Power grid stability under proportional and derivative control

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This work investigates the resilience of an elementary electricity system (power plant - consumer) under proportional and derivative (PD) control when subject to large perturbations. Two models of power plants are used. The first one is a simple synchronous-motor model with constant power, while the second one includes primary and secondary control to modify the mechanical power to keep the frequency of the system within the statutory limits. A particular attention is paid to small power grids, representative of power grid structure in some developing countries. The considered elementary electrical system consists of a consumer (machine), a power plant (generator) and a transmission line. Runge-Kutta method is used to solve the dynamical equations. In the case where the power plant is modeled with the uncontrolled swing equation [1], it is found that the PD-control increases the resilience of the system [2]. We also show that time delays associated to the feedback loop of the controller have a negative impact on the performance [2]. These effects are also analyzed in the case with frequency control.

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