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Capacity vs Energy Subsidies for Renewables: Benefits and Costs for the 2030 EU Power Market

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It is widely agreed that renewable electricity policies, such as feed-in tariffs, that encourage selection of the type and location of renewable development irrespective of the marginal value of its output will promote inefficient investment. Such policies tend to value maximization of renewable production without considering the economic value of that energy for meeting power demands or emissions goals. Therefore, the EU and its member states are moving towards feed-in premiums, curtailment requirements, and other policies that are intended to align renewable investment profitability with the market value of electric energy. Development may therefore be encouraged at locations where resources produce fewer annual MWh, but where the increased energy market value more than makes up for decreased production, due to timing or transmission availability. This supports the objective of minimizing the net economic cost of achieving renewable energy targets, at least in the short-term.

A longer term objective is to reduce renewable energy costs through learning-by-doing. Learning externalities are widely recognized as a benefit of renewables promotion, although estimates of the magnitude of learning differ among studies even of the same technology. Some authors have quantified the magnitude of learning externalities for technologies as justifications for particular subsidy levels. However, it has been argued that feed-in premia, renewable portfolio standards, production tax credits, and other policies that subsidize energy (MWh) generation are inefficient means for achieving the goal of promoting technology improvement.

In particular, if learning-by-doing is a function of cumulative MW investment rather than cumulative MWh production, then policies that are tied to capacity installation rather than energy output might be more effective in reducing technology costs. On the other hand, capacity-oriented policies are argued to be less cost-

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effective than well-designed energy subsidies for achieving energy penetration targets and reducing external environmental costs, at least in the short run. The simplest capacity-focused policies could take the form of straight-forward per MW investment subsidies, such as auctions or investment tax credits. A more sophisticated variant would instead solicit offers based on a per MWh cost, but would pay only up to a maximum number of MWh per MW of capacity over the lifetime of the project. We term this policy the mixed investment/output subsidy policy.

This paper addresses the cost and technology impacts of energy- versus capacity-based renewable policies using a detailed model of market-based generation investment and dispatch in Europe. The choice of capacity vs. energy-based subsidy could significantly affect the amount and mix of renewable energy investment, and its cost. In this paper, we ask what the outcomes would be in a much more realistic context – the European Union (including the UK, Norway, and Switzerland), accounting for varying market conditions, transmission limitations, and renewable energy development opportunities across the continent. In particular, we compare the impact of energy-focused (feed-in premium or renewable portfolio standard (RPS)) and capacity-focused (investment subsidies) renewable policies upon the EU-wide electric power market in 2030 using an EU-wide transmission-constrained power market equilibrium model. The specific question we focus on is the following: *How do the different policies impact the mix of renewable and non-renewable generation investment, electricity costs, renewable output, the amount of subsidies, and consumer prices in the year 2030? Specifically, do capacity-based policies result in significantly more investment and possibly learning?*

We use a power market model in order to determine what renewable investments would earn from selling energy and the resulting net costs that the investment must then recover from subsidies. These net costs must account for the value of power at different times and places, which in turn depends on the simultaneous interaction of supply and demand throughout the network; analysis methods that focus only on renewable resource capital and operating costs will miss these crucial interactions.

We also consider the mixed capacity/energy subsidy policy; its result is a combination of investments that lies between the mixes incented by the pure energy and pure capacity subsidy policies. We also examine the interaction of energy and capacity policies with policies concerning trading of renewable energy credits across country borders. In particular, we evaluate the efficiency of national policy targets for renewable electricity production or capacity (as a whole or per technology) and compare these with a cost-effective EU-wide allocation of renewable energy investment, given resource quality, network constraints and the structure of the electricity system in the various EU countries.