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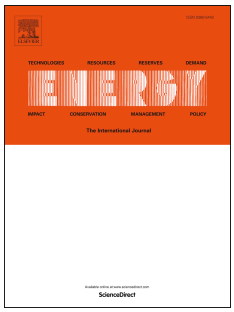

High solar photovoltaic penetration in the absence of substantial wind capacity: Storage requirements and effects on capacity adequacy

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High Solar Photovoltaic Penetration in the Absence of Substantial Wind Capacity: Storage Requirements and Effects on Capacity Adequacy

Abstract

The penetration of solar photovoltaic (PV) generation is increasing in many countries, with significant implications for the adequacy and operation of power systems. This work considers the Nord bidding zone within Italy, which hosts 7.7 GW of PV and almost no wind power. We simulate the implications of different PV penetration levels on the need for firm generation capacity and on ramping requirements over one to several hours. We compare ten years of synthetic hourly PV generation series derived from CM-SAF SARAH satellite data and observed load. The analysis also provides insights into the storage capacity required to smooth residual load over different time horizons. Results show that without storage (i) the penetration of PV in the region does not sensibly reduce the need for firm generation; (ii) the marginal contribution of PV to meet power demand decreases with its penetration; and (iii) high penetrations lead to larger and more frequent ramps, although extreme ramp rates do not last more than one hour. The availability of storage significantly alters these results, but large storage capacities are required. Smoothing net load by a few hours requires 2-7 GWh of storage per GW of PV installed.

Keywords: Solar Energy, Electricity Storage, Capacity Adequacy, Power system, Solar PV, Ramp Rate

1. Introduction

The share of photovoltaics (PV) in power generation capacity is rapidly increasing in many countries worldwide. In just a few years, it has reached a