7.1 CONCLUSION

The final summary of the research work is carried out with various FACTS devices with coordinated control of SMES and SFCL coils presented for improving the voltage stability and power quality issues of wind turbine driven DFIG. Various types of WECS system with different types of generator is considered and analyzed. From the detailed literature survey, the horizontal axis wind turbine driven DFIG is most suitable for WECS, because low cost installation, power can be fed from both stator and rotor, easy to control, independent active and reactive power control, higher power factor, possibility of speed control. The DFIG and wind turbine are modeled simulated in MATLAB / Simulink environment and it is analyzed for various input wind velocities. The power generated by the DFIG is fed into grid during normal operation without any grid disturbance the DFIG could deliver the power with desired voltage, frequency and phase. However when fault occurs in the grid, the voltage across the stator of DFIG drops, thus causing over voltage and excess current in the rotor circuit. This excess rotor current starts oscillating the rotor and destroys the rotor side power converter. Also this fault could lead to transient instability and chances for disconnection of DFIG from the grid. To overcome these issues, various FACTS devices are studied and analyzed in this research work.
The increase of power transfer capability in utility grid during grid fault conditions a various types of FACTS devices are used such as TCR, DVR, SSSC, STATCOM, SVC, UPFC etc. From the detailed literature survey this research work considered the DVR, STATCOM and UPFC for solving the problem associated with grid connected DFIG wind form.

The DVR, STATCOM and UPFC FACTS devices are modeled and simulated with wind turbine driven DFIG for various fault conditions such as single line to ground fault, double line to ground fault and three phase fault. Also a suitable controller for DVR, STATCOM and UPFC system were designed and analyzed and their results are presented.

The DVR, STATCOM and UPFC with suitable controllers are designed and modeled in the MATLAB / SIMULINK. These FACTS devices are analyzed with grid connected DFIG for various fault conditions.

The DVR based series compensators are effective for voltage sag and swell mitigation. DVR is used to boost the voltage to the grid and keeping DFIG stator voltage as constant. Thus bring the DFIG in to normal operating condition, even during full compensation during 100 % voltage sag, capacitor in the DVR is not enough to compensate the voltages. STATCOM is used to provide both VAR compensation and voltage requisition in grid connected DFIG. Fast dynamic response STATCOM is used to mitigate short term voltage fluctuations. The conventional STATCOM is having six steps voltage source inverter. To overcome the limitations of VSI this thesis considered the cascaded multilevel inverter topology for power processing in STATCOM. The cascaded MLI topology requires separate storage devices owing to its modularity and flexibility. To reduce the number of power switches, no. of DC sources (replaced by capacitors) this research work proposed seven level MLI with only 8 switches. The proposed MLI based STATCOM provides high voltage and power ratings. Also it effectively compensates the both real
and reactive power during fault conditions. Also MLI improves the power quality of the STATCOM. From the result analysis the MLI, based STATCOM is capable of suppressing voltage fluctuations and supply reactive power during grid fault conditions. To further improve the power system stability from any grid disturbances, SMES and SFCL coils are proposed and designed. SMES is effective to damp the voltage fluctuation during grid fault conditions. By proper control of chopper circuit duty ratio in SMES system, the better voltage compensation is achieved. During normal operation, the voltage induced in the SMES coil is almost zero so, the net impedance across the ac lines are very minimum, hence effect of SMES coil is almost zero. During grid fault conditions, the time varying pulses from the chopper circuit, the SMES coil having higher voltages as result the net impedance across the ac line is increased and hence the fault current is limited.

UPFC provides the simultaneous control of the shunt compensation. The shunt converter of the UPFC controls the reactive power and dc link capacitor voltage. The series converter of UPFC controls the real power flow by injecting series voltage of desired magnitude and phase angle. From the results it is observed that UPFC provides the better transient stability over the other compensators so it improves FRT capability during transient conditions.

When the fault occurs in the grid simultaneously the voltage sag and short circuit current appears in the system. It is quite complex to control by SMES and SFCL respectively. Hence coordination between SMES and SFCL is required during fault condition. The SMES controls the voltage sag along with STATCOM or shunt controller in UPFC. The short circuit current is limited by SFCL. Each simulations are verified the performance of SMES and SFCL systems. The coordinated control system further enhanced the transient stability and power quality.
7.2 FUTURE SCOPE

The research work can be extended in the following aspects.

- Optimization technique can be used for stored energy in superconducting magnetic materials for simultaneous fault conditions.

- The load current harmonics can be reduced by incorporating the superconductors.