Chapter 7

7. Conclusions and Further Research Area

7.1. Conclusion

This research was basically focused on analyzing the impact of large wind integration on the power system both in the steady state and the transient state. Therefore the steady state , frequency stability and voltage stability studies were carried out for year 2010, 2012, 2014 and 2016 power systems to perform the above task and finally to quantify maximum wind absorption capabilities.

Chapter 1 contains a general introduction to this dissertation and to wind power technology. It highlights the necessity of wind absorption capability study for the Sri Lankan power system. Further this chapter concluded that this research can be narrowed down to Kalpitiya peninsula for the studied period.

Chapter 2 was devoted to present the wind power modelling techniques.

Steady state system analysis was carried out in chapter 3. The outcome of this exercise were steady state wind power absorption limits at Puttlam 132kV level without modifying the proposed network and by considering approximately 30% wind availability.

Frequency stability studies were carried out in chapter 4 to quantify the maximum wind absorption level where the adverse system wide frequency effects begin to occur.

Voltage stability studies were carried out in chapter 5 to analyze the impact of wind additions on the system voltage.

Finally a transient stability analysis was carried out in chapter 6 to confirm the stable operation of the power system with proposed wind integrations.

The outcome of this dissertation is depicted in table 6.1 and the decisive factors used during this dissertation are listed below:

- There should not be any load shedding schemes activated due to anticipated wind variations and system voltages & frequency should be recovered without any problem.
- Maintain 5% spinning reserve in year 2010 & 2012 and maintain 10% spinning reserve in year 2014 & 2016
- Maximum voltage fluctuation allowed at the Point of Common Coupling (PCC) should be limited to 2% of the nominal voltage.

Year	Steady state limit absorption capability (MW)	Transient stability limit			Proposed capacity at PCC (MW)		
		Absorption capability (MW)	Limiting factor	Operating condition	33kV	132kV	220kV
2010	160	20	Voltage	5% spinning reserve	20	-	-
2012	160	90	Frequency	5% spinning reserve	-	<85	<80
2014	70	185	Voltage	10% spinning reserve	-	90	95
2016	400	220	Voltage	10% spinning reserve	-	90	130

Table 7-1: Wind absorption capability of the Sri Lankan power system around Puttlam area

7.2. Further research area

The outcome of this research was a quantified wind penetration level around Kalpitiya peninsula based on the limit at which the adverse effects of the wind power begin to occur on the power system.

This study was carried out for the proposed years 2010, 2012, 2014 and 2016 power systems. The limits obtained from this study can be extended by applying various mitigation techniques such as introducing static var compensators and automatic generation control techniques.

In addition, wind absorption capability of the power system can be improved by maintaining high spinning reserves.

However introducing mitigating techniques and maintaining large spinning reserve involve considerable amount of cost. Therefore, analyzing the most economical wind absorption capability level of the power system associated with a proper economic evaluation is proposed as further research to this study.