NET VERSUS FLOW-BASED ALLOCATION OF CROSS-BORDER TRANSFER CAPACITY IN AN INTERNATIONAL ELECTRICITY MARKET

Thomas P. Tangerås, Mälardalen University, +46707275448, thomas.tangeras@mdu.se

Overview

A long-standing objective of energy policy in the European Union (EU) has been to create an internal electricity market to accomplish competitive prices, efficient investment signals, increased security of supply and sustainable electricity supply. The EU has, for instance, implemented a centralized market platform which facilitates trade of electricity between the participating countries.

The extent to which electricity can be traded across national borders depends fundamentally on the capacity of the interconnectors that join together the domestic electricity networks of the countries comprising the internal market. Historically, the transmission system operators (TSOs) that own these interconnectors decided how much of the cross-border transmission capacity that should be allocated to the market. The TSO in an exporting country would state a maximal export capacity, and the TSO an importing country would state a maximal import capacity on the interconnectors between the two countries. The interconnector capacity between the two countries would be set at the minimum of the stated export and the import capacities. Subsequently, the market platform would clear supply offers and demand bids taking into account how interconnector capacities constrained trade. This procedure, known as *net transfer capacity* (NTC) allocation, is still a common method for assigning interconnector capacity within the EU.

Enabling countries to unilaterally reduce trade makes sense because domestic network conditions may sometimes limit the amount of electricity than can be exchanged with other countries without jeopardizing the operational security of the transmission network. However, a mechanism in which TSOs supply capacity strictly on the basis of domestic system conditions runs the risk of sub-optimization by which the allocated transfer capacities fail to internalize the total value of trade for all countries participating in the market. Hence, an alternative method for deciding interconnector capacity was developed.

Under *flow-based transfer capacity* (FBTC) allocation, each TSO reports its domestic system condition to the market platform. Based on the collected data about system conditions, supply offers and demand bids, the market platform calculates the interconnector capacities that maximize the total value of trade while simultaneously respecting the operational constraints of the network. This method has the potential to increase efficiency by co-optimizing transfer capacities, production and consumption in an integrated model of the electricity system. FBTC has been implemented by many member states and is currently the EU's preferred method for allocating interconnector capacity in the internal electricity market.

The purpose of this paper is to assess the theoretical efficiency benefits of this reform by comparing the net and the flow-based method for allocation of interconnector capacity in an economic model of an international electricity market. Very little research has been devoted to studying the incentives of TSOs to supply transmission capacity. Glachant and Pignon (2005), van Beesten and Hulshof (2023) use numerical power grid models and show by examples how TSOs can benefit from inducing congestion on a cross-border interconnector to relieve domestic system conditions. Horn and Tangeras (2021) develop a general theoretical framework and show how network owners generally have unilateral incentives to withhold cross-border transmission capacity from the market. Hoffler and Wittmann (2007) identify a design that reduces the incentive to withhold capacity when a single network owner auctions off access to an interconnector. I deviate from the previous literature by introducing asymmetric

information and examining the efficiency properties of different applied mechanisms for allocating interconnector capacity.

Methods

I construct a theoretical model of an integrated electricity market. The model features two interconnected countries. The fundamental obstacle to implementing an efficient outcome is that the TSO in each country is privately informed about the domestic network condition. How much interconnector capacity to allocate to the market thus constitutes a mechanism design problem. The net transfer method is an indirect mechanism in the sense that TSOs supply transfer capacities that jointly determine trade. The flow-based method is an example of a direct mechanism because trade depends directly on the network type (domestic network condition) reported by each TSO. The flow-based mechanism is the direct mechanism that maximizes expected welfare.

Three constraints restrict the set of feasible mechanisms under incomplete information about system conditions. First, TSOs might have incentives to conceal the true system condition to manipulate trade, which would reduce efficiency of the mechanism. Second, it is important to avoid overloading critical network components to maintain the physical integrity of the system. Third, the mechanism must be continuous to avoid minor changes in system conditions to generate disproportionally large losses. Mechanisms that satsfy these three constraints are *feasible*.

Results

Feasible direct mechanisms have a simple characterization. They differ from the net transfer capacity mechanism only by placing an additional cap on trade. At the heart of this result is a fundamental property of the mechanism design problem under examination. Determining the quantity of trade is the only instrument available to the principal, which places it in the class of mechanisms without contingent transfers. Such a mechanism is incentive compatible only if it maximizes agency rent or is locally independent of the agent's type. In the case of a single TSO, so-called interval delegation implies that the mechanism determines a floor and a cap on transfer capacity. The TSO is free to choose any transfer capacity between the floor and the cap. Imposing the additional constrains removes the floor and leads to a cap on trade as the only possible restriction.

Finding the flow-based transfer allocation mechanism boils down to deriving the optimal cap on trade. Any such cap limits trade precisely in such circumstances when both TSOs favor more instead of less trade. The welfare-maximizing direct mechanism is therefore unrestricted trade. By implication, net and flow-based transfer capacity allocation yield *equivalent outcomes* in a two-country model.

Conclusions

This results of this paper suggest that a market reform imposing flow-based capacity allocation on TSOs is not going to increase efficiency compared to a simple mechanism based on net transfer capacity allocation. Since NTC maxmizes expected welfare in the set of direct feasible mechanisms, no other regulation simply aimed at increasing transmission capacity will increase efficiency either. The robustness of this result needs to be examined in important directions, for instance within a three country framework.

References

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