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POWER FLOW ANALYSIS OF WIND FARM FED 220/132KV POWER GRID

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Abstract

The operation , design and planning for the power system stability and better performance with the increase of reliance on electrical power is increasing drastically the most significant and beneficial approach for the power system operation is to investigation of problem relating to power system stability and maximum power flow without losing system continuity and safer function of the equipment's ,in order to make power system stable and examine system performance can be visualized and predicted by means of load flow analysis in this analysis predefined structure of power system and transmission line data is added to evaluate its functionality with ETAP.in this research paper we have collected that data from the power grid and made one line diagram with putting real time data in ETAP we examine various cases to validate the data and results with practical data of grid. The possible outcome of this research is that we see our current equipment's are working well under the limits and remain under contingency while increasing the capacity of power grid. The research is being carried out with actual grid data to rightly predict the overload scenario with addition of further new circuit.

Keywords: *Power Flow analysis, Electrical Transient Analysis Program, Single line diagram, Wind Turbine Generator, Renewable, Load Flow Analysis, Simulation.*

INTRODUCTION

In our new energy systems, such as solar energy, air is growing rapidly as a source of electricity, including resources in existing system flows (also known as power flows), which are the backbone of the system and are important for the planning and operation of the system, because we know that the demand for electricity is over and loading learning streams can play an important role. Load flow is more accurate, computational time is less, and grid flow loads are performed using the very reliable user-friendly software ETAP Electrical Transient Analyzer program. This Jhimpir network is in Trend province and is connected to the NTDC (National Transport and Shipping Company). The main cause of all major failures of the power system is the lack of voltage, reactive power cannot be transmitted far, especially under heavy load conditions, therefore, it should have a backbone in our energy load flow system (also known as power flow), is very important for planning the system and operation, because we know that the energy required for electricity is higher and expanding day after day, loading learning flow can play an important role. Load flow is considered an obligation under the utility component to plan, operate, operate economically, and replace development with electricity. Load analysis flows are further used for stability in transient, optimum power flow and continuous or emergency studies, thus overcoming growing demand not only by developing more production

stations, but also by developing advanced programs and reorganizing the current grid to add data from flow analysis. (ETAP), which makes it easier to find accuracy than manual computing, and by implementing software electrical transients and analysis programs (ETAP), all of these things are easier to find accuracy than manual computation. By implementing a software electrical transient and analysis program (ETAP), all of these operations are easier to find accuracy than manual calculations (Gomez, A.V.,2019**)** the power flow analysis of a 138/69kV grid station and examined different operating setups using ETAP and result obtained from the load flow analysis to improve the system performance by different approaches of power factor rectification with fixed and switched techniques which originates with plentiful technical and financial profits. These techniques aids contain improvement in voltage stability and loss in power, with minimum equipment's loading, and reorganizing costly network advancements.
(Kemble, S.C., 2017)did the Load Flow analysis of 132 kV Hingna II By constructing the one line diagram in software named Electrical transient analysis program, and with various cases he did the analysis of substation such as by doing loss of generators , a transmission line , a transformer and a load , and to determine the load analysis at various cases and self-made conditions and he also regulate the optimal size and area in which capacitor bank is to overcome the problem of under voltage. (Kapahi,R., 2013)used ETAP software to support his research for the analysis of 220/132kV substation in which he carried out load flow analysis and found the problem of under voltages at the substation buses , and he found this software useful and excellent tool while doing the study ,and system planning also to determine the optimum size and location of capacitor to surmount the problem of under voltage and he also found this software useful while connecting or disconnecting the loads to identify the system voltages under various cases to find out the system equipment's ratings.(Mumtaz,M., 2018) did the analysis of CIGRE Micro-grid Model which he simulated in ETAP software to analyze the load flow to determine its voltage Stability, the power flow both real and reactive among all the buses. The results stated that the power flows between the buses and loads then he also explained the system voltage at buses which he concludes that these results will be helpful during system physical implementation and planning. Further research work incorporates the load transients and transient's stability study. (Natkar, K., 2015)did the Power flow analysis of power station 220/132 kV in ETAP. To carry out the study for future planning and expansion of the substation in addition to determine the best process for the present system which exist, after analysis he found the problem of under voltages, then he provide the solution of under voltage by adding a capacitor to overcome this issue to maintain the voltage levels under safe operating values of equipment.(Patel, Y., 2014)Carried out power flow analysis for reasonable process of the power system. In this analysis he adopted the results by using simulation software Power World. In this software he also analyzes the effect of adding and removing of transmission line from the power system component, simulator results gives information for what amount of power the system works with maximum efficiency and he also found the software is user friendly which provides visual results.(Rehman,Z.,2017)After analyzing the 132kV net voltage two months later, he noticed the voltage problem using ETAP software, and then he also solved the pressure problem by inserting capacitor set 8MVAR to the enflower, and then he compared the results and evaluated the problem in the case of stress and loss reduction and tension not critical.

(Albadi, M., 2019)Consider a simple energy system to check the flow and compare it. Since these equations are nonlinear, which is why he used these methods to parse these equations, such as?

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Newton Rapson, Gauss-Seddle, and the fast implementation process, when he passed the solution, he concluded that he found that the fast separation method was faster and simplified by the Newton Raphon method, which was faster, faster and faster in comparison(Shinde, K.S.)The load analysis process verified the data of the 220kV MSETCL substation by comparing the results with the three methods used for manual calculations (data collected by ABT measures installed on substations and ETAP), and then technically found that the result difference between all bus voltages was less than 1% and the difference between all power flows was less than 2%, which he found useful for ETAP software.

POWER FLOW ANALYSIS

BUS CLASSIFICATION

The asexuality and phase angle of the pressure and strength and reaction force are the main volumes associated with the bus or node in the energy system. Based on four quantities, the bus is divided into three categories, two of which are specified and two are found by comparative solutions.

Charging case: The active and reactive load bus forces are defined, but a portion of the bus voltage is determined. Load tanks that allow the purchase of voltage allowable quantities, such as 5 percent, will specify only active power (PD) and response current (QD), and the voltage phase angle is not important. The voltage generator controls the bus. A standard real power (PG) and a standard voltage size are defined for this bus. Determine the voltage phase angle and the remaining two tasks of the bus's reactive power generation (QG). Relax, reference, or swing the bus. The swing bus size and voltage phase angle are known, while the actual power (PG) and reactive power (QG) are determined by the load flow solution. This is a generator bus that causes transmission losses, resulting in additional real and reactive power supplies. For this factor bus is called a swing bus or a slack bus.

Bus Classification	Specified Parameters	Obtained Parameters
Generator Bus	Voltage magnitude, Active power	Voltage angle, Reactive Power
Swing Bus	Voltage magnitude, Voltage Angle	Active Power, Reactive Power
Load Bus	ctive Power, Reactive Power	Voltage magnitude, Voltage angle

Table 1: summary of three types of busses

ETAP

ETAP is an electric tool with an open circuit electric transition analyzer program that provides users with faster, real-time data and complete solutions to all-electric problems, such as current, arc flash lamp and short circuit overview, transient stability relay coordination, cable capabilities, estimate expectations. One of the most advanced structures of prevention is that it provides atmospheric design with continuous functions of processing. It provides personalized clarity for anyone with a small or large energy system. Here we focus on additional high voltage lines related to 132kV analysis.

RESEARCH METHODOLOGY

Simulating model of 220/132kV grid under study is developed in ETAP as shown in (Fig.1). The model is made to simulate in order to determine the performance of grid Table 2: Summary of Data collected from the grid for generating plants. The actual rating of the grid components such

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as transformers summary of data in Table 5, circuit breakers, current transformers, potential transformers, isolators and various buses data summary at (Table no 3,4) the data are taken from grid and modified accordingly in the ETAP.

Generating Plants	Control Breaker	Capacity	Voltage Rating
ARTISTIC	(E17Q1)	50MW	11/132kV
MASTER	(E13Q1)	49.5MW	11/132kV
Metro	(E5Q1)	60MW	11/132kV
Sachal	(E7Q1)	49.5MW	11/132kV
TBA	(E4Q1)	50MW	11/132kV
TBC	(E3Q1)	50MW	11/132kV
TGS	(E9Q1)	50MW	11/132kV
TGT	(E8Q1)	50MW	11/132kV
UEP	(E18Q1)	99MW	11/132kV
ZEPHYR	(E14Q1)	50MW	11/132kV

Table 2: Summary of WTG Capacity and Ratings

Name of T/line	Control Breaker	*Length of line (KM)*	Conductor	
			Type	*Capacity (Amps)*
TMK Road CKT-I	(D3Q1)	83.98	Greely ACCR	1582
TMK Road CKT-II	(D4Q1)	83.98	Greely ACCR	1582

Table 3: Summary of 220kV transmission line Capacity

Name of T/line	Control Breaker	*Length of line (KM)*	Conductor	
			Type	*Capacity (Amps)*
TMK City CKT-I	(E16Q1)	75	Greely ACCR	791
TMK City CKT-II	(E17Q1)	75	Greely ACCR	791

Table 4: Summary of 132kV transmission line Rating

Name of T/line	Bus Bar	*CT Ratio*	Conductor	
			Type	*Capacity (Amps)*
220 KV Bus Bar-I	2 Bundled flexible	2400/1	Coreops is	2416
220 KV Bus Bar-II	2 Bundled flexible	2400/1	Coreops is	2416
132 KV Bus Bar-I	Rigid	1600/1	Coreops is	4000
132 KV Bus Bar-II	Rigid	1600/1	Coreops is	4000

Table 5: Summary of 132/220kV Capacity.

Transformers	Make	Ratting	Capacity Amps	
			HV	LV
Auto T/F T-1	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-2	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-3	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Auto T/F T-4*	XIAN XD China	250 MVA, 220/132kV	656.099	1093.498
Power T/F T-t	PEL	10/13MVA , 132/11kV	56.9	652.7

Table 6: Summary of Transformers capacity.

RESULTS AND DISCUSSION

CASE 1: WIND FARM RUNNING AT MAXIMUM CAPACITY

In this case WTG are running at maximum installed capacity and power injected to 132kV bus with 2 incoming grid circuits of TMK and power is taken from 220KV two kV circuits as , Results of various equipment's and buses.

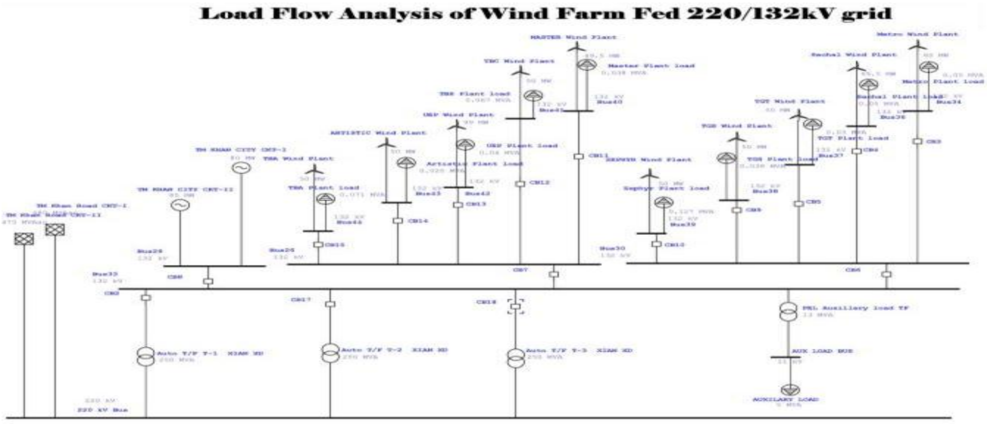

Figure 1: One-line diagram of System under study in ETAP

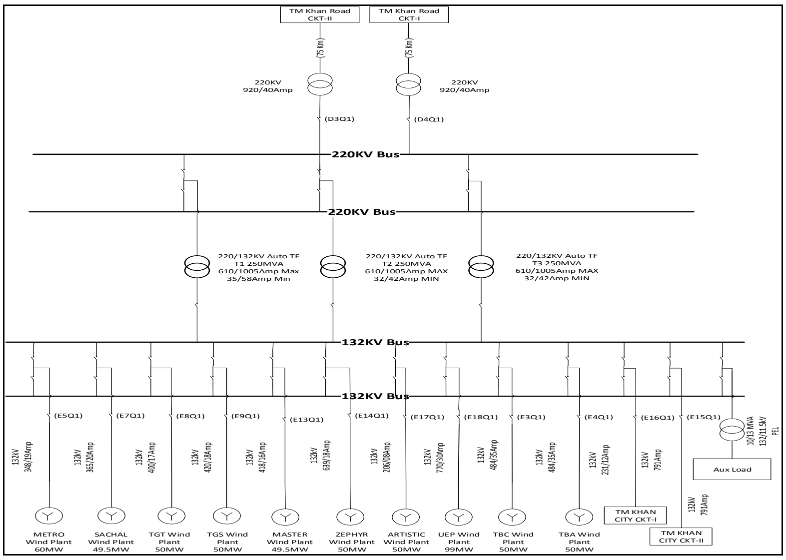

Figure 2: One-line diagram of System under study

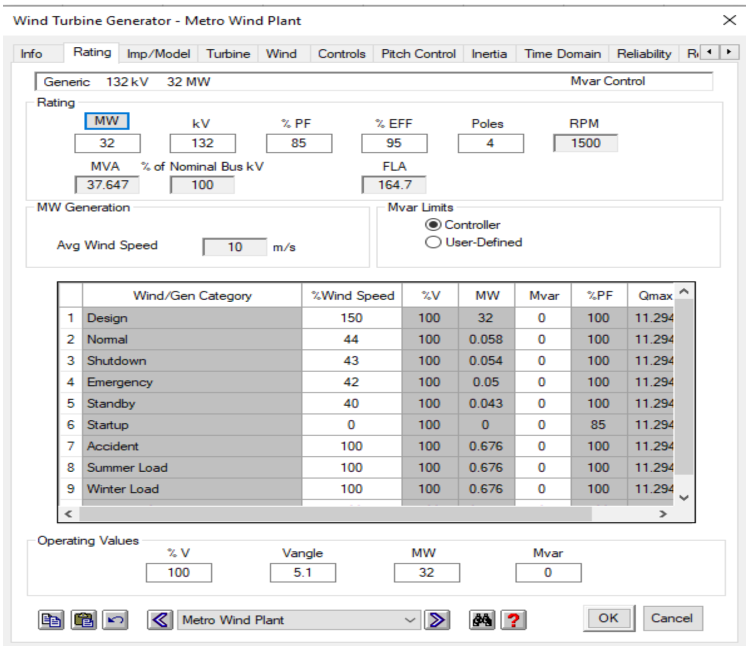

Figure 3: Property Diagram of Wind Turbine generator

In figure 3, the parameters we have placed to simulate the analysis of wind farms to incorporate the total generation.

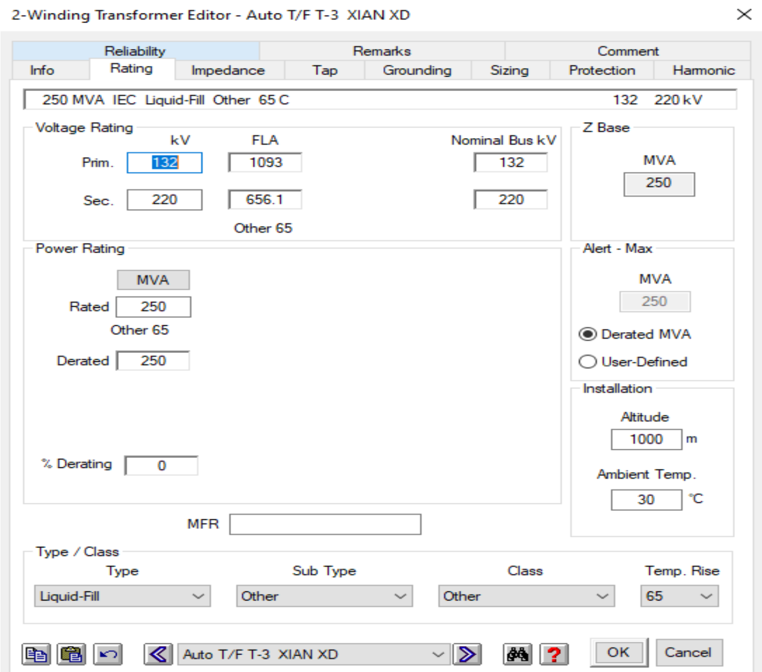

Figure 4: Property Diagram Transformer

CASE 2: WIND FARMS RUNNING AT DIFFERENT CAPACITIES (AS PER GRID DATA)

In this case WTG are running at different generation ratings capacity which are collected form the grid data here we will compare four months data i.e. (March, April, May, June) to analyze the power flow injected to 132kV bus with 2 incoming grid circuits of TMK and power fed to 220kV two circuits as shown in **(Fig.1)**, Results of various buses, transformers and generator loading are shown respectively.

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CASE 3: WIND FARMS RESPONSE AFTER ADDING ONE MORE AUTOTRANSFORMER IN GRID.

In this case WTG are running at optimum ratings capacity and the new transformer of 250MVA is added to the simulation which is going to be installed in future at the present grid to increase its power capacity to accommodate more power ,which will allow to take more power from the 132kV TMK city grid circuits and wind power stations, so that it can transfer more power to the load side which is 220kV two circuits connecting TMK Road Grid as shown in Results of various generators, buses and transformer loading are shown in respectively to examine the load flow so that all bus, transformer are well under limits according to the software calculation.

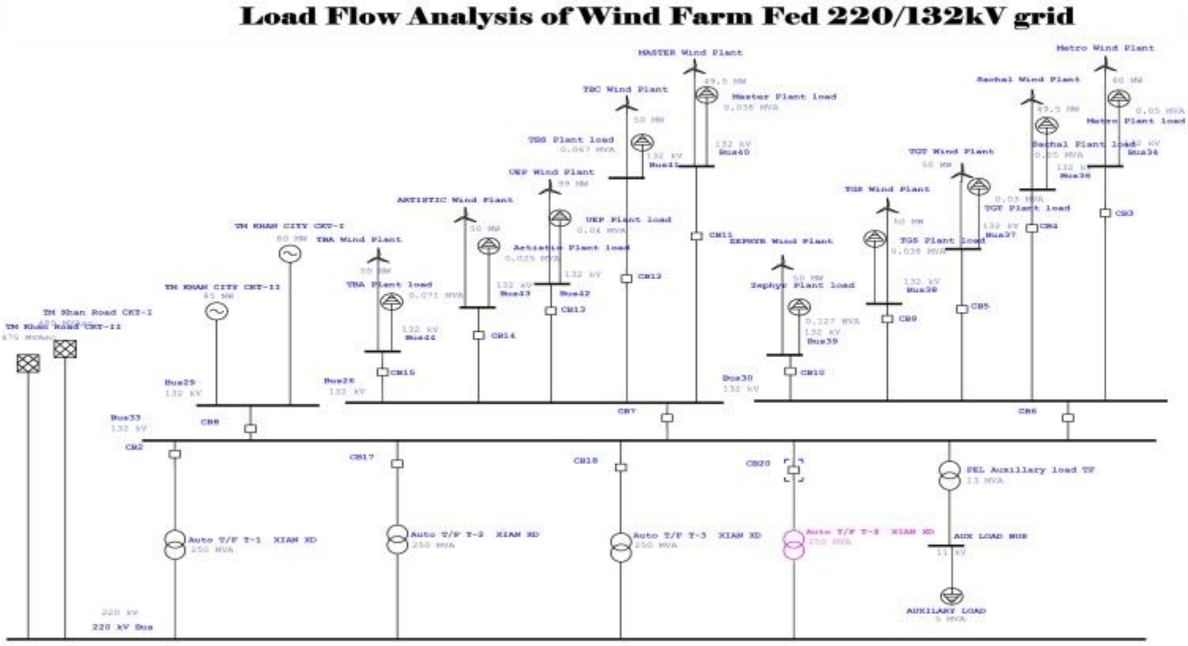

Figure 5: One-line diagram after expansion of system in ETAP

CASE 4: **RESPONSE OF GRID ON LOSING GENERATOR**

In this case WTG are running at nominal ratings capacity then one of generator is lose after that we will see the Results of various equipment's and buses as shown in respectively to examine the load flow on 132kV TMK and load side which is 220kV two circuits connecting TMK Road Grid.

CONCLUSION

This paper points out that load flow analysis for future network expansion will be performed successfully, simulating the optimal load capacity for various situations, such as maximum power generation, so that we can see that the bus's behavior of a fault-free system at maximum capacity will remain the same. Its capacity and the grid include transformers to increase its capacity from 750 MW to 1120MW, we analyzed from the simulation, the performance of all bus is far below the specified limits, can continue to operate safely, without any obstacles to the maximum power fluctuations, and loaded into the maximum possible state, the simulation results confirm the effectiveness of the proposed work.

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