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The long-run equilibrium impact of intermittent renewables on wholesale electricity prices

EPRG Working Paper 1601

Cambridge Working Paper in Economics 1601

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Intermittent renewable electricity supply (RES) is currently subsidized in many liberalized electricity markets, partly to redress the under-pricing of carbon, but also to support the public good aspect of delivering learning benefits. RES displaces conventional fossil generation, reducing both carbon emissions and fuel costs. It also depresses wholesale electricity prices and benefits final consumers. This paper asks by how much consumers gain in the long run from lower costs induced by the RES capacity, as that amount could be a legitimate charge to impose on final electricity consumers, leaving the remaining subsidy for public good aspects, logically a charge on general tax revenue.

RES can lower wholesale prices in the short run through the merit-order effect in which low cost RES displaces high cost price-setting plant. Liski and Vehviläinen (2015) have econometrically estimated the short-run impact that wind has on electricity wholesale prices and hence on the distribution of rents between producers and consumers in the Nordic market in the presence of massive storage hydro. In contrast this paper models the impact of RES on wholesale prices in a fossil-based electricity industry with no storage in long-run free entry competitive equilibrium. In that state with constant returns to investment, wholesale prices will be driven to the point that all conventional generators earn a normal rate of return on their investments, and so need no compensation for the subsidized RES capacity. A number of authors have considered the long-run impact of RES on electricity wholesale markets in equilibrium, either to find the impact on the choice of plant, or to identify the impact of various, usually distorting, forms of RES subsidy on wholesale prices and on subsidy costs.

In the model studied here, demand does not respond to prices but does vary over the hours of the year, as does the output of RES. Costs are minimized and the industry is in long-run equilibrium with the optimal plant mix for each level of RES capacity. The aim is to find the impact of changes in RES capacity on plant mix and cost, which will be reflected in changes in average prices if they are efficiently set. In a very recent paper, Green and Léautier (2015) develop a fully analytical model of plant mix, price determination and various distorting RES subsidy regimes to examine the long-run equilibrium for very high levels of renewables penetration, examining the likelihood that subsidies will decline as their costs fall.

In this simplified model, which can be considered as complementary to Green and Léautier (2015), the market design assumes efficient prices and RES supports, and the focus is on the extent to which electricity consumers, rather than general taxes, can efficiently be charged for renewables penetration in return for the reduced prices that RES might induce. Payments for the system services needed to provide flexibility and reserve power attributable to RES are allocated entirely to RES, and assumed not to impact fossil generators nor affect consumer bills. The market structure can be thought of as a Pool (like the former Electricity Pool of England and Wales and the 2007-2016 Single Electricity Market of the island of Ireland) in which generators are paid the system marginal cost for energy, including the carbon cost, and capacity payments are only paid to plant available, with payments concentrated in tighter hours. Consumers face efficient prices and pay the wholesale price, (uprated by various ancillary service costs), which includes capacity payments in scarcity hours.

The paper shows that the equilibrium number of hours that peaking plant runs is unaffected by the level of RES capacity installed, and that consequently there are no changes in wholesale prices as long as conventional plant is at the margin. Although RES displaces a comparable amount of conventional derated capacity and output, this is paid the same price as the plant it displaced, except for the hours RES displaces all conventional plant and is price setting at its very low variable cost. Provided carbon is already efficiently charged, preferably on the carbon content of fossil fuels, the amount of RES subsidy that is legitimately chargeable to electricity consumers is equal to the difference in fossil capacity costs with and without the RES, and the difference between the baseload system marginal price and the variable cost of RES, but only for the hours in which RES is price-setting. An illustrative example from the recent GB auctions suggests that for wind less than two-fifths of the required wind subsidy should be charged to electricity consumers, although this amount is very sensitive to fossil and carbon prices. The remaining required subsidy, which is a public good, is properly charged to general taxation.

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Publication	January 2016
Financial Support	