Inter-Area Oscillations in the 500-kV Vietnamese Power System

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***Abstract*— The paper presents the study of the 500-kV Vietnamese power system. The oscillatory response of the system is analyzed both with a modal analysis and a time domain analysis. The 500-kV system of Vietnam is modeled in details, including all the power plants with the corresponding regulators. The model is developed in collaboration with the Institute of Energy Science IES-VAST of Vietnam and it is validated with the data provided by the National Load Dispatch Centre (NLDC) of Vietnam. The simulation results reveal a clear identification of potential inter-area oscillations between North and South of the Country. A worsening of the observed phenomenon should be considered as possible, especially in the perspective of the new installation of a significant amount of power from renewable sources into the Vietnamese system.**

***Keywords*— inter-area oscillations, small signal stability, transient stability, dynamic analysis, Vietnamese power system.**

I. INTRODUCTION

The Vietnamese power system is strongly characterized by the geographical conditions of the Country. North and South are connected by very long 500-kV transmission lines, with a significant amount of power flowing from the North to the South through the Center. The concentration of power generation in the two areas can bring in the appearance of inter-area oscillations at low frequency between the power generation plants located in the North and in the South. The peculiar topology of the system in its current configuration is inclined to host inter-area oscillations and it would be interesting in future works to explore the reaction of such situation in the presence of the described different installations, considering the power converters technology and possible delays in the different parts of the upgrading project. In this paper, a first study about the appearance of such phenomenon is considered in the current power network of Vietnam. In order to check and identify the oscillation modes of the system, a detailed model of the 500-kV power system of Vietnam is developed. The model is suitable to perform a complete dynamic analysis of the system, including small signal and transient stability simulations. The modal analysis is first performed, in order to identify the oscillation modes of the system. The results of the time domain analysis are then examined, when the system is subjected to a power plant outage which causes frequency oscillations.

II. OVERVIEW

The model of the 500-kV Vietnamese power system is developed in collaboration with the Institute of Energy Science (IES-VAST) of Vietnam and it is validated with the data provided by the National Load Dispatch Centre (NLDC) of Vietnam. The model is suitable to perform small signal and transient stability simulations and it is implemented in NEPLAN, software for power systems analysis. The geographical representation of the implemented system is shown in Figure 1. The disturbance applied to the system is a sudden generation loss ($\Delta P \approx 440$ MW), corresponding to the outage of one generator in the Center area of the country.

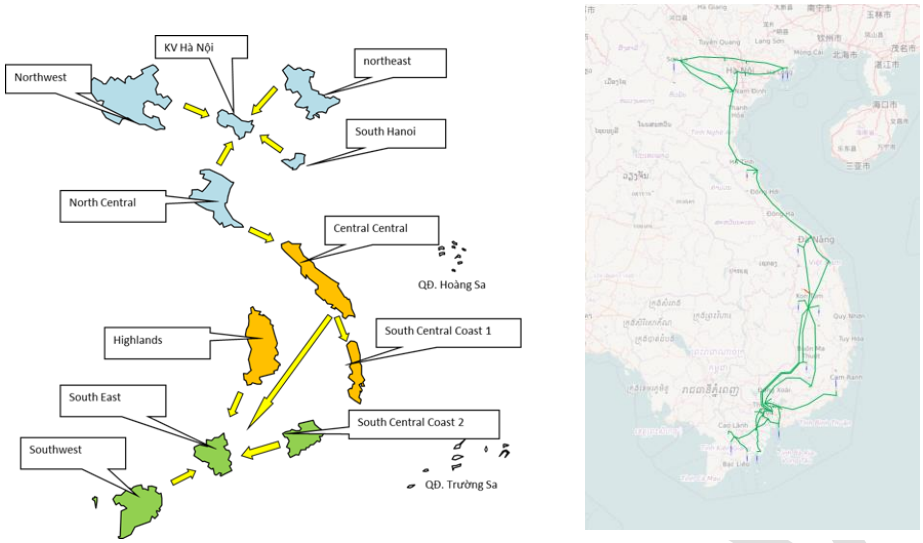

Fig. 1. Inter-regional exchange and system representation of the implemented 500-kV Vietnamese power system.

The time-domain analysis of the system produces the results shown in Figure 2. The system reacts to the loss of generation in the Center area with an expected under-frequency transient: the visual inspection of the results shows clearly the existence of two clusters of synchronous machines, with the North and Center-South areas involved in inter-area oscillations, as the two clusters swing against each other. In the paper, the modal analysis of the system is performed and presented, reporting the calculated eigenvalues and identifying oscillation mode and frequency of the observed inter-area oscillations.

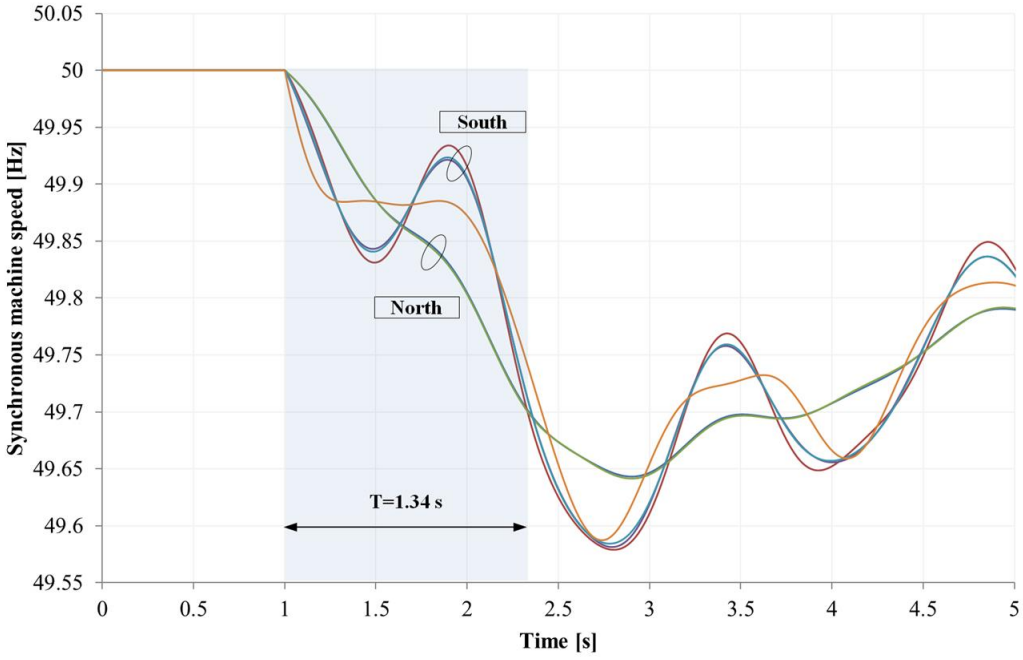

Fig. 2. Inter-area oscillations between North and South of Vietnam.