

# **Modeling, Dynamic Characteristics and Steady-State Performance of Hybrid Powered DC Shunt Motor via Photovoltaic and Permanent-Magnet DC Generators**

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## **Abstract**

This paper presents the dynamical model and performance characteristics (dynamic and steady-state) of hybrid powered DC shunt motor. The sources are fuel-driven Permanent Magnet (PM) DC generator and Photovoltaic (PV) Array. The PV array is designed such that its Maximum Power Point (MPP) at full solar illumination is at the rated conditions of the DC shunt motor. The dynamical study includes the response after successive step changes in the mechanical load coupled to the motor. In case of shortages of the power delivered by the PV generator due to reduction in solar illumination and/or increase in the power needed by the motor, the PM DC generator should cover this shortage. In case of very low solar illumination, the PM DC generator should supply the total power demanded by the DC motor. The steady-state power sharing between the two generators is investigated. The electromechanical system of the PM DC generator is equipped with state feedback control system which adjusts the rotational speed of the prime mover and so the rotational speed of the generator by changing the developed mechanical torque such that to have a constant voltage across the terminals of the generator for all realistic solar illuminations and practical motor loading conditions. The study is extended to include two partial solar illuminations. The steady-state output characteristics of the DC motor for all cases are extracted and compared. The nonlinearities of the system due to the PV output characteristics and the ferromagnetic material of the DC shunt machine are taken into account.