Average and Phasor Models of Single Phase PV Generators for Large Power Distribution Systems Simulation

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As the penetration of distributed photovoltaic (PV) generation becomes larger and larger, its impact on the stability and security of the power system will become more and more significant. Suitable models for the PV generators are needed for studying the dynamics in a power system containing many such distributed PV generators. Although there is much information in the literature on the detailed modeling of an individual PV converter [1], development of dynamic models of grid-tied PV systems for power system simulation has been the topic of only a few publications [2]-[4].

In this work two dynamic models for a representative residential single phase PV generator are developed: a simplified average model and a phasor model. The former is useful for time-domain simulation. The latter is suitable for fast phasor simulation where only the magnitudes and phases at the line frequency of the voltages and currents in the power system network are of interest, as in a transient stability program. Simulation results show that the proposed models greatly improve the simulation speed over the detailed average model, while maintaining the accuracy needed for typical power system analyses.

[1] M. Ciobotaru, T. Kerekes, R. Teodorescu, A. Bouscayrol, "PV inverter simulation using MATLAB/Simulink graphical environment and PLECS blockset," *IEEE IECON 2006 Annual Conference on Industrial Electronics*, pp.5313-5318, Nov. 2006.

[2] O. Wasynczuk, N. A. Anwah, "Modeling and dynamic performance of a self-commutated photovoltaic inverter system," *IEEE Transaction on Energy Conversion*, vol.4, no.3, pp.322-328, Sep. 1989.

[3] O. Wasynczuk, "Modeling and dynamic performance of a line-commutated photovoltaic inverter system,"*IEEE Transaction on Energy Conversion*, vol.4, no.3, pp.337-343, Sep. 1989

[4] T. T. Yun, D. S. Kirschen, N. Jenkins, "A model of PV generation suitable for stability analysis," *IEEE Trans. on Energy Conversion*, vol.19, no.4, pp. 748-755, Dec. 2004.

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