INVESTIGATION OF LONG-TERM VOLTAGE STABILITY CONSIDERING A VOLTAGE-REACTIVE POWER DROOP CHARACTERISTIC

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This paper proposes an expansion of the Newton-Raphson method in the steady state power flow calculations to include a more accurate modeling of the reactive power capabilities of renewable energy sources (RESs) connected at the EHV/HV interfaces. Voltage control capability of synchronous generation units is typically modeled via PV buses in the steady state power flow resulting in QV curves with an infinite slope. However, the reactive power exchange of the converter-coupled RESs with the grid is usually a function of the current operating voltage at the grid connection point. The reactive power injection results from the measured voltage at the grid connection point and the parameters of the characteristic curve. The reference voltage is changed to enable a different reactive power exchange at the connection point [1]. An illustration of a typical Q(U) droop characteristic is shown in Figure 1.

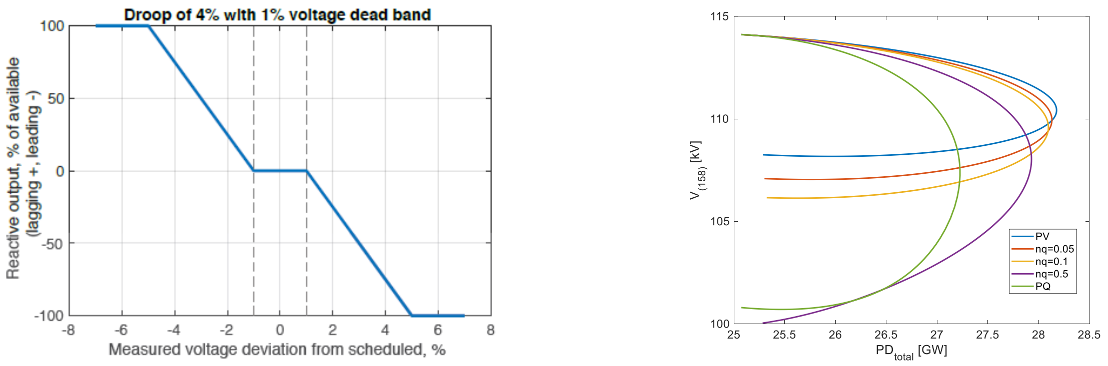

Figure 1: (Left) Exemplary voltage-reactive power droop characteristic, (right) Exemplary PV curves with different droop coefficients (nq)

Within this paper, the steady state and continuation power flow (CPF) equations are expanded to include the Q(U) droop characteristic [2]. The CPF is applied to acquire the PV curve of a system. The droop characteristic is included in the CPF formulation via the introduction of new bus type, namely a droop bus.

The results show that an extended loading margin can be obtained when a droop bus formulation is used to model the reactive power contribution of the converter-coupled RESs within the steady state and CPF calculations. Furthermore, it can be seen that a droop bus approximates the behavior of a PV bus when a small droop coefficient of less than 2% is defined. Besides, the CPF is used to calculate the system transition path between discrete operating points. It can be shown that the voltage gradients are reduced once a droop characteristic is considered to adjust the reactive power injection of the RESs within a CPF transition.

Referenzen

[1] VDE-AR-N 4130 (VDE-AR-N 4130) Anwendungsregel: 2018-11
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[2] F. Mumtaz, M. H. Syed, et al, “A Novel Approach to Solve Power Flow for Islanded Microgrids Using Modified Newton Raphson with Droop Control of DG,” IEEE Transactions on Sustainable Energy, vol. 7, No. 2, 2016, pp. 493–503

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