A Second and Longer ± 800 kV DC Bipole Completes Belo Monte's Integration

CIGRE 2016
B4-101

Dr. Taghrid Amer

Summary

- Paper B4-101 describes the completion of the planning for building two bipole HVDC transmission links, connecting the **Belo Monte hydroelectric project in the Northern Brazil** to the load centers in the South East.

- Extensive simulations, both desktop and real time, have been carried out confirming the level of their interactions with the nearby HVDC terminals (Madeira and Itaipu) as well as the ac network.

January 13, 2017 – Ultra-high-voltage transformers to help deliver clean hydropower via Belo Monte link to ten million people

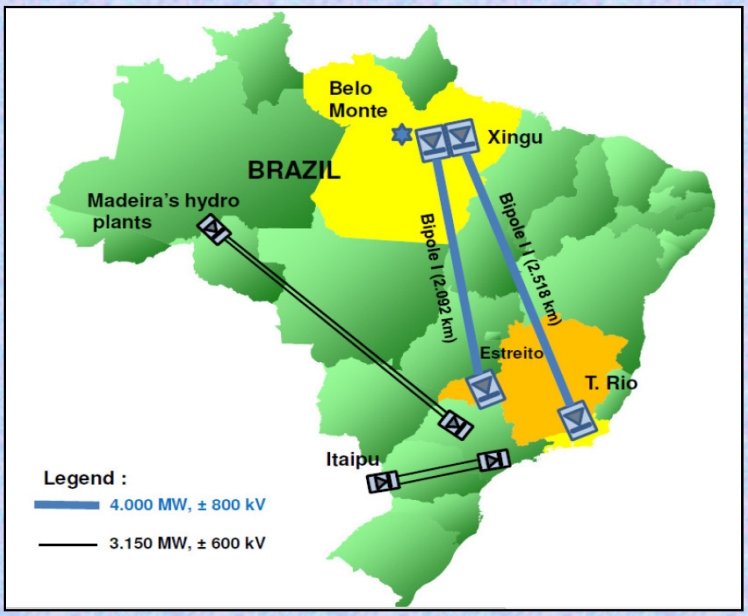
- ABB has won an order worth around $75 million to supply advanced converter transformers for the Belo Monte 800 kilovolts (kV) ultra-high-voltage direct current (UHVDC) transmission link.
- The 2,518 kilometer (km) link will transmit clean power generated in the north of Brazil, from the Xingu substation, to the Rio Substation in the southeast.
- It will be capable of transporting up to 4000 megawatts (MW) of electricity – enough to meet the needs of around ten million people.
- The order was booked in the fourth quarter of 2016.

Introduction

- The results of the analysis, and the final planning concept for the second ± 800 kV DC bipole, 4000 MW are given.
- This will be implemented in Brazil (Bipole II), which will complete the HVDC system necessary to integrate the Belo Monte power plant into the national network.
- Planning studies to integrate Belo Monte 11,000 MW hydro project into the national network recommended a ± 800 kV HVDC system composed of two 4,000 MW bipoles

Belo Monte hydroelectric project

Operational Date: 2019

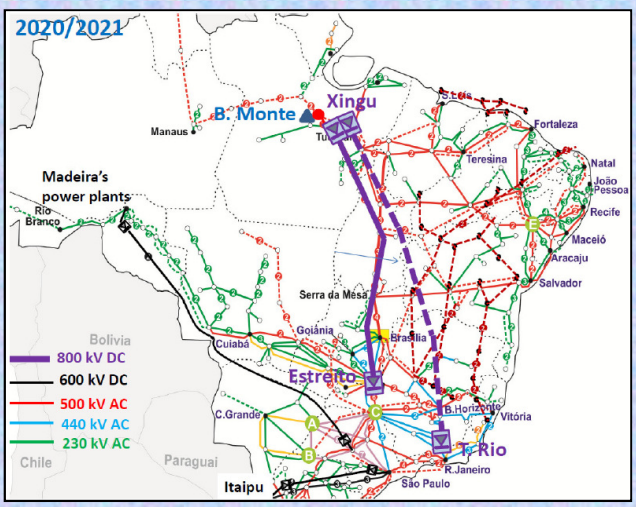


Long distance HVDC transmission links in the Brazilian network

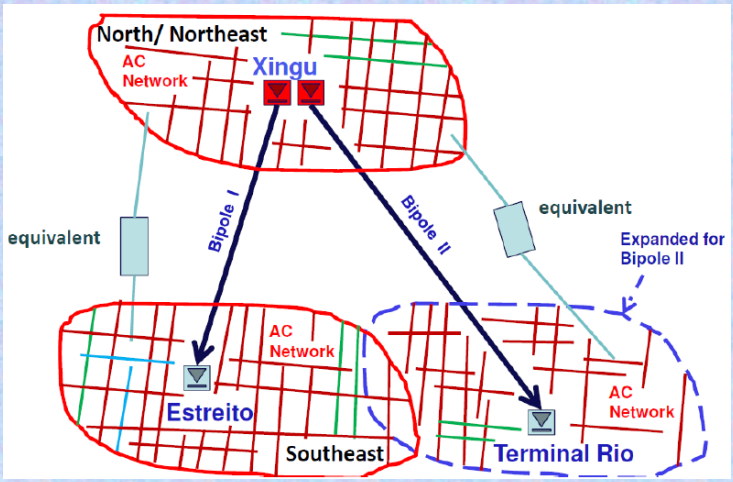
AC System representation

Two scenarios were considered for the complementary investigations of Bipole II's performance:

- Wet season
- Dry season



Belo Monte 800 kV bipoles embedded in the Brazilian network



Network representation scheme in PSCAD

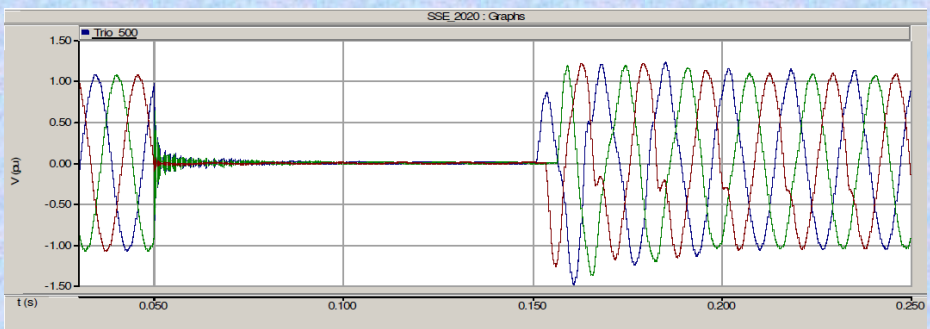
The modeling strategy was to make an AC network representation, suitable for the three types of simulations :

- Electromagnetic transients
- Dynamic performance
- Multi-infeed

HVDC link modeling

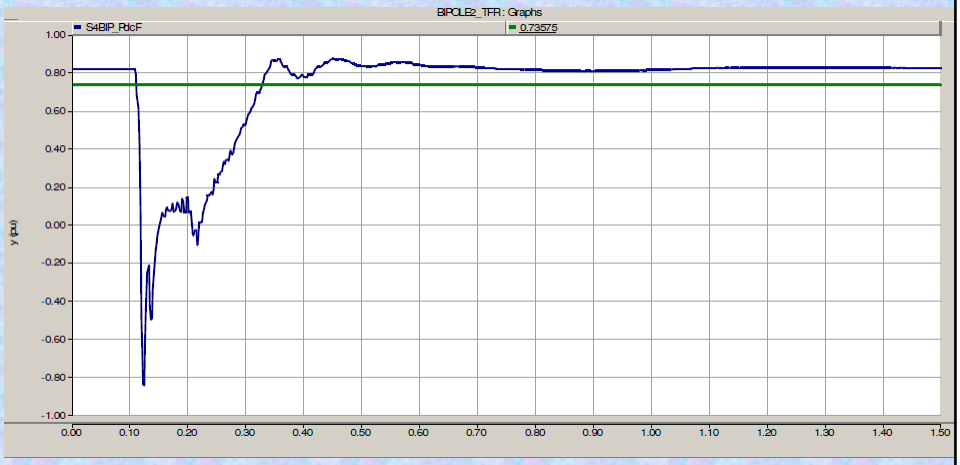
- The previous experience obtained during the Madeira's HVDC system basic project design gave some indication for the development of this actual 800 kV model,(set of basic controls and elements necessary for the type of simulations involved).
- The primary objective of the 800 kV HVDC model was to provide a resource for the electromagnetic transients studies

Electromagnetic Transients Performance



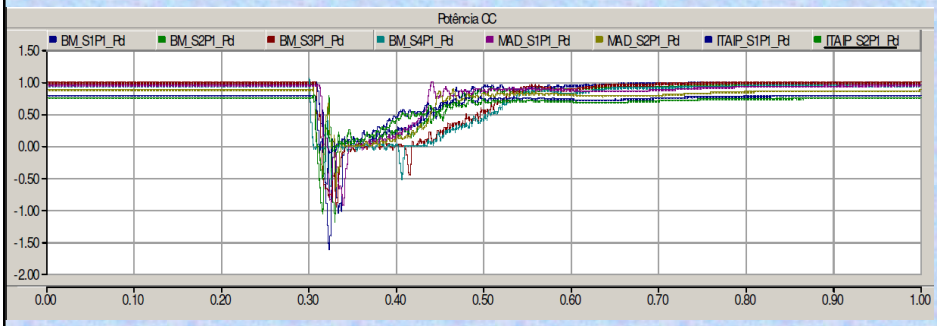
Three-phase fault applied at T. Rio 500 kV AC – phase to ground voltages in p.u.

Dynamic Performance



Bipole II's DC power (p.u.) recovery, after a phase to ground short circuit at Xingu 500 kV

Multi-Infeed Evaluation



Power (p.u.) recovery in HVDC links, after a three-phase short circuit applied at Terminal Rio 500 kV

Final Planning Concept

The revision of the DC transmission line basic concept imposed by new limits :

- Electric fields in the right of way (20 kV instead of 40 kV inside the right of way and 5 kV instead of 10 kV at its border
- Increased the minimum conductor clearance to ground (additional 5 m), the tower structures height and the right of way (additional 20 m).

Belo Monte's HVDC ± 800 kV Bipole II

Main Technical Characteristics

- Direct transmission: Xingu to Terminal Rio : 4,000 MW at Xingu ± 800 kV
- Reverse transmission: Terminal Rio to Xingu : 3,270 MW at Terminal Rio ± 800 kV
- Min power transmitted: 10% of nominal power
- Overload capacity: 33% during 30 minutes after pole or bipole outage; 50 % during 5 seconds

Belo Monte's HVDC ± 800 kV Bipole II

Operation modes:

- Bipole, pole with metallic return, pole with ground return
- Min DC voltage: 0.7 of nominal voltage Max DC voltage: 830 kV~~ 1.037
- AC Filters: 4 units of 420 Mvar in Xingu & 5 units of 400 Mvar in Terminal Rio
- Transmission line length: 2,518 km
- Conductor: 6 ACSR, 1590 MCM "Lapwing", per pole
- Guyed type tower in most of the route.
- Ground electrodes: max. resistance: 0.35 Ω; min. distance to converter: 15 km