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The continuing evolution that is affecting the energy system is bringing changes to the electric grid, such as increasing penetration of renewables, decreasing power plants from conventional sources, decreased system inertia, and greater angularspreads between grid nodes.
Under particular electrical system operating conditions, there may be a decrease in damping associated with low-frequency oscillations to levels considered insufficient for safe operation of the grid.The continuous exchange among the inertia-based rotating masses frequently can cause electromechanical oscillations in electrical power systems. The **WAMPAC** systems allow a real time tracking of electromechanical oscillations in large interconnected systems and proper implementation of wide area control logics. In such an environment, a grid event, even one that is not exceptionally critical, could in fact trigger undamped oscillations, which could limit the power transfer capability of connecting lines and even lead to system separation and an interruption of the power supply.

In order to mitigate these phenomena, the excitation systems of the generators are equipped with the so-called Power System Stabilizer (PSS), able to provide a stabilizing contribution to the system. The tuning of this system is performed taking into account both local problems (generator oscillations against the main grid) and wide area problems (oscillations between groups of generators, i.e. the above mentioned interarea frequency oscillations). Synchronous condensers (SCs), in spite of the characteristics that differentiate them from power plants (i.e., no active power generation) are also typically equipped with PSS. In these cases, the inputpower channel to the PSS, normally supplied with the electrical power produced by the generator, can be supplied with the measurement along a power line connected to the substationwhere the condenser is located, or not used at all. SCs reactive power control and the relatedmodulation of the bus terminal voltage in terms of magnitude and phase as well as the active power of transmission lines and loads in the system can help in damping oscillations.

The **WADC architecture** adopted for Terna project uses a phasor data concentrator (**PDC**) collecting Phasor Measurement Unit (**PMU**) measurements, to feed the Supervisory Control with the data necessary to process the set point of the WADC system, carried out by the specific software developed in collaboration with **EPRI**. Through a fast protocol, the WADC sends the set point to the field devices, in this case a customized PMU acts as an interface with the excitation system of the synchronous condenser. Through appropriate implementations, the excitation system injects the signal into the Automatic Voltage Regulator (AVR), which controls the excitation of the synchronous machine and allows the actual implementation of the set point.

Field testing of the WADC system, using recently installed synchronous condensers in the Italian network, is planned during 2022. For this purpose, the excitation systems of some SCs have been suitably prepared for the reception and implementation of the WADC set point. Field tests will have as first objective to verify the correct communication between the central WADC system and the apparatus placed in the premises of the synchronous condenser. These communications shall take place with adequate performances in terms of latency and reliability, in compliance with the characteristics specified in the design phase. The interfacing between the PMU and the SC excitation system will also be tested, verifying the correct exchange of digital and analog signals. It will be also verified the correct implementation of the modifications made to the excitation system (specifically to the AVR). From the point of view of the electrical system, the tests will verify the impact of the WADC set-point on the electrical quantities. As the activities progress and the system is installed on a larger number of SCs, the impact of the WADC will be further investigated and it will be possible to better appreciate its contribution on the grid stability.

Parameterization criteria

The parameters chosen for the characteristic transfer function of the **WADC** must guarantee a non-introduction of low-frequency harmonic components and a phase compensation in the range of interarea frequencies using wide area measurements. **PSS** does the same job looking at local frequency. Both the control can act exclusively or coexist

Experience

Through field tests carried out both in open and closed cycle exciting the inter area mode of interest, an excellent behavior of the **WADC** system in **dampening** oscillations has occurred.

Tuning criteria

The **WADC** and **PSS** coexistence is proven to be effective into the field operation thanks to the proper choice of lead lag pole/zero locations.