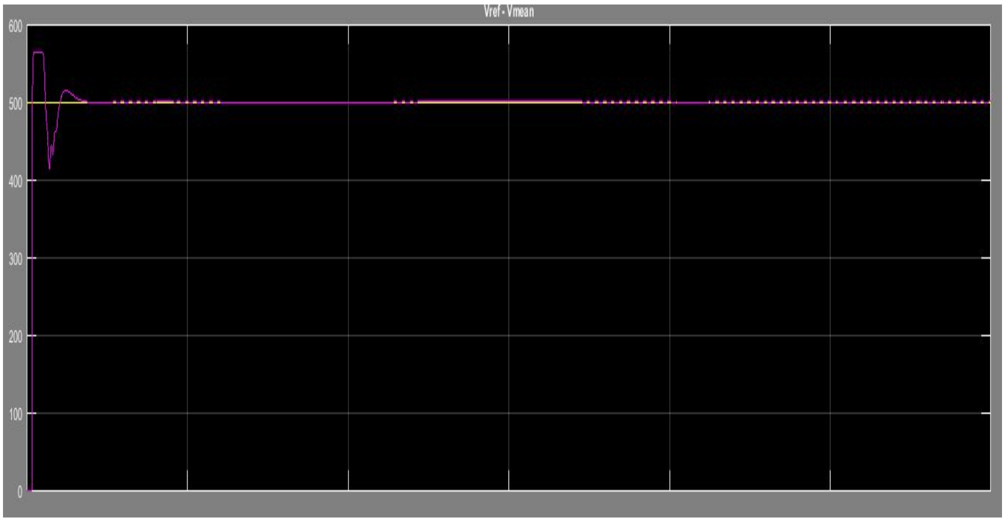
IRRADIANCE&TEMPERATURE



GRAPH2: Irradiance&Temperaturecurve

The irradiance value is changing from 1000 to 250 and back to 250.The value of temperature risesfrom25to50.

V_{dc}IN BOOSTCONVERTER



GRAPH3: Resultant graph of boost converter

The DC voltage remains 500Vafter sometime e of settlement.

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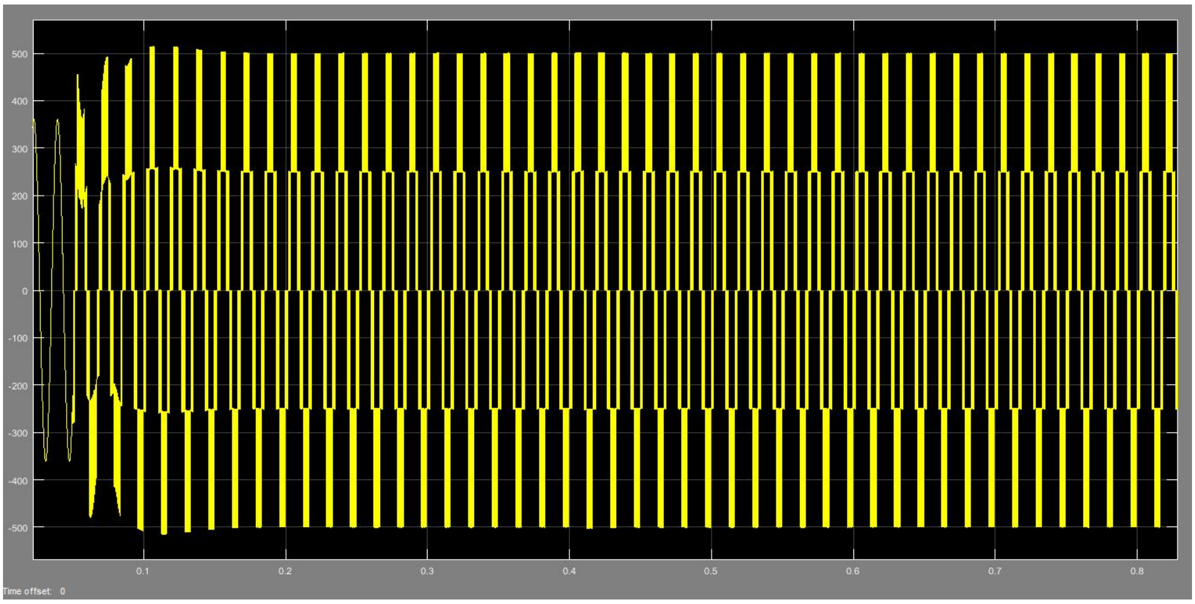
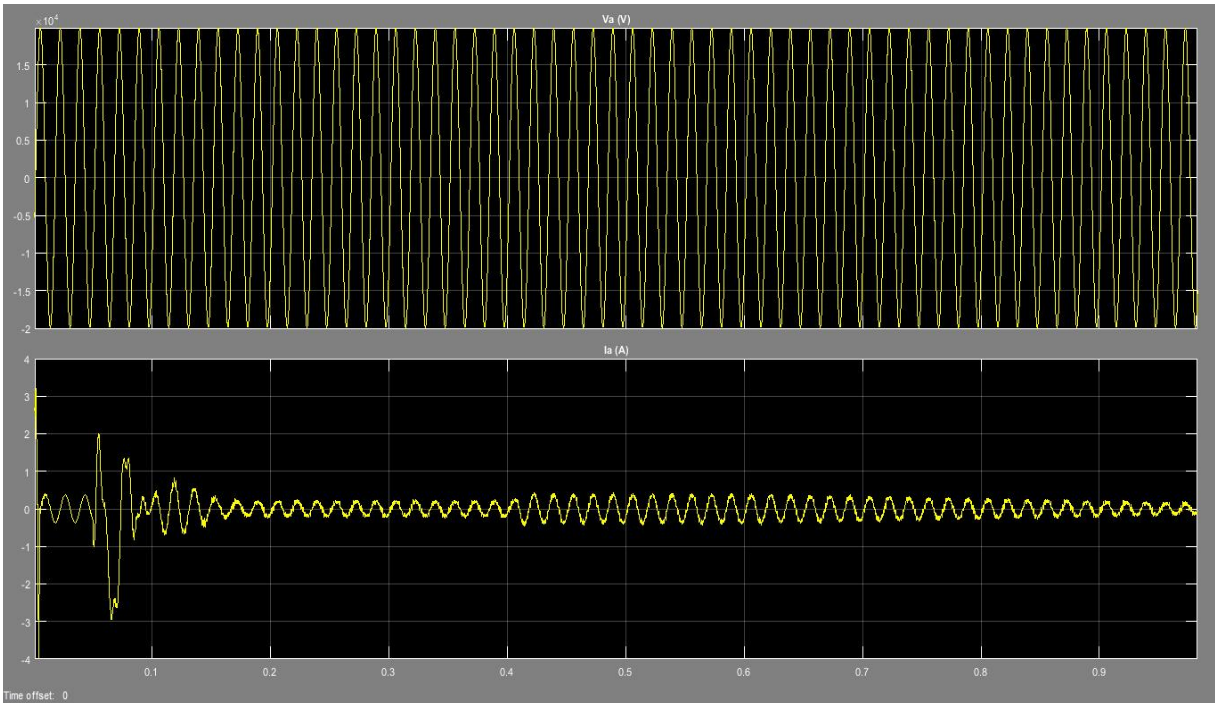
Vab_sc:



GRAPH4: Resultant graph of voltage at inverter

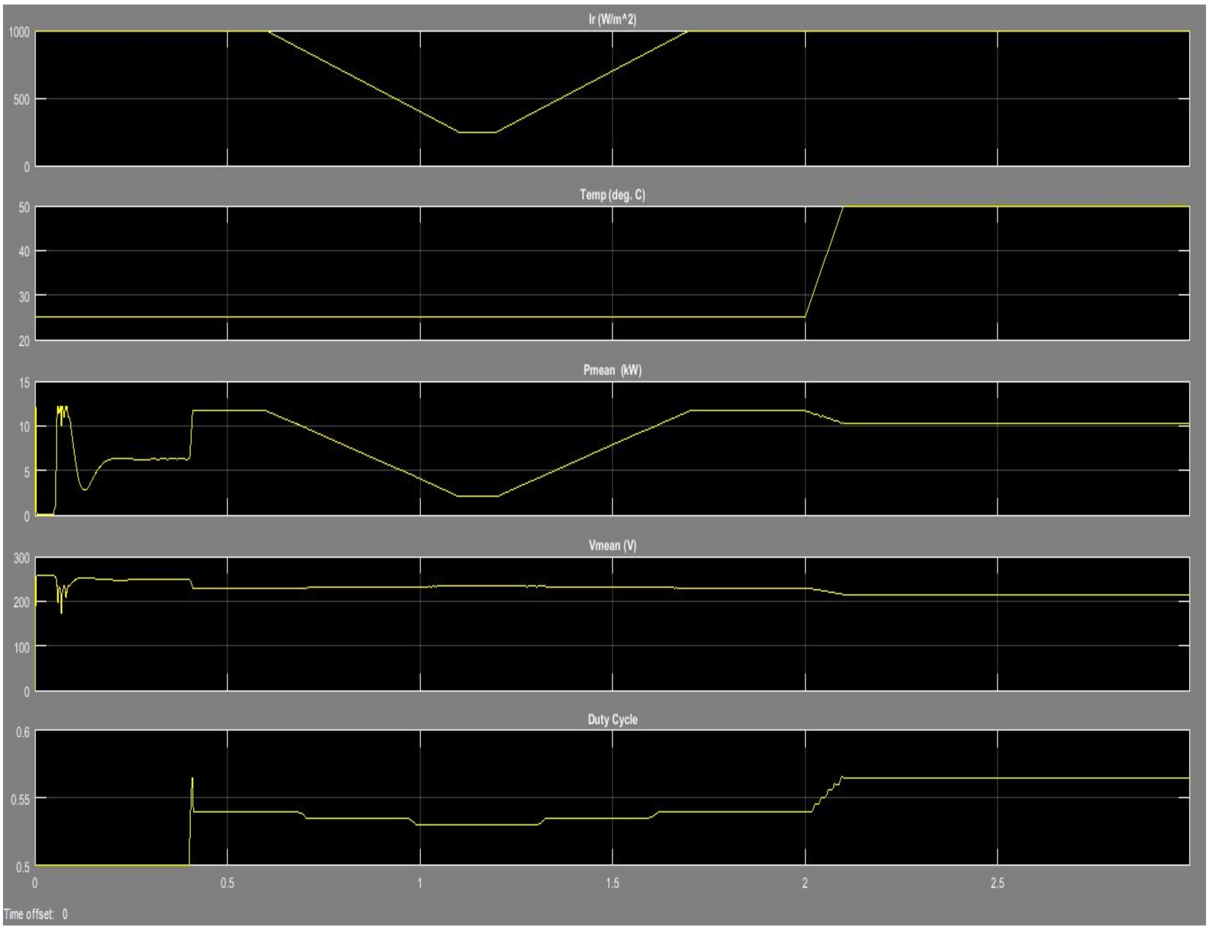
GRID:



GRAPH5: Resultant graph of voltage and current at filter of capacitor bank

Clearly, after passing through filter of capacitor bank, the sinusoid of voltage and current becomes very smooth as compare to the curves after inverter.

PV:



GRAPH6,7,8,9,10:Result antgraph so firradiance, temperature,Pmean,Vmean, dutycycle.

- First graph is of irradiance and itis changing as expected from1000->250->1000.
- Secondgraphisoftemperatureanditischangingfrom25->50.
- 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 andas duty cycle changes the power mean also drops and when Ir rises to 1000W/m2, Pmeanagainrises.
- Fourth graph is of Vmean which changes according to the change in duty cycle graph(fifthgraph)

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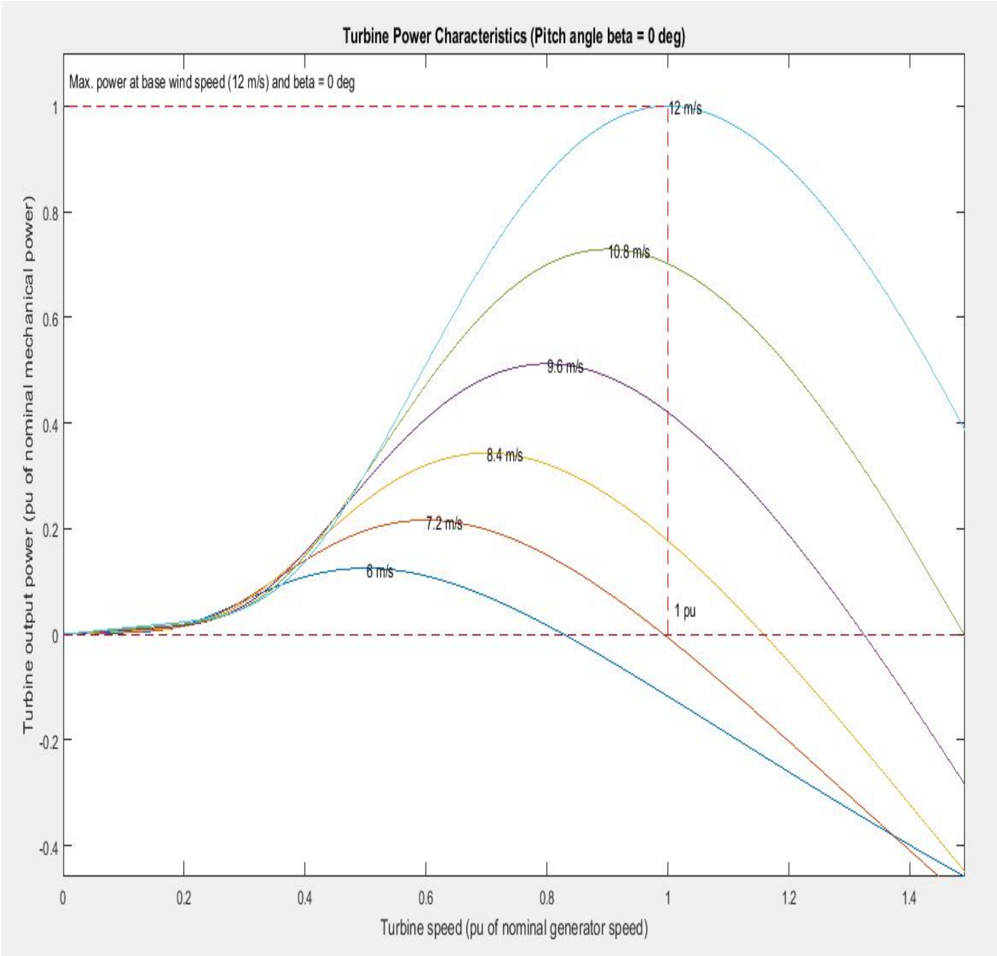
WINDPOWERCHARACTERISTICS:



GRAPH11: Resultant graph of powe routput of windturbin eat different peeds of wind

- This graph is showing the power output at different speeds of wind. As we have selected wind of 12m/s as nominal,thenit shows the maximum powerof1pu(12kW)onawindspeedof1pu(12m/s).
- Power out put on other wind speeds is also shown on the graph.

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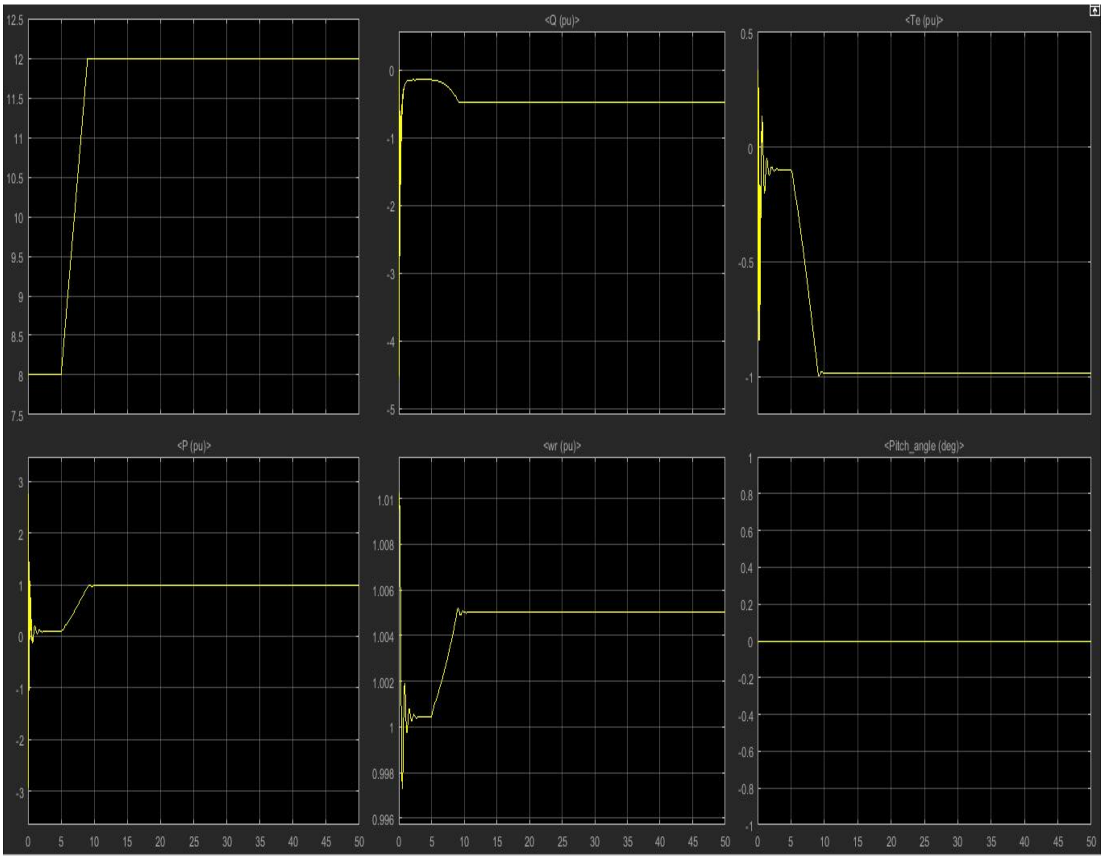
P,Q,wr,Te,PITCHANGLE,WINDSPEED:



Graph 12, 13, 14, 15, 16, 17: Resultant graphs of wind speed, outputpower, reactivepower, rotorspeed,torqueand pitch angle

CONCLUSION

This paper has described a hybrid energy system with variable speed wind generation, photovoltaic system along with power electronic interface under stand-alone mode. Computer simulation was conducted using MATLAB/SIMULINK. In the stand-alone mode the performance of the system is evaluated for various wind speeds and various irradiation levels. Due to variations in wind speed and solar irradiation AC voltagevaries.Battery system is used to maintain the balance between the sourceandload.Thissystemisexpectedtomeetupelectricitydemandinaremotearea.Theperformance of the developed system is evaluated in MATLAB/SIMULINK platform and the results are presented.

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