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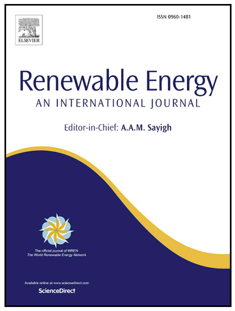

Representing node-internal transmission and distribution grids in energy system models

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Representing node-internal transmission and distribution grids in energy system models

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Today's energy system models calculate power flows between simplified nodes representing transmission and distribution grid of a region or a country – so called copper plates. Such nodes are often restricted to a few tens thus the grid is not well represented or totally neglected in the whole energy system analysis due to limited computational performance using such models. Here we introduce our new methodology of node-internal grid calculation representing the electricity grid in cost values based on strong correlations between peak load, grid cost and feed-in share of wind and photovoltaic capacity. We validate in our case study this approach using a 491 node model for Germany. This examination area is modelled as enclosed energy system to calculate the grid in a 100% renewable energy system in 2050 enabling maximum grid expansion. Our grid model facilitates grid expansion cost and reduces computational effort. The quantification of the German electricity grid show that the grid makes up to 12% of total system cost equivalent up to 12 billion € per year.

Keywords: grid expansion, copper plate, energy system model, balanced energy mix, fluctuating and dispatchable renewable energy shares, CSP-HVDC

1 Introduction

Energy system models are todays methods to calculate and optimize future energy systems often with the target function of minimal system cost (REMix, PLEXOS, TIMES, ReEDS, etc. [1]). One major barrier of such numerical calculation methods is the complexity of the model. A higher spatial granularity often increases the computing capacity and calculation time exponentially. However, reducing spatial resolution does not lead to more robust results when neglecting effects like grid expansion especially with high shares of fluctuating renewable energies like photovoltaics (PV) and wind turbines. Neglecting grid cost means that in a model node (continent, country or region) an ideal exchange of power flows is possible without any transmission constraint – the so called copper plate. This obviously leads to wrong system cost and a distorted power plant structure. Interconnecting model nodes using transmission links is a first step to solve the problem but computing capacity quickly reaches its limit when spatial resolution and the number of interconnection paths rise. Such transmission models are used e.g. in renewable energy-based power supply

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