GROUP REF. : B4
COUNTRY : BRAZIL
PREF. SUBJECT : PS1
REGISTRATION NUMBER : 5542
QUESTION N° : 1.4 – Bullet 2

AC System Strength issues – Applications in Brazil

1 – Introduction

With the growing up of application of renewables (wind and solar power) in the power system, AC system strength and inertia problems have become common in operation issues by the fact that these power sources are not capable to aggregate inertia to the power system as Hydro or Thermal.

On the other side the number of LCC-HVDC links under construction, in operation, or in planning stages is increasing so far with the purpose of bulk power transmission over long distances (transmitting energy from large Hydroelectric power plants to the main load centers).

As known in the technical literature the LCC operation is deeply affected by reduced AC system strength. It is recommended by the literature that the LCC operates, at least, with the SCR of 3 to reach a satisfactory and safe operation. AC short-circuit at the LCC inverter terminal, in reduced AC system strength conditions, may lead to successive commutation failures, and the power restoration can be harmed or delayed.

Considering these characteristics that the power system operators have to face many studies have been developed to solve or reduce the impact of this problem in the operation of large power systems. Synthetic Inertia in wind turbines or batteries have been proposed. One proposition that has been widely used is the application of Synchronous Condensers (SC) at the inverter terminal of the LCC-HVDC to increase the AC grid strength.

For example, in Brazil, we have the following examples of applying SC to increase the AC system strength in LCC-HVDC:

- Four Synchronous Condensers were applied to increase the inverter AC system strength of the Furnas LCC-HVDC system;
- Two Synchronous Condensers were used to increase the inverter AC system strength of the Terminal Rio LCC-HVDC;
- It was studied (planned only) the interconnection of Lechuga Station (Manaus) to Porto-Velho by an LCC-HVDC (1000 MW) and Lechuga station has a very low AC strength (SCR ≈ 0.8);
- It was proposed three SC to Lechuga Station, as shown in Figure 1;

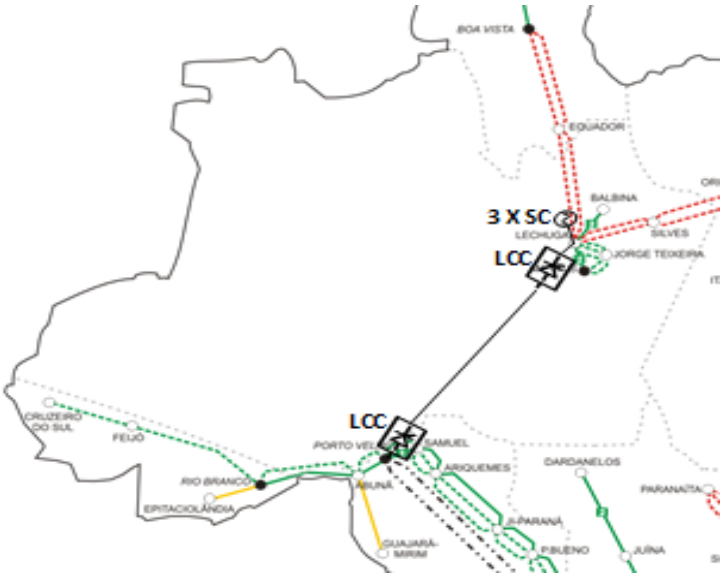

Figure 1 – LCC-HVDC Link between Porto Velho - Manaus.

Other technologies as LCC-CCC or VSC-HVDC are either proposed to operate in reduced AC system strength conditions. For example, in Brazil, we have the following example of applying other technology in low AC system strength conditions:

- Madeira River LCC Back-to-Back was thought initially to operate with three SC, but after the auction, LCC-CCC was proposed by the manufacturer and accepted;

Considering the VSC-HVDC we can note the following characteristics considering its application in low AC system strength conditions:

- VSC-HVDC is fully recommended to be applied at and operate satisfactorily even in very low AC system strength conditions;
- VSC "apparently" increases the AC system strength to near LCC (AISCR) [1];
- MMC-STATCOM may also increase AC grid strength, but faster than SC if with fast reactive power control;
- Hybrid HVDC System with VSC operating in parallel with LCC may be free of commutation failure as the VSC can act as a huge STATCOM;
- The second option to be used in Lechuga station was VSC-HVDC or Hybrid HVDC with no SC;

3 – Reference

[1] Analysis of Dual-Infeed HVDC With LCC–HVDC and VSC–HVDC - IEEE TRANSACTIONS ON POWER DELIVERY, VOL. 27, NO. 3, JULY 2012.