Chapter 1

Overview of Renewable Energy Power System Dynamics

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Abstract:

Contemporary proliferation of renewable power generation is causing an overhaul in the topology, composition, and dynamics of electrical grids. Over recent decades, the penetration of renewable energy sources (RES), especially photovoltaic, micro hydro and wind power plants, has been promoted in most countries. However, as these both alternative sources have power electronics at the grid interface (inverters), they are electrically decoupled from the grid. Subsequently, stability and reliability of power systems are compromised. Inertia in power systems has been traditionally determined by considering all the rotating masses directly connected to the grid. However, as the penetration of grid-connected RES increases, the inertia of the power system decreases due to the reduction of the directly connected rotating machines. Consequently, modern power systems require a new set of strategies to include the RES. In fact, 'hidden inertia,' 'synthetic inertia' and 'virtual inertia' are terms currently used to represent an artificial inertia created by inverter dominating generating units like the RES. This chapter provide an overview of RES, highlights the inertia concept and methods to estimate the rotational inertia in different parts of the world. In addition, an extensive discussion on wind and photovoltaic power plants and their contribution to inertia and power system stability is also presented.

Keywords: Frequency control, grid stability, inertia, power systems, inverter-interfaced renewable energy sources.

1.1 Introduction

Depletion of fossil fuel, global warming, and their environmental pollution clarify the importance of renewable energy sources (RES). Renewable energy is derived from the earth's natural resources that are not finite or exhaustible especially at the human life time. Renewable resources include biomass energy (such as ethanol), microbial fuel cell [1], hydropower, geothermal power, wind energy, and solar energy [2]. Offline solar photovoltaic (PV) can power rural villages [3]–[5] at equitable levelized cost of energy (LCOE) if wind is not enough to give economies of scale [6]–[8]. However, high penetration of RES decreases power systems inertia, hence, the system becomes more

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