Chapter 7

Conclusions and Future Scope

This chapter summarized the main conclusions of the thesis and followed by the salient benefits of the proposed methodologies. Finally, the chapter concludes with the future scope of the thesis:

7.1 Conclusions

Volt/VAR control and network reconfiguration are the promising techniques utilized by DSOs to enhance distribution system performance (e.g., good voltage profile, mitigation of maximum voltage rise and voltage drop limits, enhance system reliability, loss reduction, peak demand reduction and energy savings). To perform VVC operation, traditional devices such as OLTC, VRs, and SCBs have been employed. However, these devices are constrained by limited number of operations. Moreover, these devices may not be capable to handle the sudden voltage violations because of slow response and large delay time. The voltage fluctuations may result from various disturbances such as intermittence in power output from DERs such as PV and wind generation, change in network configuration, and load demand (especially in the case of flexible loads). To mitigate the above-mentioned problems, in this thesis a hierarchical based centralised and local control coordinated VVO methodology has been proposed for effective utilization of traditional and advanced VVC devices. For optimization process, a modified binary grey wolf optimization has been proposed. Besides, real time co-simulation platform using MATLAB and real time digital simulator (RTDS) has been developed for the validation of proposed methodology.

The arbitrary allocation of DER units in the system may lead to an uncertain increase in the feeders power flows, resulting in network congestion and increased losses in the network. Therefore, DER allocation should be carefully planned to maximize the system efficiency. Further, the high proliferation of DER and their integration to distribution systems can adversely impact on feeders voltage profile, due to reverse power flow. Besides, the intermittent nature of renewable energy sources such as wind, solar and uncertain behaviour of the load can cause voltage variation in distribution systems. The conventional voltage and reactive power control strategies in distribution systems are expected to face numerous challenges. Therefore, to mitigate the above-mentioned problems, a strategic two-layer planning and operational framework has been developed that can determine the optimal location, size and operational characteristic of DER and SOP unit in ADN. Besides, a stochastic variable module (SVM) for uncertainties was developed to model the uncertainties of PV generation, wind generation and load in distribution system. Further, introduced a hybrid optimization solver to solve the large scale non-convex MINLP problem without linearization or relaxation.

7.2 Salient benefits of proposed methodologies

The following are the salient benefits of the proposed methodologies presented in the thesis

- Total number of switching operations of traditional VVC devices and RCSs have been reduced by using coordinated scheme that enhances their life span time.

- Proposed coordinated scheme can eliminate the voltage violations and also reduce the annual total cost of system operation simultaneously even in the presence of high penetration of DG.

- Proposed coordinated scheme does not require the participation of consumers to achieve energy saving.

- Proposed scheme is capable to cope up with uncertainty in load/generation and intermittent nature of PV output generation.

- Deployment of CVR operation along with DNR and SOP can make the voltage profile more flattened compared to the deployment of CVR or DNR or SOP only.
- Proposed local Q-V control scheme can capable to handle cloud transient, further it does not require communication infrastructure in the system.
- The proposed two layer coordinated planning and operation scheme can yields higher cost savings compared to traditional scheme.
- The proposed method can improve and flatten the voltage profile without violating the permissible voltage limits. Besides, it can reduce the energy losses, energy consumption, energy not served and carbon emission effectively.
- The proposed hybrid solver can efficiently find the global optimum with less computational time.

The concluding remark of the present thesis reveals that proposed integrated approach would be beneficial for the next-generation DSO that enables technological advances for real-time control and optimization of distribution grids in the presence of massive integration of DERs. Besides, the proposed methodology will enhance the state of the art in system planning and operations to enable greater affordability, reliability, controllability, flexibility and efficiency of distribution systems, and it will systematically address DER integration challenges.

7.3 Future Scope

The present thesis work can be extended on the following aspects

- Proposed two layer coordinated planning and operation can be scalable for Networked micro-grid modelling and operations.
- An integrated CVR and Demand Response framework can be developed for Advanced Distribution Management Systems applications.
- Proposed schemes can be extended for Self-healing Mechanisms in Distribution Systems with High Distributed Generation (DG) Penetration.

- Vulnerability assessment of CVR to cyberattack in active distribution system.
- The proposed coordinated methodology can be extended to increase the DER hosting capacity and energy efficiency simultaneously in active distribution networks.
- Penetration of DERs and Reconfiguring the network topology could bring a lot of issues into the existing protection system, and may require changing the relay settings. Hence, adaptive protection scheme can be developed.
- With the knowledge of proposed local control, adaptive local controller such sliding mode control and adaptive model predictive control can be developed.