Chapter 6

Conclusions and Scopes for the Future Work

6.1 Conclusions

- The thesis' second chapter looks at several methods for measuring and increasing the reliability of electricity systems. Various uncertainty management methods are described, which may be used in wind, solar, electric cars, batteries, and other sustainable energy reliability studies. Furthermore, it is concluded that when conventional and renewable energy sources are combined with power systems, power system reliability improves. Finally, strategies for improving the reliability of wind-penetrated power networks are briefly addressed.

- A Doubly Fed Induction Generator-based Wind Integrated Power System has been adapted for research work in Chapter 3 as a result of the literature review in Chapter 2. The waveforms of lightning impulse voltage, impulse current, and rectangle pulse current are generated by using the proposed realistic equivalent circuits. The system is then subjected to the produced impulse voltage waveform in order to evaluate system performance and reliability, which is compared to the system with three phase fault. Small transients occur in the system and subsystem as a result of the impulse voltage waveform's effects, leading to changes in system governing parameters such as phase voltage, phase current, active power, reactive power, DC link voltage, and generator rotor speed. During both faults, it is found that active power is higher than zero, reactive power is almost balanced and nearly to 0 MVar, DC link voltage is roughly equal to the nominal value of 1150 V, and rotor speed is not greater than the nominal value of 1.2 pu of synchronous speed achieved using the suggested method. When compared to [22], the findings are said to be superior. The reliability assessment is carried out using the Monte-Carlo simulation technique, and different reliability indices, such as the reliability or survival function, the cumulative distribution function, the failure distribution function, and the hazard rate function are calculated as expected. The voltage source system may fail, and reliability reduces after a given number of simulation intervals, as shown by the reliability indices functions. Finally, it is determined that the test system's reliability is enhanced by decreasing the amount of converter failures during lightning faults.

- Chapter 4 adapts an IEEE 33 bus test system integrated with Wind-Solar-Battery is considered as part of the reliability study. In the 33 bus test system, the indexing technique is utilised to identify the optimum location(s) for energy sources, and an optimization methodology is proposed to figure out the size(s) of RESs. When compared to a system without distributed generations, the optimum location(s) and size(s) of RESs calculated for three instances guarantee an improvement in electrical loss reduction and also improves the bus voltage profile. After examining all of the instances, it was discovered that Case 3 produced the best results. When compared to [225], the active power loss value is lowered by 0.00003 MW, 0.014472 MW, and 0.021307 MW for Case 1, Case 2, and Case 3, respectively, at UPF. When comparing Case 3 at UPF to Case 3 without Renewable Energy Source, the minimum value of bus voltage is improved by 6.42%. At 0.85 and 0.82 power factors, the bus voltage profile improves by 7.71% and 7.78%, respectively. The reliability study for the renewable energy integrated distribution system is conducted once the acceptable results have been achieved. The combination of Case 3 and Scenario 6 yields the greatest outcomes in terms of system's reliability. However, although Scenario 6 is ideal, Case 3 with Scenario 1 is thought to provide superior outcomes in terms of improving the system's reliability.

- The robustness of suggested approach is examined in Chapter 5 by considering two test systems: IEEE 33 bus and IEEE 118 bus. In test systems, the indexing techniques are utilised to identify the optimum location(s) for distributed energy sources, and an optimization methodology is proposed to figure out the size(s) of DERs with various pfs, such as UPF, 0.90, 0.85, and 0.82. Also, commercial, industrial, and residential loads are all taken into consideration in the reliability study. The best Distributed Energy Resources size(s) and site(s) ensure that active power loss and reactive power loss in the test systems are kept to a minimum. The distribution systems are also found to optimise the system's minimum bus voltage, resulting in a better voltage profile. The results of the output are compared to those already published in the literature and found to be acceptable. The active and reactive power losses for without DER and arrangements 3 are reduced by 0.197021 MW and 0.131796 MVar, respectively. It's also worth noting that the minimum bus voltage has increased by 7.9%. After achieving satisfactory findings, the reliability assessment of the DER(s) integrated distribution system is carried out. The study's aim is to enhance the reliability of systems that have been modified for research purposes. Several reliability indices have been developed to explain why test systems are becoming more reliable. This chapter includes cost-saving index, such as ECOST, in addition to calculating consumer and energy-oriented dependability indices. After collecting the relevant indices, it was determined that arrangement 3 with case 5 provides the two test systems with greater reliability and maximum savings of 823496.53 $ per year and 1322929 $ per year for 33 and 118 bus test systems, respectively.

6.2 Benefits of the proposed work

The major advantages have been discovered as a result of this thesis study.

1. Energy Demand Management (or Demand Side Management)
2. Number of interruptions can be minimized
3. Inclusion of Uncertainties for excellent reliability evaluation
4. Repair Time can be managed
5. Failures can be avoided (or delayed)
6. Coordination between components and systems can be achieved
7. Reduced maintenance cost
8. Improvement in system's security

6.3 Scopes for the Future Work

The Thesis explores the following future research scopes.

- The uncertainties may be dealt rigorously by using a combination of probabilistic and possibilistic approaches in reliability assessment
- The power system becomes a complex network because of the incorporation of new energy sources; hence, needed to be analyzed for the trade-off between reliability and economic, reliability and planning, etc.
- Due to the availability of very few researches on Electric Vehicle and Battery Energy Storage Device unit as a reliability improvement means; thus, the work on operation and planning can be performed on these renewables
- The Thesis introduces the reliability impacts on Unit Commitment, reactive power optimization and power system protection schemes in Wind Integrated Power System, which may be further explored and analyzed in detail to find out the methods to mitigate the negative impacts on power system reliability

The future aspects can be dealt with large distribution systems. Inclusion of reliability data in terms of electrical, mechanical, and structural subsystems which would be favorable in obtaining accurate reliability of the system. Distribution system reliability improvement can also be achieved by adjusting the number of branches which is termed as a system reconfiguration technique. The system parameters can be analyzed in the future, considering the following aspects.

- Enhanced and modified test systems
- Effective use of uncertainty handling approaches
- Economical and environmental aspects
- Effective integration of Electric Vehicles and Batteries
- Analysis considering other ill conditions
- Other reliability improvement methods, such as, WF design
- Consider complex power system

- Reliability assessment using the Markov-chain process for Doubly Fed Induction Generator-based Wind Integrated Power System with Voltage Source Converter transmission
- Matrix and Hybrid multi-level converters
- Wind Turbine wake modeling
- Integration of battery energy storage system and electric vehicle for the system's reliability and stability enhancement.
- Considering ill conditions, including high impedance loading and high X/R ratio
- System reconfiguration
- System Integrated Protection Scheme