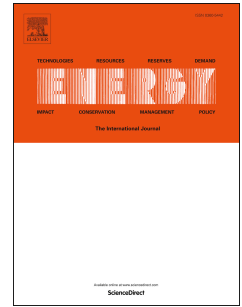


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ABSTRACT

The marginal levelized cost of electricity (LCOE) for increasing the share of Variable Renewable Energy (VRE) is estimated using the electricity investment model *greenVRE*, which entails a detailed representation of the time dimension to account for variability and variation management. The model is applied to Europe (EU-27+Norway and Switzerland), which the model divides into ten electricity balance regions and runs with 2920 time-steps. The model is applied in a greenfield setting, in which the share of renewables (VRE+Hydro) varies between 0% and 100%. The results show that the system LCOE for VRE increases linearly with the penetration level range of 20%–80%, above which it increases sharply. Systems that have a high penetration of VRE are characterized by using wind power as the major generating technology and having strong expansion of transmission capacity. A sensitivity analysis for the cost of VRE and variation management capacity (storage and transmission) reveals that the point of increase in marginal LCOE is robust under different future scenarios regarding technology costs. We conclude that VRE could constitute the bulk of electricity generation at a reasonable cost, given that there is availability of variation management, especially with respect to transmission.

Key words: variable renewables, system LCOE, marginal cost, wind power, solar power, capacity expansion model

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1. Introduction

Currently, the power generation system in Europe is undergoing a rapid transition, with thermal generation of electricity being replaced by wind and solar power generation. There are several reasons for this development: (i) the decreasing cost of solar and wind generation capacity; (ii) energy security concerns associated with the importation of natural gas; and (iii) concerns about climate change. An electricity system that is based on wind and solar is radically different from the present system, since fluctuations in the residual electricity demand (wind and solar power generation subtracted from the demand for electricity) are larger and different from those of demand alone. This is already noticeable in countries and

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