The dynamic analysis using an improved transient model of a recently introduced single-phase induction generator suitable for renewable energy conversion is presented in this paper. In this three-phase cage type induction machine based generator topology, one of the three windings is used as the control winding for real and reactive power control and the other two windings are connected in series to form the output winding. Due to larger percentage errors resulting from existing models in comparison to the experimental values, transient model of the generator is improved to take into account the core loss resistance and the nonlinearity of magnetizing reactance in the saturated region. The generator system is simulated in Matlab software to present a numerical comparison of the simulation results obtained from improved and existing models. The transient behavior of the generator is comprehensively studied by considering sudden variations in rotor speed, excitation control voltage, capacitance and load. The simulation results are verified by experiments performed on a laboratory experimental setup.