Contribution ID: **71**

Type: **not specified**

When to charge demand? Refinancing capacity renumeration mechanisms

Friday, March 27, 2026 10:00 AM (20 minutes)

Extensive research has examined how capacity markets address the missing-money problem in electricity markets and how capacity procurement auctions can be designed efficiently. Less attention has been devoted to how the costs of capacity markets are distributed to consumers. Here, we analyse the design options of demand charges for refinancing electricity capacity markets. We combine a theoretical framework with a numerical equilibrium model. Results focus on the implications for firm capacity, technology mixes, market prices, and welfare.

We compare three main design types: first, a flat demand charge, applied at all times; second, a time-of-use (TOU) charge, applied during predefined periods when scarcity is likely to occur; and third, a dynamic charge, triggered by stochastically realized or forecasted scarcity situations. Flat and TOU designs are implemented with constant charge levels; for dynamic designs, we implement constant and variable charge levels, with variable levels increasing with the degree of scarcity. TOU and dynamic charges more accurately reflect the costs of building additional capacity to cover demand during scarcity situations. Assuming that electricity demand is price-elastic, this is expected to lead to welfare gains.

Theoretical framework

In the theoretical framework, we compare the two most divergent cases of potential charge designs in terms of demand response cost reflectivity: a flat charge and a dynamic charge with a variable level. We assess the implications of the different charges for dispatch and investment decisions, and evaluate static and dynamic welfare losses, relative to a hypothetical, efficient energy-only market (EOM) without a charge.

We conclude that applying flat charges results in static welfare losses in hours with abundant supply, as the dispatch decision differs from the EOM (left plot in the figure, see PDF). Dynamic charges, applied only in hours of scarce supply, do not exhibit such static inefficiencies (right plot, see PDF). Meanwhile, during times of scarcity, dynamic charges apply higher amounts on top of energy market prices and, therefore, deliver a more efficient signal for demand reduction than flat charges. Consequently, maintaining the same reliability level under a flat charge requires more installed capacity than under a dynamic charge, increasing fixed capacity costs and lowering dynamic welfare.

Numerical model

The numerical model allows us to confirm and quantify these theoretical considerations. In the partial equilibrium model, agents optimize (brownfield) investment and dispatch decisions under perfect foresight. The model is solved using the alternating method of multipliers (ADMM), in which agents independently optimize investment and dispatch decisions, while prices in energy and capacity markets are iteratively updated to clear aggregate imbalances. We model four representative weeks in hourly resolution. The model is parametrized to loosely reflect the German electricity market in 2040. The required capacity market volume, the capacity market clearing price, and the respective charge level to recover capacity market cost are determined endogenously in the model.

The results indicate that more cost-reflective demand charges induce a substitution of demand response for capacity procured in the capacity market. This substitution reduces consumer costs under TOU and dynamic charges by about 200 million euros per year compared to a flat charge. Furthermore, demand increases when capacity is abundant, as no distortive charges are applied. This further increases consumer surplus and welfare. Moreover, we find that more cost-reflective charges reduce investment in thermal capacity, while increasing investment in wind and solar generators. For batteries, we observe ambiguous effects, which we interpret as the net effect of substitution by price-elastic demand response to more cost-reflective demand charges and complementarity with higher variable renewable energy penetration.

Finally, we discuss how key modelling assumptions and parameter choices affect the interpretation of our results, focusing on the perfect foresight assumption, the potential advantages of dynamic charges under uncertainty, and the use of historical demand elasticity estimates.

Author: BRÖCKER, Marlene

Co-authors: Ms KRAINER, Diana; Prof. RUHNAU, Oliver; Mr STRÖMER, Stefan

Presenter: BRÖCKER, Marlene

Session Classification: European Market Integration & Capacity Renumeration