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Optimal Control of Generators and Series Compensators within Multi-Space-Time Frame

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Abstract : The operation of power grid is becoming more and more complex and difficult due to its rapid development towards high voltage, long distance, and large capacity. For instance, many large-scale wind farms have connected to power grid, where their fluctuation and randomness is very likely to affect the stability and safety of the grid. Fortunately, many new-type equipments based on power electronics have been applied to power grid, such as UPFC (Unified Power Flow Controller), TCSC (Thyristor Controlled Series Compensation), STATCOM (Static Synchronous Compensator) and so on, which can help to deal with the problem above. Compared with traditional equipment such as generator, new-type controllable devices, represented by the FACTS (Flexible AC Transmission System), have more accurate control ability and respond faster. But they are too expensive to use widely. Therefore, on the basis of the comparison and analysis of the controlling characteristics between traditional control equipment and new-type controllable equipment in both time and space scale, a coordinated optimizing control method within mutil-time-space frame is proposed in this paper to bring both kinds of advantages into play, which can better both control ability and economical efficiency. Firstly, the coordination of different space sizes of grid is studied focused on the fluctuation caused by large-scale wind farms connected to power grid. With generator, FSC (Fixed Series Compensation) and TCSC, the coordination method on two-layer regional power grid vs. its sub grid is studied in detail. The coordination control model is built, the corresponding scheme is promoted, and the conclusion is verified by simulation. By analysis, interface power flow can be controlled by generator and the specific line power flow between two-layer regions can be adjusted by FSC and TCSC. The smaller the interface power flow adjusted by generator, the bigger the control margin of TCSC, instead, the total consumption of generator is much higher. Secondly, the coordination of different time sizes is studied to further the amount of the total consumption of generator and the control margin of TCSC, where the minimum control cost can be acquired. The coordination method on two-layer ultra short-term correction vs. AGC (Automatic Generation Control) is studied with generator, FSC and TCSC. The optimal control model is founded, genetic algorithm is selected to solve the problem, and the conclusion is verified by simulation. Finally, the aforementioned method within multi-time-space scale is analyzed with practical cases, and simulated on PSASP (Power System Analysis Software Package) platform. The correctness and effectiveness are verified by the simulation result. Moreover, this coordinated optimizing control method can contribute to the decrease of control cost and will provide reference to the following studies in this field.

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