Crediting Wind and Solar Renewables in Electricity Capacity Markets: The Effects of Alternative Definitions upon Market Efficiency

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Executive Summary. As the penetration of variable renewable energy in electricity markets grows, due in part to subsidies in the form of tax credits and renewable portfolio standards, there is increasing need to account for the contribution of renewables towards overall electric system reliability. In addition to tax credits and portfolio standards, variable renewables can also be subsidized by overcounting their contribution in capacity markets. On the other hand, undercounting the contribution of a resource can counter the effect of other subsidies. At present, capacity counting practices are highly inconsistent across markets. Inaccurate credits can subsidize or penalize different resources, and consequently distort investment between renewables and non-renewables, and also among different types and locations of renewables.

Using ten years of actual wind and solar generation and customer electricity demand data, we use an electricity market equilibrium model to first, define a baseline by minimizing system cost comprised of generation investment, generation operations and consumer cost when load is curtailed. Second, we modify the model to simulate markets with an energy price cap whose distorting effect on investment and reliability is partially or fully mitigated by an installed capacity market. Both models can be run with or without renewable tax credits and portfolio standards. The second model allows quantification of the loss of efficiency due to inaccurate capacity credits, and how this loss is affected by various renewable subsidies. In particular, the models are used to compare systems with equivalent reliability, as measured by expected unserved energy, by adjusting the capacity requirement to maintain reliability standards. We test our hypothesis that the most efficient capacity credit for renewable generation is the marginal value that is contributed during critical load hours, which are those hours in which there is some expected unserved energy due to the marginal cost of service being above the customers' willingness to pay.

The results of our research show that current industry practices are inefficient. The distortions from inaccurate capacity credits are both increased cost and investment shifts among different technologies as well as different renewable sites. Layering inaccurate capacity credits with existing US federal tax subsidies increases costs as much as 6.3% compared to optimal capacity crediting under those subsidies. In that case, the distortion is primarily due to displacing lower cost renewable wind investment with more heavily subsidized renewable solar investment that receives a higher capacity credit, while at the same time concentrating the remaining wind investments at locations that produce high annual energy but have low contributions to meeting customer demand during critical times. Other scenarios typically show distortions on the order of less than a percent of total cost, which can still amount to hundreds of millions of dollars in a market the size of our case study Texas system. Assigning no capacity value to renewable resources is a disincentive for renewable development and can undermine the objectives of other renewable subsidy policies. We demonstrate that the most efficient generation mix results from basing capacity payments upon the relative marginal ability of each resource to decrease expected unserved energy. This method is the most efficient no matter which other external policies are implemented.

Using a capacity credit that is determined by a generator's marginal contribution to the system provides a comparable metric for all generators despite their differing operating characteristics. Doing so aids the development of renewable generation in an efficient manner without undermining other subsidies or increasing costs unnecessarily.