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# Impact of Large Scale Renewable Integration in Bangladesh Power System

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***Abstract :*** *Bangladesh, a small developing country of south Asia observing a rapid economic transition from agriculture to industry and facing a threat of unsatisfied consumer demand of energy exacerbating with growing population. Keeping the huge potentially in mind, we need to create diversification in energy source and wind energy could be one possible solution. To see the effect of renewable energy which is the wind energy in national grid in Chittagong zone (which is the largest zone among six zones in Bangladesh) in constant speed wind and also observe its transient effect on stability which is also considering the occurrence of the fault on buses which are not similar. Wind energy plays a good source of renewable green energy without making a massive change in transient stability and sometimes comparatively less recovery time. Moreover, wind energy converted to wind power poses a high potentiality providing electricity through the reliable wind turbine without generation, pollution could bring fastness which is in Bangladesh economy system*.

***Keywords -*** *Wind turbines, Dynamic behavior of wind, Modelling of Bangladesh power system, wind integration on Bangladesh power system.*

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## I. Introduction

Bangladesh, one of the most deeply inhabited country with 161 million people depended on agriculture now transforming to an industrial reliance country achieved around 6 which is the percentage of the growth of GDP in last two decades [1]. Government aiming to be a developed nation which has taken a plan of master "Vision 2041" which definitely rely on adequate power generation capacity of a country. In 1962 Bangladesh inauguration with WAPDA (Water and Power Development Authority) took its first stages toward modern Power utility with an 80 megawatts hydropower plant which is now 1.75 of the total capacity of the country generation. Although the country is limited with natural resources its 62-percentage generation depends on Natural gas and 21.97 percentage depends on furnace oil and the energy of renewable is one percentage [3]. Including public and private sector total generation capacity is 13179 megawatts and the maximum demand served by BPDB (Bangladesh Power Development Board) which is 9212 megawatts with the rate of electrification is seventy-six percent [4].

## II. Renewable Energy in Bangladesh Power System

The government of Bangladesh has taken a methodical approach to improving sustainable energy administration alongside with the conversational energy source and developed many renewable energy sources and several projects are ongoing and some are under planning. Bangladesh Power Development Board has founded the "Directorate of Renewable Energy and Research & Development" in 2010 and has started to scrutiny the possibility in Solar, wind, biomass and other renewable sectors. In line with the target to use solar energy a "500 megawatts, Solar Power Mission" has introduced to advocate the use of solar energy. Three electrification project with solar power has established in in Juraichori Upazilla, Barkal Upazilla and Thanchi Upazilla of Rangamati District by Bangladesh power development board(BPDP). 2008-2009 fiscal year a 1.06 kilowatts power Solar PV System is introduced in Angoorpota and Dohogram Chitmohol. A total of 43.37 kilowatts power Solar Pv system has established in the fiscal year of 2010-2011 and 63.86 kilowatts power in 2011-2012 and 93 kilowatts power in 2012-2013. To enhance renewable wind energy sector 4x225 kilowatts = 900 kilowatts capacity Wind Plant established at Muhuri Dam area of Sonagazi in Feni by Bangladesh power development board which is grid connected also in Hatiya Island, Noakhali an off-grid 7.5 megawatts Wind-Solar Hybrid System with hydrogen flurried oxide/Diesel Based Engine Driven has established. In addition, a 1000 kilowatts Wind Battery Hybrid Power Plant at Kutubdia Island in 2008 [2].

### 2.1 Type A: Fixed Speed Wind Turbines

The wind turbine of fixed speed (Fig. 1) which can be handled the variation in rotor speed which is less than one percent squirrel cage induction machines are straight to the power grid. Generally, they serviced pitch control to control power expelled from the wind. Hub can be rotated several degrees into the wind. Secondly, stall controlled turbines, the rotor blades are stiffly adjusted to the hub which is planned so that the air flow over the blades qualified from the streamlined flow to refractory flow at apex wind speeds. The limits power of mechanical which are turned out by the wind at high speeds. Fixed speed a synchronous wind generator, capacitor bank also connected to the side of minimum voltage. Moreover, a synchronous induction generator linked to the box of gear [5]. There are enough advantages of fixed speed wind speed turbines likes low cost, easy to maintain, robust, reliable and it also proved in the field [6].

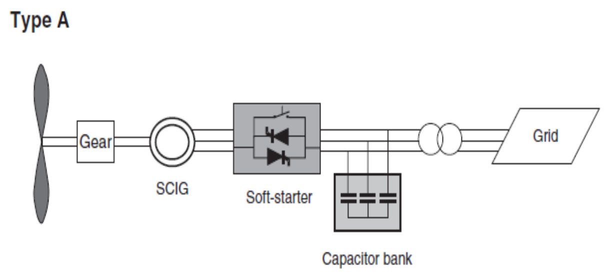


**Fig.1** Block diagram of Type A wind turbine

### 2.2 Type B: Variable- Slip Wind Turbines

Variable speed wind turbines (Fig. 2) can work at a capacious limit of rotor speed. This turbine usually supports blades-pitching. An operating slip of ample range variation can be gained by a controlled resistance in the rotor circuit of the turbines of variable slip. The rotor resistance may drain power because of heat [5].

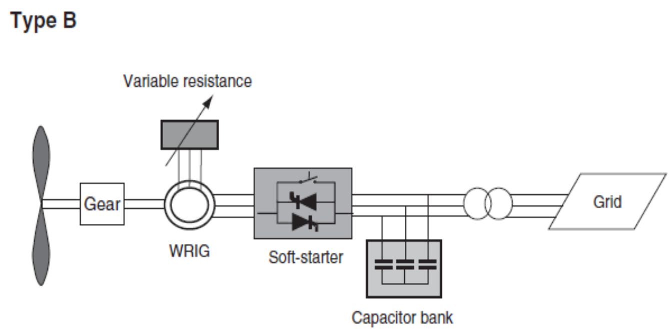


**Fig. 2** Block diagram of Type B wind turbine

### 2.3 Type C: Doubly Feed Induction Generator (DFIG) Wind Turbines

A dynamic model of DFIG (Fig. 3) which can assist to improved decouple control of effective and the power of reactive. An induction machine of wound rotor which is not dissimilar to a wound rotor induction machine. DFIG recovers the slip power. It helps to lower the machine stress and the extraction of wind power which is culminated [7].

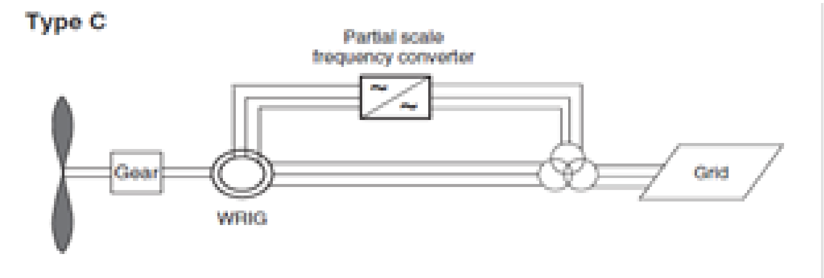


**Fig. 3** Block diagram of Type C wind turbine

### 2.4 Type D :Filled Convert Wind Turbines

The only power flow way from the turbine (Fig. 4) of wind to the grid is not forward to forward which is AC/DC/AC converter. It has no the connection of direct grid. It may corroborate induction generator. The simulation of full converter by the machine of permanent magnet alternator (PMA)[5].

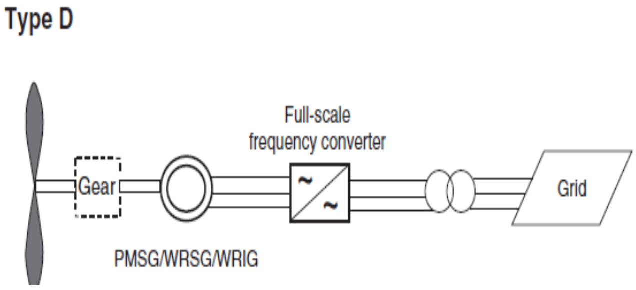


**Fig. 4** Block diagram of Type D wind turbine

## III. Power System Diagram to Terminate In Force As Not Allowed and Balanced

Required power production can be expressed as,
PG =PD +PL+PW……………. (1)
From (Fig. 5), the illustrative of power system,
Where,
PG = Required power production.
PD = Absorbed power.
PL = Z1-Z3, Impedance Electrical loss of the dance.
PW = Wind energy production.
Refer to "(1)" is to be valid. Regardless of if it short or long term look. Equations also mean that it cannot save the electric power system. Therefore electrical (style) of must be adjusted against the source of variables of the same generation supply system in the demand changes. The objective of the main supply system is providing power to consumers at any time at an inexpensive cost. One who can define the requirements of main consumer perspective [8].

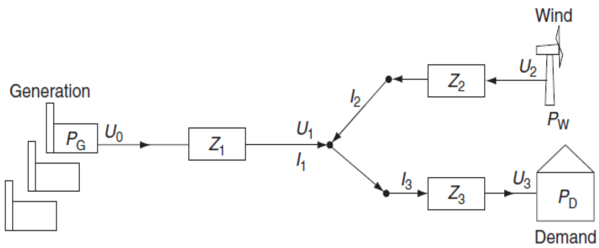


**Fig. 5** Illustrative Power System

### 3.1 Influence of Power System Dynamics

However, squirrels at the power plant used in a generator which is synchronous with constant speed wind turbine have some important differences in the cage of induction generator. The controllable engine which is used in conventional of power plants. It can which is adjust the machine to apply to generators to counteract, it helps to reduced frequency if it has decreased the frequency of power. When the frequency increases engine power is reduced, less frequently to increase the forces in the contrast. It is because this wind energy cannot control the wind can be. Moreover, the stable speed turbines which is tend to dampen the difference in frequency or the mass of rotating turbines release the energy to save energy. But the effect in the power plant of synchronous generators is weak. In a different kind of generator is the main author of power plant facts to counter frequency adjustable attributed the variety, we want to highlight the responses here [9].

### 3.2 Dynamic Behavior of The Wind

More and more wind turbines which are grouped in a land or marine wind farms. A common reason is the desire to concentrate the impact which is visual of the wind turbine wind effectively place your limited. If the blades which are modern wind turbines are located vertically, a total apex of 150 meters. Tend to put wind farms off the coast due to the turbulence intensity is weaker, wind and noise problem is so serious, reduces the impact which is visual, if the farm of wind is located far distance from the coastal area. All possible configurations that are bolstered with the not useless of windmills for power generation essentially that they share certain features on the interaction of wind and grid. Poor and changing these features cases, the power output of the predictability of the maneuverability and energy. However, depend on wind response and disturbance frequency wind farm configuration to voltage. Therefore, discuss the Terminal voltage drops and failure to change various the configuration of the wind farm associated with different frequency responses [11].

### 3.3 Variable Speed Wind Turbine

The behavior of dynamic Speed WTG has radically different turbines of fixed-speed. The frequency which is converter of power electronic and the separation of mechanical frequency which are conveyed the turbines of variable speed. During normal operation, those types of separation are also during the after the disturbance takes place. Power electronics are responsive to the current with very, very short time constant of thermal which is described in the paper. When the voltage which is fallen down then the semiconductor current increases very quickly. kilohertz-order is power electronic converter controller roller which has the greater sampling rate. Cheating which will be noticed by the power electronic converter and it bolster to avoid damage to the converter in variable speed wind turbines will be not connected immediately. The entrance system of Variable-speed wind energy Turbine remarkable if this effect is, of course, is not desirable. Variable-speed wind turbine which is not connected with minimum energy fall and you can lose huge amounts of generation. This situation is in the high voltage network fault occurring voltage drop large geographic areas to occur. This is a system in the field of the connected level controls to the serious problem of the balance of power [10].

## IV. Results and Analysis

### 4.1 Modeling of BD Power System

Bangladesh Distribution Board (BPDP) is accountable for the major proportion of electricity generation and distribution, mainly for the urban area leaving Dhaka city and west Zone of the country. A mammoth capacity expansion plan has been taken by Bangladesh power development board(BPDP) to add about 10500 megawatts Generation capacity in next 5 years to gain a goal of 24000 megawatts Capacity according to 2010. By 2021 BPDP also poses a benevolent desire of ensuring quality and reliable electricity for the people of the country and aiming for an ultimate socio-economic development. To keep pace with the fast demand and also, keeping the goal in mind, the power system has been expanded and the vision of a better economy with PGCG is being uplifted by forwarding electricity to all through the reliable transmission. As the purpose of power grid company of Bangladesh (PGCB) promises a proficient and productive management of general power grid united with the feasible and worth delivery of electricity to the range of the country [12].

### 4.2 Block diagram of Chittagong zone power station

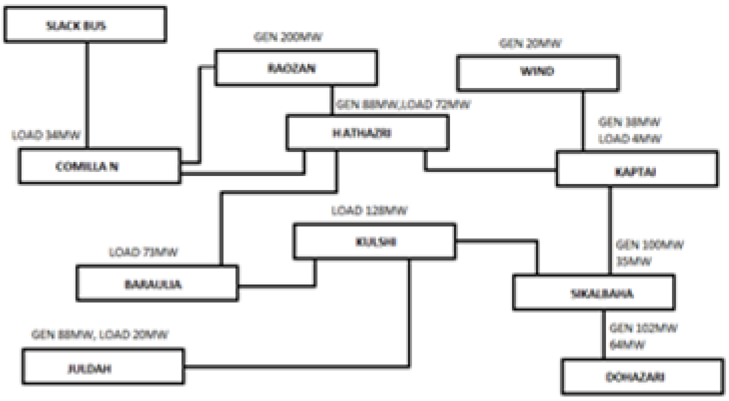


**Fig. 6** Block diagram of Chittagong zone power station.

From this block diagram (Fig. 6), there are many areas which are including Chittagong zone power station like Comilla N (the north side of commila), Raozan, Kaptai, Sikalbaha, Kulshi, Hathazri, Baraulia, Juldha etc. There are variation types of loads, generators are including in those areas. Some areas have only loads like Kulshi, Baraulia etc. Consequently, some areas have combined load and generator like Kaptai, Hathazri,Juldha etc. Moreover, some areas have focused on just only generators like Raozan, Wind.

### 4.3 Modeling of Chittagong zone power station in the Power World Software

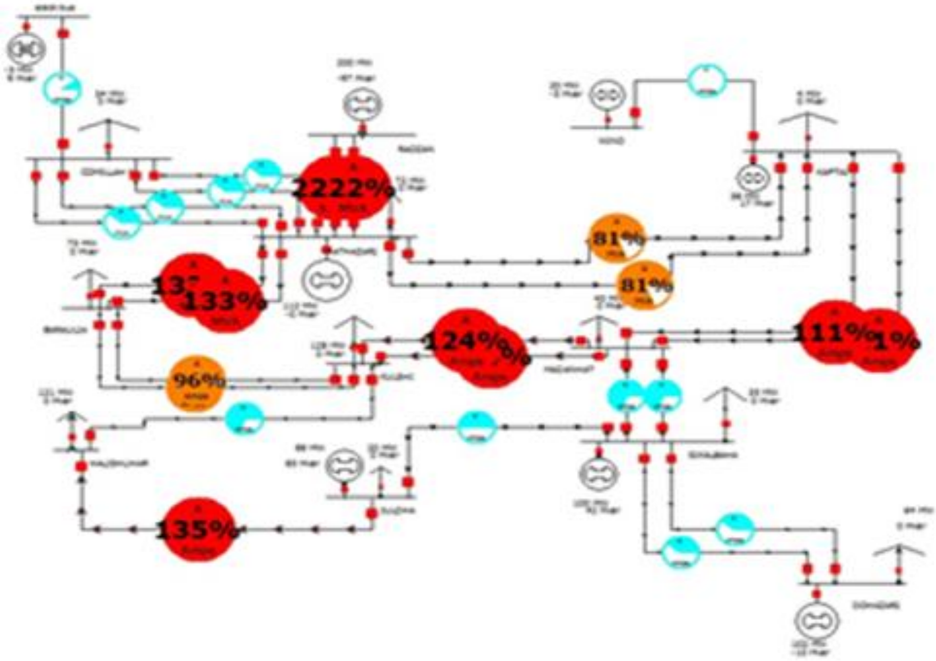


**Fig. 7** Modeling of Chittagong Zone Power Station in the Power World Software

From this model (Fig. 7), some areas of Chittagong zone power station in Bangladesh which are simulated by Power World Software 6.0.1. From this software, we also calculated the percentage of the flow of current, how many MVAR power consumed and how many Megawatts power distributed. Moreover, we also calculated the percentage of MVA.

### 4.4 Data Tables

**TABLE 1** Generation Data and Load Data

| BUS | GENERATOR (megawatts) | LOAD (megawatts) |
|---|---|---|
| 1. Comilla (N) | nill | 34 |
| 2. Barulia | nill | 73 |
| 3. Hathazari | 88 | 72 |
| 4. Kulshi | nill | 128 |
| 5. Sikalbaha | 100 | nill |
| 6. Dohazari | 102 | 35 |
| 7. Kaptai | 38 | 64 |
| 8. Halishuhor | nill | 4 |
| 9. Raozan (2) | 200 | 121 |
| 10. Madanhat | nill | 45 |
| 11. Juldha | 88 | 20 |

From this (Table 1), we see that the highest generator generates the power which is 200 megawatts in Raozan (2) and the highest loads in Kulshi which is 128 megawatts.

**TABLE 2** Impedance and Capacity

| NAME | SIZE | VOLT (KV) | POSITIVE SEQUENCE IMPEDENCE | | | CAPACITY (A) |
|---|---|---|---|---|---|---|
| | | | R(Ohms/K) | X(H/Km) | B(F/Km) | |
| GROSS BEAK | 636MCM | 132 | 0.0022 | 0.0022 | 0.005 | 650 |
| TWIN AAAC | 37/4.176 mm | 232 | 0.0001 | 0.0007 | 0.0017 | 1500 |

From this (Table 2), we see that the gross beak size is 636 mcm and volt is 132kv. The capacity of the gross beak is 650A. However, the size of Twin AAAC is 37/4.176 mm and volt is 232 kilovolts. Admittedly, the capacity of Twin AAAC is 1500A.

**TABLE 3** Distance Date

| BUS TO BUS | LENGTH(kilometers) |
|---|---|
| HATHAZARI-RAOZAN | 24.043 |
| HATHAZARI-KAPTAI | 47.295 |
| HATHAZARI-MADANHAT | 10.916 |
| MADANHAT-KAPTAI | 40.243 |
| MADANHAT-KULSI | 12.496 |
| MADANHAT-SIKALBAHA | 17.682 |
| KULSI-BARAULIA | 15 |
| BARAULIA-HATHAZARI | 10.314 |
| BARAULIA-COMILLAH N | 161.314 |
| KULSI-HALISHUHAR | 15.040 |
| HALISHUHAR-JULDHA | 7.184 |
| HALISHUHAR-SIKALBAHA | 45.279 |
| SIKALBAHA-JOLDAH | 38.906 |
| SIKALBAHA-DOHAZARI | 32.084 |

From this (Table 3), the maximum distance from bus to bus connection is Baraulia to Comillah (N) which is 161.314 kilometers. Consequently, the minimum distance from bus to bus connection is Halishuhar to Juldha which is 7.184 kilometers.

**4.5 Impact of Wind Integration on Bangladesh Power System**

Here, we remark the impact of wind integration on Bangladesh power system especially in Chittagong zone. In this case, we consider type-A wind properties which are constant speed. In power world simulator, we observe the transient stability of Chittagong zone with the wind. We connect the wind at Kaptai bus. Now estimate the fault occur at Kaptai bus and the impact toward other bus shown in below.

**(Blue curve present the result when wind is connected and red curve present the result when wind is disconnected).**

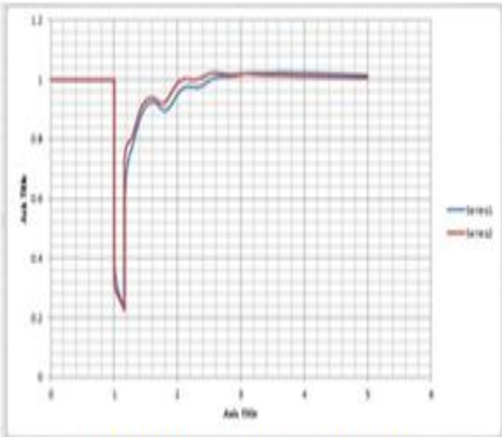

**Fig.8** Per unit vs Time (KAPTAI).

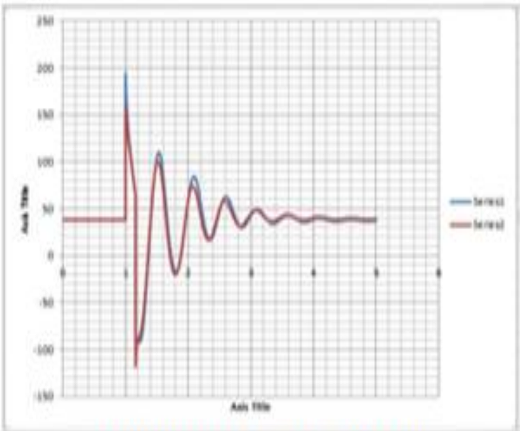

**Fig.9** Megawatts vs Time (KAPTAI).

From (Fig. 8), Here we did not find any massive change in transient stability of the system when the wind is connected or disconnected. From the curve, we see fault occur at time 1 and it clear within 1.16 meters per second (132 kilovolts). when the wind is connected with the system then it will take comparatively less time to gain its recovery voltage rather than when the wind is disconnecting. It gains its recovery voltage within 2/3 cycle. Here fault across with impedance is 0.02 ohm. From (Fig. 9), during the fault (with the wind) at time 1 it rises from 38 megawatts to 190 megawatts which is 4 to 5 times higher than the initial generation. Fault clearing time is 1.16 seconds. when the wind is disconnected, at this time 1 it rises from 38 megawatts to 160 megawatts. Here we see recovery generation is gain within 2/3 cycle.

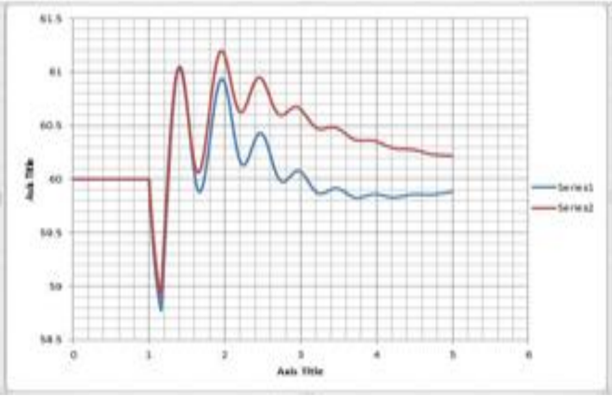


**Fig. 10** Speed vs Time (KAPTAI).

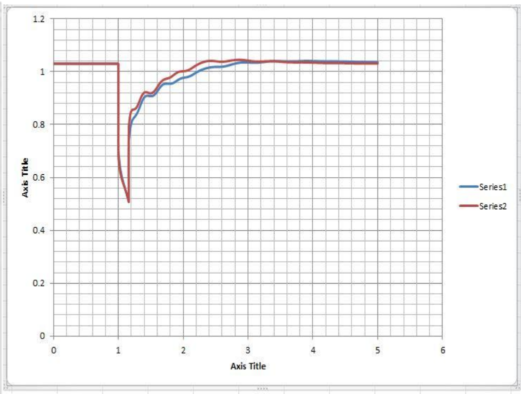


**Fig.11** Per unit vs Time(RAOZAN).

From (Fig.10**)** the curve, we see it takes more time to gain its original speed. when the wind is connected. Here from (Fig.11**),** we did not find any remarkable change due to the wind integration (connected/disconnected).

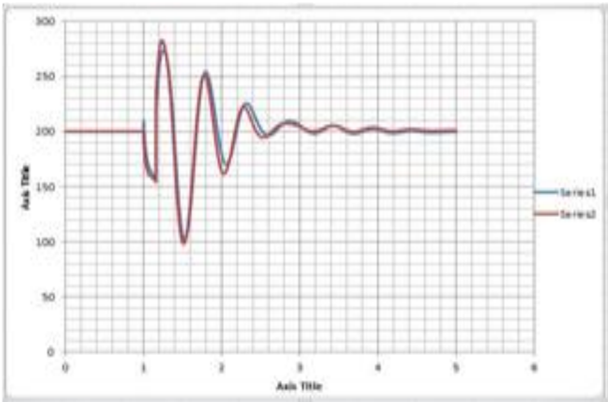


**Fig. 12** Megawatts VS Time (RAOZAN).

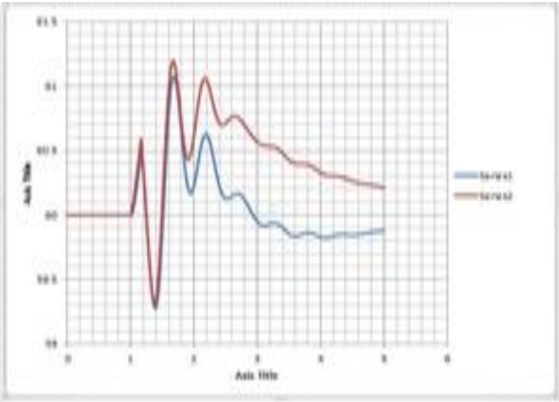


**Fig. 13** Speed vs Time (RAOZAN).

Here from (Fig. 12), we see the impact of wind at Raozan bus. More fluctuation is occurred during fault clearing time when the wind is disconnected. From (Fig.13), during fault condition speed increase (wind connected/disconnected). From the curve, we see it takes more time to gain its original speed then when the wind is connected.

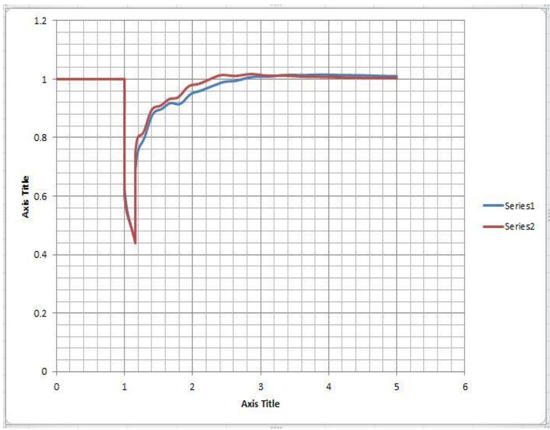


**Fig. 14** Per unit vs Time(HATHAZARI).

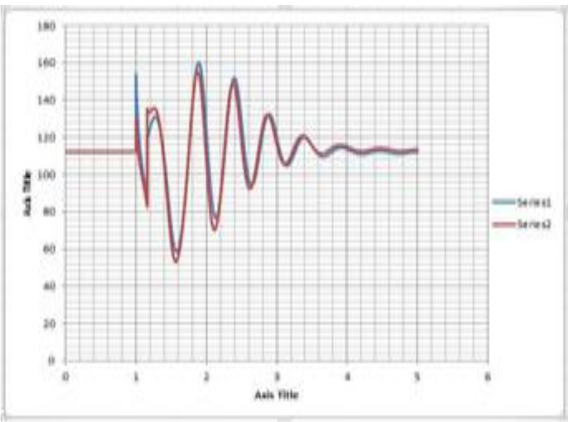


**Fig. 15** Megawatts vs Time (HATHAZARI).

From (Fig. 14), here we did not find any enormous change due to the fault (wind connected/disconnected). From (Fig. 15), during the fault condition generation is rises from 112 megawatts to155 megawatts (wind connected) and 112 megawatts to 130 megawatts (wind disconnected). Finally, basic generation is achieved after 2/3 cycle.

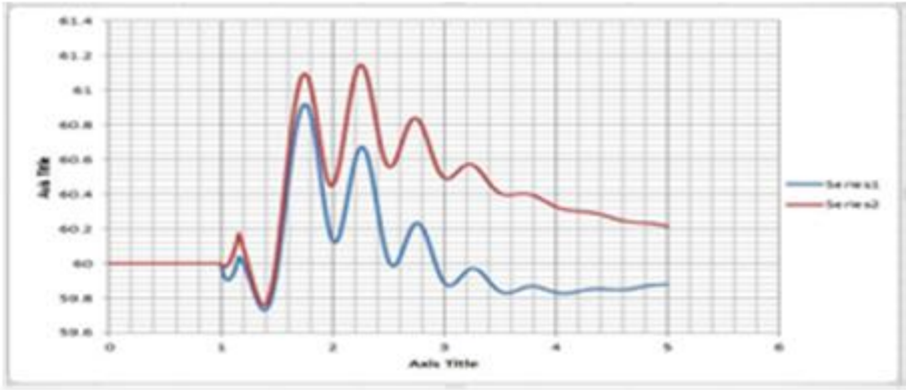


**Fig. 16** Speed vs Time (HATHAZARI).

From (Fig. 16), we see it takes less time to gain its original speed then when the wind is disconnected.

## V. Conclusion

From this paper, an overall purpose of action independent of the rate of penetration of wind power system offers an acceptable voltage to consumers must be fully distributed to production and consumption. A wind turbine in this paper, an electrical systems wind turbine modeling and computer provided the outline of aspects related to simulation. In different mathematical models gave a basic description of the representation of the physical characteristics of the wind turbine as well as an overview of modeling a wind turbine aerodynamics. An overall wind turbine in order to achieve a better understanding of the model wind turbines, a variety of interactions with each other a common wind turbine described a separate component model is shown. We are especially focused on the system of the wind turbine mechanical system for rice research per unit (Pu) announced the outline of the system. Describes the content include certain template give the overview of the different types of simulation and each simulation wind turbine types.

## Acknowledgements

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