High Taxes on Cloudy Days: Dynamic State-Induced Price Components in Power Markets

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Compliance with European climate policy objectives necessitates a major expansion of variable renewable energy (VRE) sources like wind and solar. The power generation costs of these technologies have dropped substantially in recent years but, due to the fluctuating nature of VRE, its large-scale integration into the power system continues to be a challenge. To achieve a better match between demand and generation of VRE, one measure frequently proposed is that of passing on wholesale price signals to consumers, a policy that is also referred to as "real-time pricing (RTP)". Taking the idea of RTP one step further, we analyze how charging state-induced price components—which often constitute the major share of electricity prices—at time-variant rates can foster the integration of VRE and thus support decarbonization in the power sector.

Specifically, we focus on an energy-based subsidy scheme for renewables which is financed by a levy on the consumption of electricity, and we analyze how charging this levy proportionally to wholesale prices affects the costs of integrating VRE and of avoiding greenhouse gas (GHG) emissions. For this purpose, we apply a detailed power market model that puts particular emphasis on electricity demand and its price sensitivity. For a quantitative case study, the model is parametrized to represent a hypothetical electricity market situation in Germany with an 85% share of renewables.

Based on our study we find a decrease in integration costs of VRE from price dynamization of up to 4%. Findings on decarbonization, however, are ambiguous. If specific emissions of mid-load power plants exceed those of peak-load plants, we observe an overall increase in CO_2 mitigation costs. If this is not the case, CO_2 mitigation cost reductions of up to 5 €/tCO_2 can be observed. The reason for this is that dynamization in general causes demand to increase and to shift from peak-load towards mid-load power plants. Accordingly, positive impacts of dynamization are found to arise if the gap between marginal costs of mid-load and peak-load power plants widens and also if the own-price elasticity of demand increases. Furthermore, strong distributional effects can be observed: Those consumers who are able to shift their demand to low-price hours profit from doing so at the expense of less flexible consumers.

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