

DESIGN AND STABILITY ANALYSIS OF HYBRID POWER SYSTEM(USING ETAP)

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Abstract -In the present scenario, we know that the demand for power from the load side is very high and should be a consistent power supply.

The non-renewable power supply is not that effective. It is not providing that amount of power and neither it is consistent and also it's not sustainable i.e cannot be used again in the future. So there is an advantage of integrating renewable power supply to the traditional power grid.

In this project, there is a review of a hybrid power system in which the power flow analysis, transient stability analysis, harmonic analysis, and filter designing is performed.

The IEEE 9 bus system is used for studying the parameters and the analysis is done using ETAP software.

The Power System has a wind turbine, solar PV array, energy storage system, diesel generator for backup, and a battery bank. The power flow analysis has been done for measuring the power supply at different loads. It is studied for different cases after the 3 phase fault detection. Then transient stability analysis is done which includes fault detection and fault clearing for the stability of the grid network. Then there is a harmonic analysis which is important to remove harmonic current/voltage for improving the power quality. The harmonic distortion is eliminated by methods such as harmonic filter designing and capacitor banks.

Keywords: Hybrid System, Fault Detection, ETAP, Transient Analysis, Harmonic Analysis, Fault locating system, Renewable Energy Source.

1.INTRODUCTION

In today's scenario, maximum reliability is tending towards renewable energy resources and so does their need is increasing and this increasing demand for energy has set researchers to adopt new methodologies. Very soon renewable energy sources are going to take crucial places in the future energy system. Moreover, fossil fuel sources are unevenly distributed on the earth and in particular location if there is an abundance of other natural resources that can be utilized as sources of renewable energy. Many countries and researchers are working collectively over these projects and hybridization of energies playing a crucial role in today's demand side. As a result, researchers are thinking about utilizing and mixing renewable and non-renewable resources for meeting up the up growing energy demand hence the idea of the hybrid energy system came. In a hybrid system, there can be many power generation resources, for example, wind turbines, solar photovoltaic cell, small hydro system, diesel generators, etc. The hybrid system is capable to provide electricity supply small systems, a small community to very large areas including remote island grid. In recent, due to remote power transmission constraint, the hybrid power system is getting popular in many remote communities in developing countries. In remote areas, transmission and distribution expansion are

very costly as well as transportation of diesel fuel, coal, gas transmission are very expensive hence conventional energy sources cannot provide low-cost electricity to remote

locality. The use of renewable power generation and distributed energy system offers a solution to this problem which can reduce use of fossil fuel, cleaner generation, and cheap electricity. However, different renewable sources and diesel systems are providing electricity at different rates. Combining these all sources, there is a need for optimization and unit commitment methodology to get cheaper electricity based on the availability of energy sources.

The objectives of this project are to design a hybrid microgrid which includes wind turbine, solar system, energy storage system & backup diesel generators and study the transient stability of system, load flow analysis, power-factor using ETAP software considering different generation system's availability/downtime and load conditions.

2.LITERATURE SURVEY

Sr. No.	Paper Title	Year	Work
1.	Power ---Flow analysis of hybrid power system using ETAP	2017	The author investigated the total power at each bus(active power+ reactive power).
2.	Transient Analysis of a hybrid system	2017	The author investigated the fault location and remove the fault by opening the circuit breaker.
3.	Harmonics Analysis of the hybrid system	2019	The author investigated the harmonics analysis of the overall system and eliminate the harmonics by using filters.

3.REVIEW OF RESEARCH PAPERS

As we all know that power systems are required for generation and distribution of power for various purposes so their protection

and efficiencies are important aspects. There are many types faults, which occur in power systems that need to be cleared as soon as possible so that power systems don't get affected and they are not harmed to severe conditions. So there are many methods of fault detection and their removal which requires a lot of manpower and time consuming and also real-time fault detection is not possible. So in these research papers, the author has discussed the power at all the buses. So that we can compare between the power supply and power demand. By the help of etap find the overall transient analysis of the system so that it can detect the fault location and by the opening of circuit breaker remove the faulty section with the healthy section of the circuit and later on remove the fault or disturbance from the overall system. Then there is a harmonic analysis which is important to remove harmonic current/voltage for improving the power quality. The harmonic distortion is eliminated by methods such as harmonic filter designing and capacitor banks

4. APPROACH OF OUR MODEL

This chapter describes the methodology to implement the Hybrid Wind-Solar System and simulate in ETAP software program. The Wind – Solar- Diesel Hybrid power system was tested on a simple network. An IEEE 9-Bus test system consists of initially of nine busses, three generators with a total capacity of 519.5 MW & a total load of 330.618 MW is taken as a test network. The IEEE 9-Bus system is slightly customized to simulate the Solar-Wind Hybrid system shown in Figure. The the modified network consists of two generators – G1 which operates as a voltage-controlled generator and the backup generator and G2 which operates as the battery bank since it operates as a swing generator to supply the load in case of not enough power from other sources and a combination of wind turbines represented by one 163.2 MW wind turbine connected to bus-7 via bus-11 and a PV panel represented simply by a battery (2552 AH, 143 V) which connected to the bus-9 through an inverter (inv1). Inv 1 is placed between bus 10 and dcbus1

5.CIRCUIT DIAGRAM OF PROPOSED SYSTEM

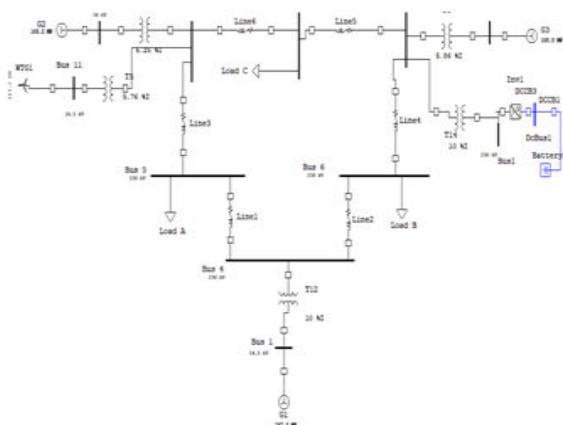


Fig-1

The above Circuit Diagram represents the single line diagram of the hybrid system (using ETAP).

5.1 WIND TURBINE

It is used for power generation purposes. It generates power by using wind hence it is a renewable energy source. it changes the kinetic energy of wind into electrical energy.

5.2 SOLAR PANEL(PV ARRAY)

It is used for power generation purposes. It generates power by using sun energy hence it is a renewable energy source. it changes the solar energy of the sun into electrical energy. many number of solar panels are connected in series/parallel for converting sun energy into electricity.

5.2.1 INVERTER

It is an electrical device that is used for converting dc signals into ac signals. It is also known as a source converter (convert DC into AC). Power electronics devices are used in the inverter.

5.2.2 TRANSFORMER

It is an electrical device that is used to step-up/step-down voltage level. A Step-up transformer is used to increase the voltage level. Step down transformer is used to decrease the voltage level.

5.3 CIRCUIT BREAKER

A circuit breaker is an electrical device which is used for switching purpose. It is designed to protect electrical equipment or electrical circuit from any fault and disturbance. Its function is to detect the fault and immediately discontinue electrical flow.

5.4 RELAY

Relay with circuit breaker combination is used for breaking the fault section of the circuit from the whole healthy section. It is important in a power system. Here in case of overcurrent is flowing through any load due to disturbance it conveys the message to a circuit breaker for braking faulty section.

5.5 DIESEL GENERATOR

It generates electrical power output worked as a power generation source of energy. It is a combination of a diesel engine with an electric generator to generate electrical energy.

5.6 ETAP

h) Saving of fossil fuels.

ETAP is a software. Which is used for design, simulation, operation in power system.. It stands for ELECTRICAL TRANSIENT ANALYZER PROGRAM.

5.7 HYBRID POWER SYSTEM

A hybrid power system is defined as a system in which two or more sources are connected to provide electricity or heat or both to the consumers. These different sources are solar-photovoltaic, biomass, geothermal, hydropower, etc.

6.ADVANTAGE

- The system helps in the identification of exact faults in the respective phase.
- User environmental protection, especially in terms of CO₂ emission reduction.
- Improves system time response and performance.
- Low running cost.
- Constant power generation source.
- Ecofriendly to the environment.
- Fulfill the overall demand of the load.

7. SIMULATION MODEL

CASE1: WIND AND SOLAR IS ACTIVE

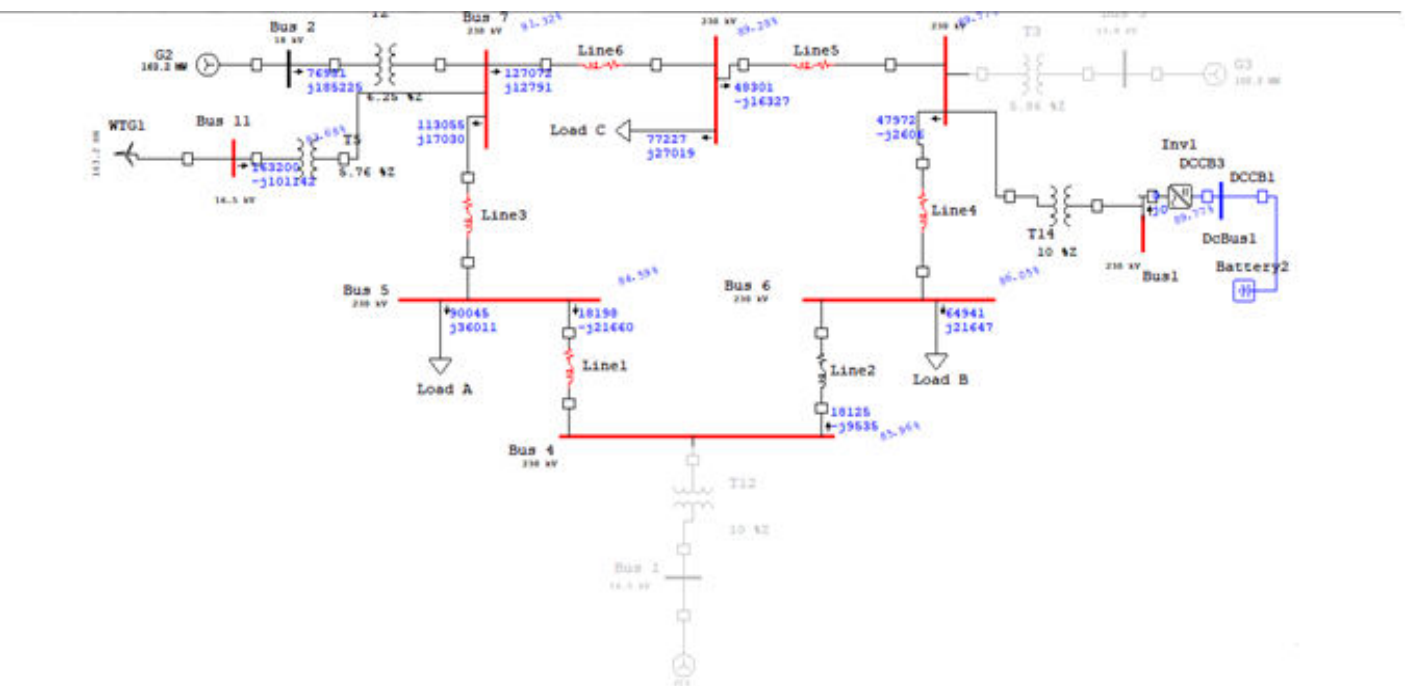


Figure 2: WTG and solar is active

CASE 2:SOLAR IS ACTIVE

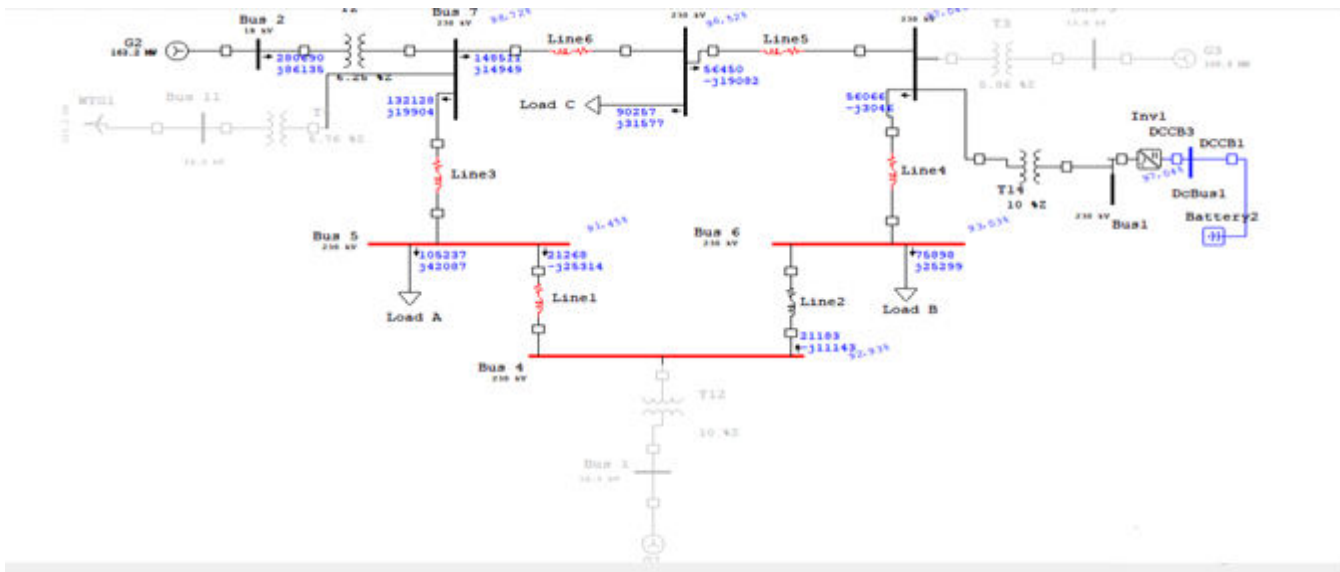


Figure3: Solar is active only

CASE 3:WTG IS ACTIVE

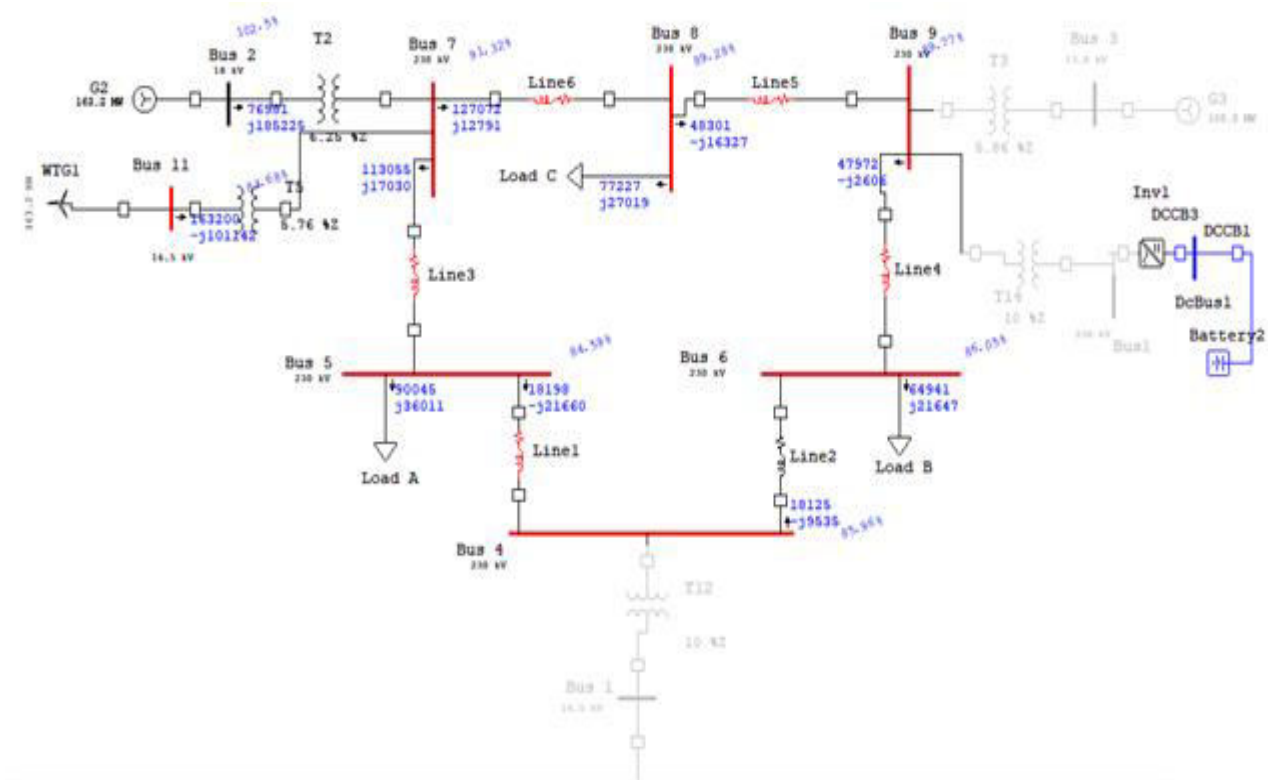


Figure 4: WTG active only

CASE 4: GENERATOR IS ACTIVE ONLY

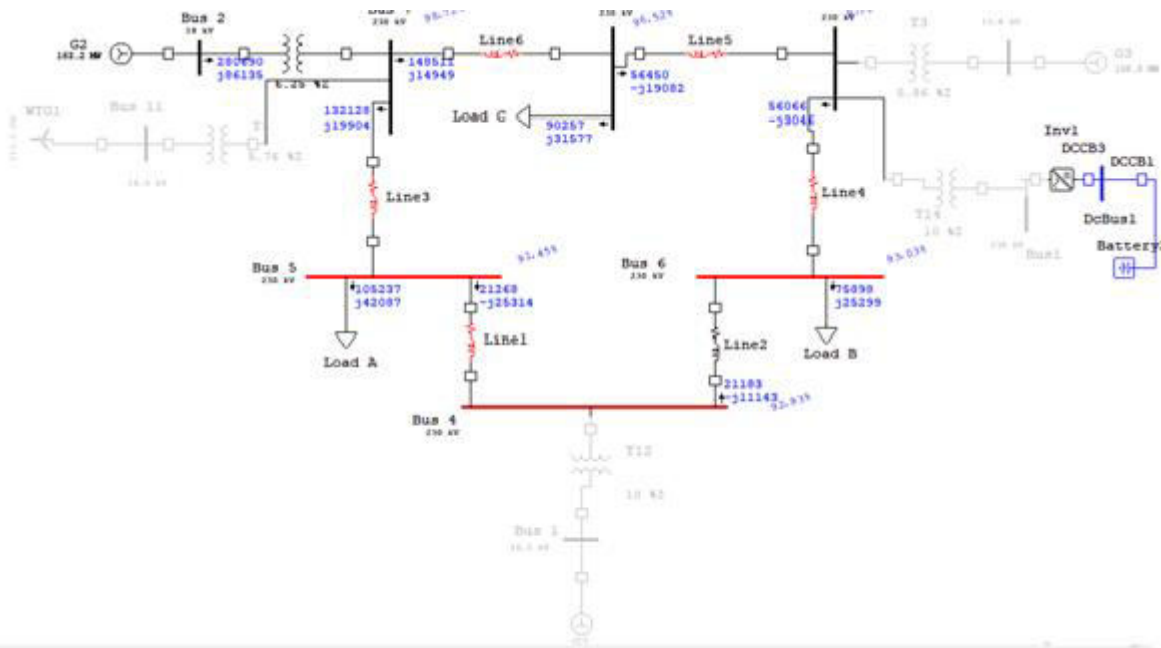


Figure 5: Generator is active only

8.SUMMARY TABLE

CASES	WTG	PV CELL	DIESEL GENERATOR	BATTERY	ANALYSIS
CASE 1	ON	ON	ON	OFF	The bus near wind turbine is overvoltage
CASE 2	OFF	ON	ON	ON	PV system operates with battery bank maintain the required voltage level
CASE 3	ON	OFF	ON	OFF	Bus at wind turbine is overvoltage and the transmission line is the overload
CASE 4	OFF	OFF	ON	OFF	The whole network maintains the required voltage profile but one line is overloaded.

9.CONCLUSION

In this paper, the key technologies of the hybrid power system have been studied and reviewed. A hybrid power system consists of Solar PV, Wind turbine, Diesel Generator, and energy storage system along with the energy conversion system. In this report, the Entire network is based upon IEEE 9 Bus system. Which is modified and implemented on ETAP software. This hybrid system is classified as an isolated network. The simulation and analysis have been applied in different combinations of operation and fault location. Overall the results demonstrate the multi-function capability of the system to provide uninterrupted power to the load and stabilize the load voltage when the grid experience under/over voltage conditions it has no negative impact on the stability of the system as it is also found that hybrid power system including solar and wind generation can meet up the load demand. The ETAP ver. 7 does not provide a solar PV symbol, so in that case, the solar PV system is represented by a battery. At present, solar and wind sources are available in various parts of India. As mentioned, the Hybrid power system can be adopted by remote areas and it's popular due to economic benefit also, Isolated networks of remote areas or could be tied to the national grid when a large amount of energy is produced. It can be concluded that the advancements are being made in the area of renewable energy and power generation.

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