***Assessing the regional redistributive effect of renewable power production through a spot market algorithm simulator: the case of Italy***

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**Overview**

The recent economic literature on the impact of renewable production on wholesale electricity market functioning has highlighted 3 sets of results: a correct assessment of the “merit order” effect should take into account the renewable generation source and its production cycle; in interconnected power markets with locational pricing mechanisms, the “merit order” effect may not occur as straightforwardly as it usually acknowledged and the geographical localisation of the renewable power plant is a relevant variable in forecasting possible benefits; the attainment of environmental benefits through the substitution of polluting production units is still largely discussed. We have investigated this topic in detail, using Italy as case study: Italian Power market is composed by six zonal markets with heterogeneous inter-zonal transmission capacities and zonal production capabilities, and the congestion has an economic value thanks to the implementation of a zonal pricing scheme.

**Methods**

We have developed an algorithm called M.I.D.A.S. (Italian Day-Ahead Market Solver) that simulates by iterative splitting the hourly equilibrium (price-quantity) of the Italian day-ahead market taking into account all transmission constraints between zones and the import from neighbouring countries. The algorithm is built on GME (the market operator) data and it is trained using 2015-2018 market outcomes. M.I.D.A.S. is employed to study the sensitivity of market outcomes to changes in production from units employing variable renewable sources, notably sun and wind, at different locations. We have used as reference for our simulations the 2030 targets for solar and wind production included in the National Integrated Energy and Climate Plan, approved in 2020 by the European Commission. Two sets of simulations are performed: the first considers equal increases of renewable supply in all zones, while the second achieves the same national total increment by concentrating the additional production in specific zones. We study the impact of larger renewable production on zonal prices, zonal generation mix (“technological substitution effect”), congestion occurrence and zonal balance.

**Results**

We show that, when power markets are organised on zonal-basis with locational price signals and final buyers pay a unique price for the power bought in the day-ahead market, a larger renewable production decreases the average zonal prices (“zonal merit order” effect), but the distribution of benefits largely depends on power plants’ localisation. Concentrating the additional production in the zones with larger demand allows to obtain the best results in terms of unique price reduction, although these zones are not the ones experiencing the more important price decreases for the same amount of additional generation. For small and large increases in renewable supply, solar and small renewables achieve the largest reduction in the unique price, while for intermediate increments, wind seems to be more efficient.

We provide evidence of competition between renewables and thermal sources but also within renewables sources. By calculating the zonal substitution effects between technologies, we highlight the heterogenous impact that the additional renewable production can have on the zonal generation mix. We finally show which configurations have the strongest impact on network congestion and zonal balances between demand and supply.

**Conclusions**

M.I.D.A.S. results to be a powerful tool as it sheds some lights on the multiple consequences of energy transition policies. Our analysis highlights how complex is the task of formulating policy recommendations when multiple objectives are to be pursued with a single instrument: a prioritisation is therefore mandatory. Up to our knowledge, the reduction in the wholesale price has never been regarded as a direct goal to be achieved through the development of renewable sources; it is rather considered as a positive “side effect”. If policies especially seek to attend environmental targets, they should focus on the localisation that delivers the largest substitution between non pollutant and pollutant units, which might not necessarily be the one guaranteeing the lowest wholesale price. The same reasoning applies to security of supply and zonal balance which can be as well improved at the expenses of substitution and price level. In our specific case study, it is not possible to reconcile all these objectives with a single best solution.

**References**

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