Chapter 6

6. Transient Stability Analysis

6.1. Introduction

Transient stability studies determine the response of a power system to the occurrence of faults, tripping of a transmission line (with or without auto-reclosing), tripping of a generator, or load shedding.

The recovery of a power system subjected to a severe disturbance is of interest to both system planners and operators. Typically the system must be designed and operated in such a way that a specified number of credible contingencies do not result in failure of quality and continuity of power supply to the loads.

Transient stability studies are carried out during the transmission planning synthesis to ensure the stable operation of the power system. However this research study proposes to integrate considerable amount of wind power in to year 2012, 2014 and 2016 power systems proposed in the "Long Term Transmission Development Plan 2008-2016". Therefore it is necessary to reinvestigate the transient stability of the wind integrated power system.

This section will present the transient stability analysis of the year 2012, 2014 and 2016 power systems.

6.2. Stability criteria

Stability criteria should ensure the system stability during and after a system disturbance.

For all pertaining equipment in service, the system should remain stable in case of:

- Three-phase fault at any one overhead line terminal, cleared by the primary protection with successful and unsuccessful auto re-closing
- Loss of any one generation unit
- Load rejection by loss of any transformer

6.3. Transient stability studies year 2012, 2014 and 2016

6.3.1. Methodology

Transient system stability analysis was carried out for year 2012, 2014 and 2016 power systems. During the study, the transmission system was subjected to specific pre-identified transient system disturbances which are expected to be critical.

Studies were carried out under two switching sequences as given below.

I. Successful Re-closing : t=0 Fault occurs
t=120ms, fault cleared & circuit tripped
t=620ms, circuit re-closed

II. Unsuccessful Re-closing : t=0 Fault occurs
t=120ms, circuit tripped
t=620ms, circuit re-closed with fault
t=740ms circuit tripped

Following assumptions are made when carrying out stability studies.

- 5% spinning reserve is maintained in year 2012 while 10% spinning reserve is maintained in year 2014 and 2016.
- An automatic load shedding scheme is incorporated in the study in order to sustain the stability of the system.
- Typical exciter and governor models are included for all generators.

6.3.2. Transient stability results

The year 2012 network with 90MW wind integration was tested against severe system disturbances and confirms the system stability. The summary of the analysis is shown in table 6-1.

Fault	Location	Scenario		
		NP	DP	OP
Puttlam – Veyangoda 132kV line . 3-ph fault	Puttlam end	SS	SS	SS
Puttlam – Asia-w 132kV line. 3-ph fault	Power plant end	SS	SS	SS
Puttlam 285MW unit tripping	N/A	SS	SS	SSLS
Puttlam- Anuradhapura 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Heladanavi unit tripping	N/A	SS	SS	SS
Puttlam – New_Chilaw 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Wind farm tripping	N/A	SS	SS	SS

SS System Stable SSLS System Stable with Load Shedding

Table 6-1: System stability analysis results, year 2012

The year 2014 power system with 185MW wind integration at Kalpitiya area was also tested against severe system disturbances and it was found that the system is stable in the transient state. The results are depicted in the table below:

Fault	Location	Scenario		
		NP	DP	OP
Puttlam – New_Chilaw 220kV line . 3-ph fault	Puttlam end	SS	SS	SS
Puttlam- New Anuradhapura 220kV line . 3-ph fault	Puttlam end	SS	SS	SS
Puttlam 285MW unit tripping	N/A	SS	SS	SSLS
Puttlam- Anuradhapura 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Heladanavi unit tripping	N/A	SS	SS	SS
Puttlam – New_Chilaw 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Wind farm tripping	N/A	SS	SS	SS

SS System Stable SSLS System Stable with Load Shedding

Table 6-2: System stability analysis results, year 2014

Finally transient stability studies were carried out for year 2016 system. It has been observed that the system is stable in the transient state following critical system disturbances with 220MW wind integration at Puttlam GS/PS. Transient stability analysis results for year 2016 is given in table 2-3.

Fault	Location	Scenario		
		NP	DP	OP
Puttlam – New_Chilaw 220kV line . 3-ph fault	Puttlam end	SS	SS	SS
Puttlam- New Anuradhapura 220kV line . 3-ph fault	Puttlam end	SS	SS	SS
Puttlam 285MW unit tripping	N/A	SS	SS	SSLS
Puttlam- Anuradhapura 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Puttlam – New_Chilaw 132kV line. 3-ph fault	Puttlam end	SS	SS	SS
Wind farm tripping	N/A	SS	SS	SS

SS System Stable SSLS System Stable with Load Shedding

Table 6-3: System stability analysis results, year 2016