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A Statcom-Control Scheme for Grid Connected Wind Energy System for Power Quality Improvement

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Abstract

Utilization of FACTS controller called Static Synchronous Compensator STATCOM to enhance the execution of power grid with Wind Farms is researched .The fundamental component of the STATCOM is that it can retain or infuse the responsive power with power grid. In this manner, the voltage control of the power grid with STATCOM FACTS gadget is accomplished. Additionally reestablishing the stability of the power system having wind cultivate subsequent to happening extreme unsettling influence, for example, blames or wind cultivate mechanical power variety is acquired with STATCOM controller. The dynamic model of the power system having wind cultivate controlled by proposed STATCOM is created. To approve the powerful of the STATCOM FACTS controller, the contemplated power system is mimicked and subjected to various extreme unsettling influences. The outcomes demonstrate the viability of the proposed STATCOM controller as far as quick damping the power system motions and reestablishing the power system stability.

Keywords: STATCOM, Wind Generation, Transient Stability.

I. Introduction

Presently a days wind as a huge extent of non poison energy generation is broadly utilized .If an expansive wind cultivate, which electrically is far from its association point to power system, isn't sustained by sufficient responsive power, it show real instability issue. Different techniques to examine and enhance wind cultivate stability have been performed. The stability of wind driven self energized acceptance generator SEIG s is examined. A breaking resistor to retain dynamic power amid blame to improve the system stability is created . Adaptable.Air conditioning transmission system FACTS gadgets, for example, Static Synchronous Compensator STATCOM to enhance the stability in wind cultivate is contemplated.

As an outcome, it will end up plainly important to require wind homesteads to keep up nonstop operation amid grid unsettling influences and along these lines bolster the system voltage and recurrence. What's more, in

the territory of a deregulated power industry, the arrangement of open access to transmission systems, which made focused power markets, prompted a colossal increment in energy exchanges over the grid and conceivable blockage in transmission systems[1]. The development of power exchange capacity of transmission systems has been a noteworthy issue in the course of recent decades. Under these conditions, the advanced power system has needed to stand up to some major working issues, for example, voltage direction, power stream control, transient stability, and damping of power motions, and so on. Certainties gadgets can be an answer for these issues.

They can give quick dynamic and receptive power remunerations to power systems, and in this manner can be utilized to give voltage support and power stream control, increment transient stability and enhance power wavering damping. Appropriately found FACTSdevices permit more proficient use of existing transmission networks.The STATCOM is utilized to give quick and quick control of voltage amid enduring state and transient stability. This issue is significantly more basic on account of microgirds, since specific FACTS controllers, especially STATCOMs, are being considered as a conceivable answer for a portion of the voltage and edge stability issues innate to these power grids. Thus, regular STATCOM models are approved here utilizing system ID strategies to remove the applicable electromechanical mode data from time-area signals . System recognizable proof strategies are utilized to promptly and straightforwardly look at genuinely particular STATCOM models, subsequently dodging lattice based eigenvalue investigations of complex system models or potentially displaying approximations.

In this paper, a STATCOM is added to the power system to give dynamic voltage control to the wind cultivate, dynamic power stream control for the transmission lines, alleviate transmission blockage and enhance power swaying damping. Reproduction comes about demonstrate that the STATCOM gadgets fundamentally enhance the execution of the wind cultivate and the power organize amid transient aggravations.

Wind Farm And Electric Generator Model

A wind turbine is a gadget that believers dynamic energy from the wind into electrical power. Wind turbine utilize squirrel confine enlistment generator yield power to its ostensible incentive for high wind speeds. So as to produce power the acceptance speed must be somewhat over the synchronous speed yet the speed variety is normally so little that the WTI is thought to be appended speed wind generator.

A wind turbine utilized for charging batteries might be alluded to as a wind charger[2].The consequence of over a thousand years of windmill advancement and present day designing, the present wind turbines are made in an extensive variety of vertical and even hub sorts. The littlest turbines are utilized for applications, for example, battery charging for assistant power for water crafts or trains or to power movement cautioning signs. Somewhat bigger turbines can be utilized for making little commitments to a household power supply while offering unused power back to the utility provider by means of the electrical grid. Varieties of substantial turbines, known as wind ranches, are turning into an undeniably imperative wellspring of sustainable power source and are utilized by numerous nations as a component of a system to lessen their dependence on non-renewable energy sources. Not at all like the pattern toward huge scale grid connected wind turbines found in the West, the more prompt interest for provincial energy supply in creating nations is for littler machines in the 5 - 100 kW range[3]. These can be connected to little, limited miniaturized scale grid systems and utilized as a part of conjunction with diesel producing sets and additionally sun powered photovoltaic systems (see cross breed systems area later in this reality sheet). Currently, the utilization of wind power for power creation in creating nations is restricted, the principle zone of development being for little battery charging wind turbines (50 - 150 Watts). In Inner Mongolia there are more than 30,000 such machines utilized by herders for giving power to lighting, TVs, radios, and so on.

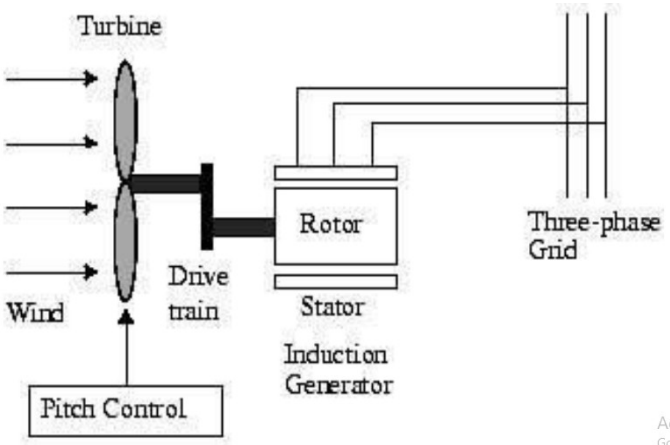

Figure 1: Wind turbine and induction generator

Where you assemble your wind turbine is imperative. Keep in mind that if close-by houses, tree lines and storehouses impede the full power of the wind from your wind turbine, you won't have the capacity to produce as much power. Wind speeds have a tendency to be higher on the highest point of an edge or slope, and consequently it is a smart thought to find wind turbines at uneven areas [4]. Simply make sure to keep your turbine far from high turbulence. Neighbors should likewise be mulled over when picking a spot to assemble your turbine. The more distant your wind turbine site is from neighboring houses, the better. Try not to anticipate that your wind turbine will create a similar measure of power

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constantly. The wind speed at a solitary area may differ extensively, and this can significantly affect the power generation from a wind turbine. Regardless of whether the wind speed fluctuates by just 10%, the power creation from a wind turbine can shift by up to 25%.

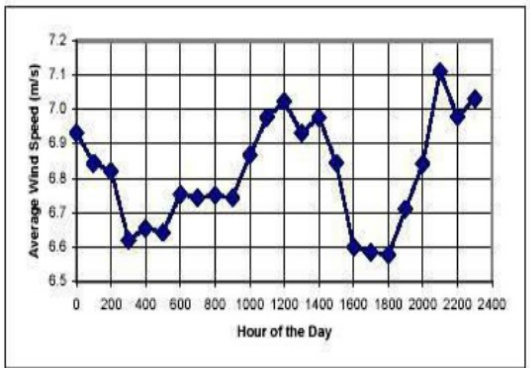

Figure 2: Example of wind speed dissemination by hour of the day. Qualities indicated are month to month midpoints of estimations made by anemometers. (Source: US Department of Energy).

The power accessible in the wind is relative to the shape of its speed. This implies if wind speed duplicates, the power accessible to the wind generator increments by a factor of 8 (2 x 2 x 2 = 8) [7].

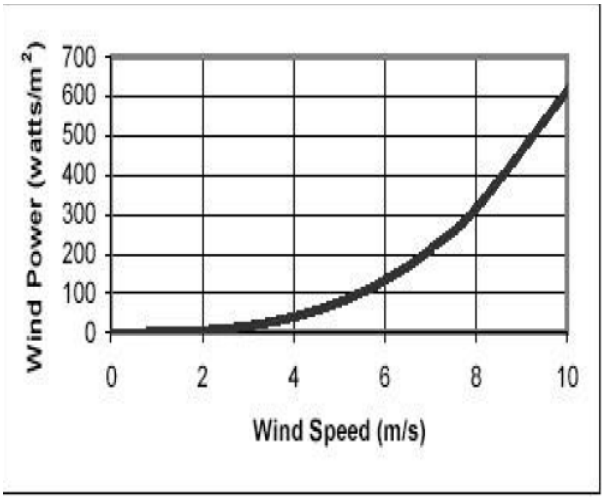

Figure 3: Relationship between wind speed and wind power.

Statcom Model

A static synchronous compensator (STATCOM), otherwise called a "static synchronous condenser" ("STATCON"), is a directing gadget utilized on exchanging current power transmission systems. It depends on a power electronics iiiiiiii voltage-source converter and can go about as either a source or sink of responsive AC power to a power arrange. On the off chance that connected to a wellspring of power it can likewise give dynamic AC power. It is an individual from the FACTS group of gadgets

Generally a STATCOM is introduced to help power arranges that have a poor power factor and regularly poor voltage direction. There are be that as it may, different utilizations, the most well-known utilize is for voltage stability. A STATCOM is a voltage source converter (VSC)- based gadget, with the voltage source

behind a reactor. The voltage source is made from a DC capacitor and in this way a STATCOM has almost no dynamic power ability. Be that as it may, its dynamic power ability can be expanded if a reasonable energy stockpiling gadget is connected over the DC capacitor. The receptive power at the terminals of the STATCOM relies upon the adequacy of the voltage source. For instance, if the terminal voltage of the VSC is higher than the AC voltage at the purpose of association, the STATCOM produces receptive current; then again, when the adequacy of the voltage source is lower than the AC voltage, it ingests responsive power.

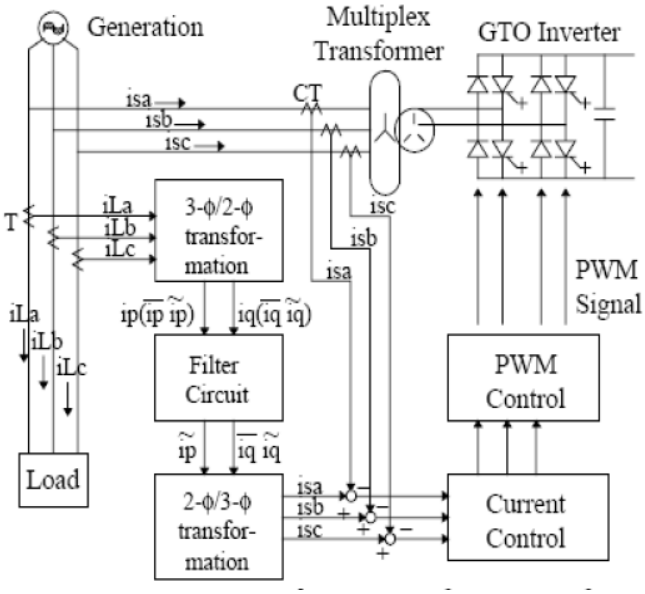

Figure 4: A typical control circuit of the STATCOM

The three-stage stack currents to be adjusted (iLa,iLb, and iLc appeared in the last Figure) are measured from the system and changed to two stage orthogonal segments (ip and iq) on pivoting arranges synchronized with the line voltage. The yields of the channel circuit are conversely changed to three-stage segments (isa, isband isc appeared in Figure). The yield current of the STATCOM is controlled by three-stage current input control utilizing isa, isb, and isc as reference signals for each stage. The yield signs of the current control included by a detected system voltage flag turns into the voltage reference flag of the PWM control. The PWM control circuit produces the terminating sign of the GTO by contrasting triangular wave transporter signals with the voltage reference flag.

The reaction time of a STATCOM is shorter than that of a SVC, for the most part because of the quick exchanging circumstances gave by the IGBTs of the voltage source converter. The STATCOM likewise gives better responsive power bolster at low AC voltages than a SVC, since the receptive power from a STATCOM diminishes straightly with the AC voltage (as the current can be kept up at the evaluated esteem even down to low AC voltage). A static VAR compensator (SVC) can likewise be utilized for voltage stability. Be that as it may, a STATCOM has preferable qualities over a SVC. At the point when the system voltage drops adequately to compel the STATCOM yield current to its roof, its most extreme receptive yield current won't be

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influenced by the voltage greatness. Along these lines, it displays consistent current qualities when the voltage is low under the point of confinement. Conversely the SVC's responsive yield is relative to the square of the voltage extent. This makes the gave receptive power diminish quickly when voltage diminishes, subsequently lessening its stability. Likewise, the speed of reaction of a STATCOM is quicker than that of a SVC and the symphonious discharge is lower. Then again STATCOMs regularly display higher misfortunes and might be more costly than SVCs, so the (more established) SVC innovation is as yet boundless.

Modelling

A wind cultivate comprising of six 1.5-MW wind turbines is connected to a 25-kV appropriation system sends out power to a 120-kV grid through a 25-km 25-kV feeder. The 9-MW wind cultivate is reenacted by three sets of 1.5 MW wind-turbines. Wind turbines utilize squirrel-confine acceptance generators (IG). The stator winding is connected specifically to the 60 Hz grid and the rotor is driven by a variable-pitch wind turbine. The contribute edge is controlled request to constrain the generator yield power at its ostensible incentive for winds surpassing the nomin al speed (9 m/s).

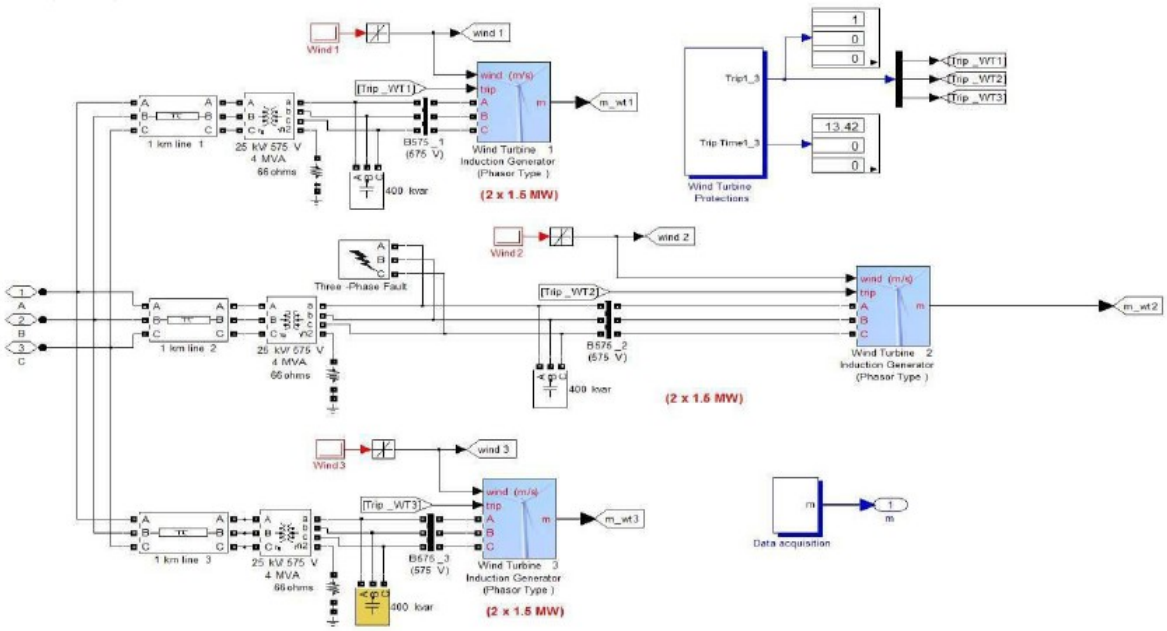

Fig 5.Wind farm consisting of 6 wind turbine induction generator

Keeping in mind the end goal to produce power the IG speed must be somewhat over the synchronous speed. Speed shifts around between 1 Pu at no heap and 1.005 Pu at full load. Each wind turbine has an insurance system checking voltage, current and machine speed. Responsive power consumed by the IGs is incompletely repaid by capacitor banks connected at each wind turbine low voltage transport (400 kvar for each combine of 1.5 MW turbine). The wind speed connected to every turbine is controlled by the "Wind 1" to "Wind 3" squares. At first, wind speed is set at 8 m/s, at that point beginning at t=2s for "Wind turbine 1", wind speed is smashed to 11 m/s in 3 seconds. A similar whirlwind is connected to Turbine 2 and Turbine 3, separately with 2 seconds and 4 seconds delays. At that point, at t=15 s an impermanent blame is connected at the low voltage terminals (575 V) of "Wind Turbine 2".Start reproduction and watch the signs on the "Wind Turbines" scope checking dynamic and responsive power, generator speed, wind speed and pitch plot for every turbine.

From the Fig.6 obviously to keep the voltage near 1 Pu, the STATCOM introduced in the system gives 3 Mvar. So this measure of receptive power provided by the STATCOM keeps the voltage consistent independent of changes in the wind speed which generally isn't conceivable if wind system is specifically connected to the grid. So it is critical to keep the voltage steady in the dispersion system, henceforth voltage direction is required in the appropriation arrange. Voltage Source Converter (VSC) based STATCOM accomplishes voltage control in the connected transport by engrossing/providing the required receptive power .For each match of turbine the created dynamic power begins expanding easily (together with the wind speed) to achieve its evaluated estimation of 3 MW in roughly 8s. Over that time period the turbine speed will have expanded from 1.0028 Pu to 1.0047 Pu. At first, the pitch point of the turbine cutting edges is zero degree. At the point when the yield power surpass 3 MW, the pitch edge is expanded from 0 deg to 8 deg with a specific end goal to take yield power back to its ostensible esteem. Watch that the retained receptive power increments as the created dynamic power increases.At ostensible power, each combine of wind turbine ingests 1.47 Mvar. For 11m/s wind speed, the aggregate traded power measured at the B25 transport is 9 MW and the STATCOM keeps up voltage at 0.984 Pu by producing 1.62 Mvar (see "B25 Bus" and "Statcom scopes).

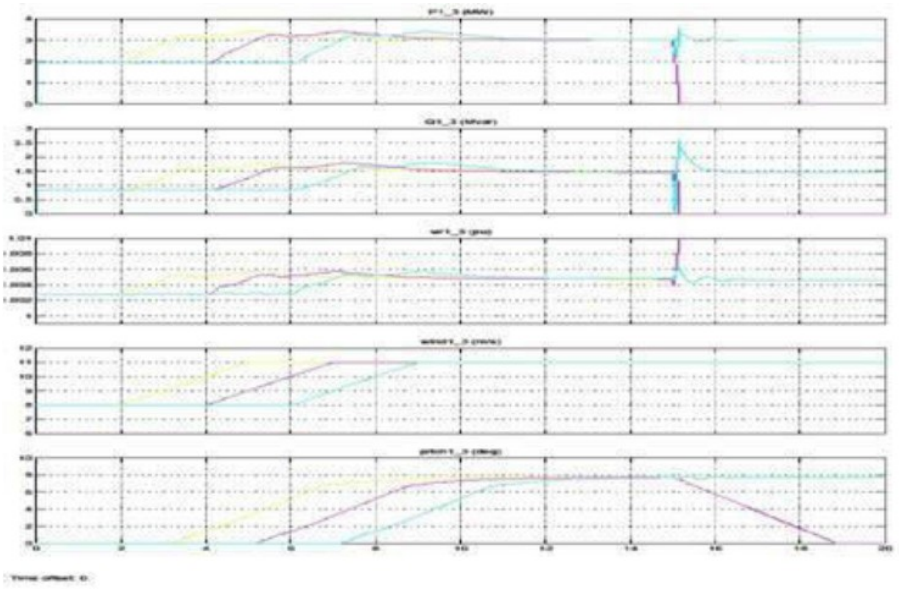

Figure7: Phase to phase fault

4.1 WITH STATCOM

Whatever is left of receptive power required to keep up the 25-kV voltage at transport B25 near 1 Pu is given by a 3-Mvar STATCOM with a 3% hang setting. Open the "Wind Farm" piece and take a gander at "Wind Turbine 1". Open the turbine menu and take a gander at the two arrangements of parameters determined for the turbine and the generator. Each wind turbine square speaks to two 1.5 MW turbines. Open the turbine menu, select "Turbine information" and check "Show wind-turbine power attributes". The turbine mechanical power as capacity of turbine speed is shown for wind speeds going from 4 m/s to 10 m/s. The ostensible wind speed yielding the ostensible mechanical power (1pu=3 MW) is 9 m/s. The wind turbine demonstrate (from the DR library) and the Statcom show (from the FACTS library) are phasor models that permit transient stability sort thinks about with long reproduction times. In this demo, the system is seen amid 20 s.

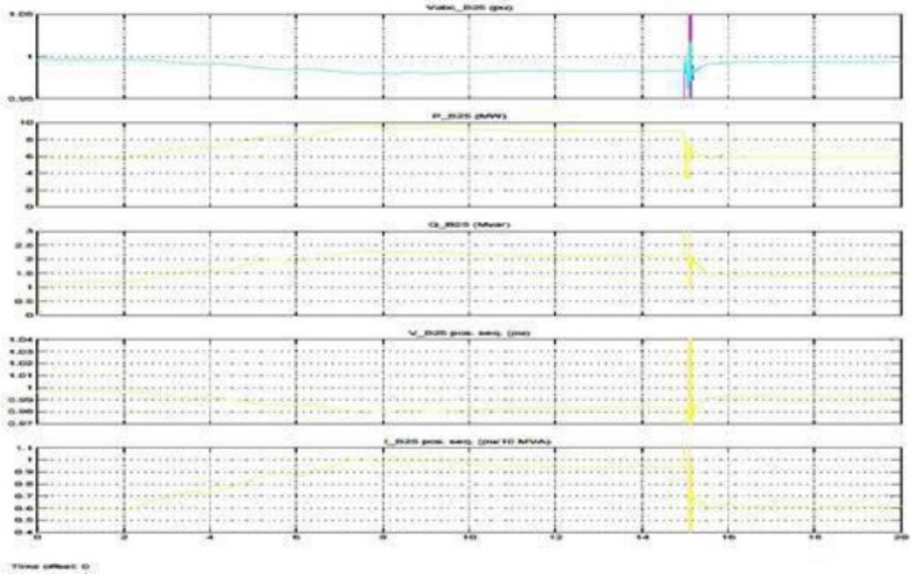

Figure8: Waveforms of different quantities with STATCOM

4.2 WITHOUT STATCOM

See on " B25 Bus" scope that on account of the absence of receptive power bolster, the voltage at transport "B25" now drops to 0.91pu[Fig.10]. This low voltage condition brings about an over heap of the IG of "Wind Turbine 1". "Wind Turbine 1" is stumbled at t=13.43 s. In the event that you glimpse inside the "Wind Turbine Protections" piece you will see that the trek has been started by the AC Over current security.

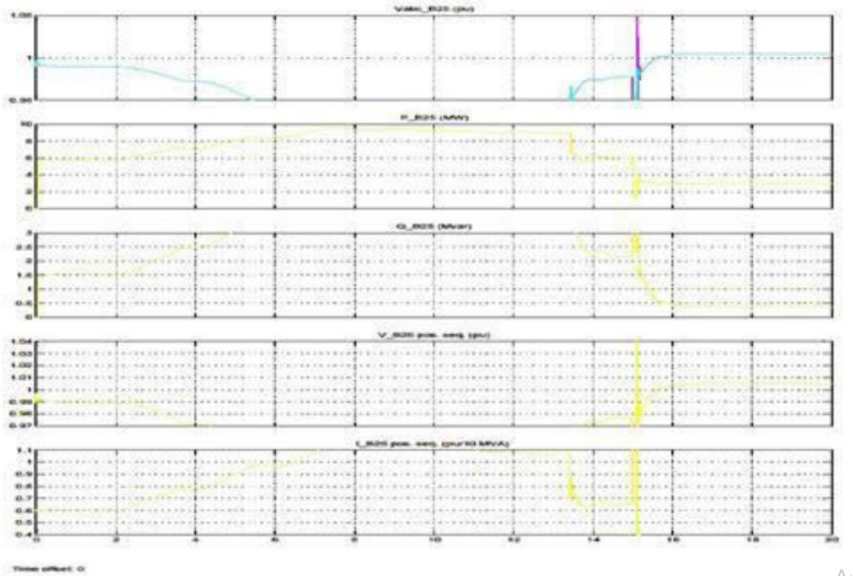

Figure9: Waveforms of different quantities without STATCOM

V. CONCLUSION

Power system with wind ranches execution can be enhanced utilizing FACTS gadgets, for example, STATCOM. The dynamic model of the examined power system is recreated utilizing Simulink Matlab bundle programming. To approve the impact of the STATCOM controller of power system operation, the system is subjected to various unsettling influences, for example, blames and power working conditions. The computerized comes about demonstrate the powerful of the proposed STATCOM controller as far as Stability improvement, power swings damping, voltage direction, and increment of power transmission and mostly as a provider of controllable responsive power to quicken voltage recuperation after blame event.

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