A FRAMEWORK FOR DESIGNING & CATEGORISING CAPACITY MARKETS – INSIGHTS FROM AN APPLICATION TO EUROPE

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Overview

Resource adequacy in electricity markets refers to the mechanisms that manage the capacity of installed generating technology, and the adequacy of that generation to meet anticipated demand. Electricity markets around the world are currently facing new pressures that exacerbate challenges around market mechanisms for maintaining resource adequacy. Plateauing or reducing demand in many nations is combined with policies intended to drive investment in renewable and other clean technologies, many of which have highly variable availability (such as wind and solar photovoltaics). Both of these factors are likely to create a more challenging investment environment, with less certainty around the future market revenues that drive investment in new generation.

For this reason, many jurisdictions are considering moving towards more explicit capacity remuneration mechanisms to increase investment certainty (including France, Germany, Great Britain, Italy and others). These mechanisms are intended to operate alongside markets trading wholesale energy. This makes it an important time to provide improved frameworks for making decisions about the design of capacity markets. Furthermore, in the European context, the emergence of a multitude of different market designs within individual countries in an interconnected electricity market raises questions with regards to the possibility of cross-border participation, market integrity and compliance with EU trade and state aid regulations.

Methods

The process for making key design choices was analysed in markets where a fundamental change in market design is being or has been considered. A two-tiered classification framework was developed, aiming to capture key design choices and provide a starting foundation for considering capacity market design questions. This framework was applied to a number of capacity markets in operation or under consideration in Europe, namely France, Germany (where different design options are discussed at the time of writing), Italy and the United Kingdom. Besides discussing the respective design choices made or under consideration, special attention was given to issues such as cross-border participation of generators situated in neighbouring countries (both EU and non-EU).

Results

Three key design choices were identified as being fundamental in defining the distinguishing features of various capacity market designs. These were defined as "first tier" design choices. Other design choices will also be significant in determining how the mechanism operates, but do not differentiate between common models; these were classified as "second tier" design choices.

First Tier Design Choice 1 – What is the capacity product to be traded?

Most common types of capacity markets trade physical capacity via a "capacity credit" or similar product, which is usually defined as a megawatt (MW) of generating (or demand-side) capacity made available to the market in a particular year (or defined timeframe). There may be complex provisions that define the consequences if that capacity is ultimately not available at times when it is required, to ensure adequate incentives for capacity availability during rare scarcity periods when it is actually required. A more recent innovation has been to instead trade a financial instrument such as "Reliability Options". A reliability option is a call option similar to a cap contract traded in energy-only electricity markets. In a reliability options model, generators sell reliability options (usually to a central authority, although not necessarily), and must then pay that central authority the difference between the spot price and the strike price, whenever the spot price exceeds the strike price [1]. In markets with a high spot market price ceiling, this creates a severe penalty for failing to be available during scarcity periods (when the spot price may exceed the strike price by a significant margin, and any generator that is not operating will not be earning spot market revenues to meet that contractual requirement). Any capacity market that trades reliability options (rather than capacity credits) could be termed a Reliability Options mechanism. Reliability Options are currently under consideration in Italy.

First Tier Design Choice 2 – Who determines the amount of capacity that will be required?

In many capacity markets, a central authority directly determines the volume of capacity that is required (possibly based upon a forecast of peak demand several years in advance). In other models, Load Serving Entities (LSEs) self-determine the amount of capacity to be procured, based upon their own forecast of their anticipated customers' demand, and the risk associated with the penalties defined by a central authority if they fail to forecast accurately. In yet other models, customers themselves determine the amount of capacity that they want to contract for directly with providers (this is termed a Capacity Subscription model [2]). For the French capacity market it is proposed that the central authority will determine the amount of capacity required, whereas one of the options discussed in Germany is for the amount of capacity to be determined in a decentralised manner.

First Tier Design Choice 3 – What is the procurement process for that capacity?

There are two broad options for capacity procurement: either a central authority directly procures capacity through a central process (such as an auction or tender), or LSEs are responsible for procuring capacity, potentially through a bilateral trading process. Whilst the French capacity mechanism requires LSEs to purchase and hold the necessary certificates, the Italian and UK mechanisms centrally procure the capacity needed by way of an auction.

Common Terminology based upon First Tier Design Choices

If a central authority determines the amount of physical capacity required, and then directly procures that capacity from the market, this would often be termed a Centralised Capacity Market. In contrast, in a Capacity Obligation model the central authority determines the amount of capacity required, and then passes the obligation for procuring that capacity on to LSEs (usually in proportion to their respective customer loads). LSEs then bilaterally procure capacity directly from providers. If LSEs themselves determine how much capacity is required, and then bilaterally procure that capacity, this would often be termed a Decentralised Capacity Market.

Second Tier Design Choices

There are a wide range of second tier design choices. For example, there is an extensive design process to determine how capacity auctions might be performed, if they are to be utilised. In Italy a descending clock auction is used. The duration of contracts for the provision of capacity is also of high importance, as is the lead-time for the procurement of contracts. In addition, not all technologies may be eligible to participate (this is the case in Italy). In other markets, such as in France, a "de-rating" of capacity is used to take technical constraints (such as variable availability) and flexibility issues into account.

Cross-border issues

Cross-border issues were found to be of high significance in the choice of capacity market design in countries with significant integration with neighbours (such as Switzerland). In order to reduce the negative impacts of a national capacity mechanism on cross-border trade, it was found that interconnector capacity should be eligible to participate in the capacity mechanisms. This is fostered by the EU Electricity Directive which states that capacity mechanisms must be non-discriminatory and foreign capacity can only be excluded in situations where a country can demonstrate that there are physical constraints on delivery. Depending on the choice of model, interconnector capacity could be included by being able to create cerfiticates (such as in France) or may be treated in the same manner as demand side resources.

Conclusions

Many design choices are important in dictating how capacity markets operate. Three design choices (outlined above) have been found to capture the distinguishing features of commonly discussed models (Centralised Capacity Markets, Decentralised Capacity Markets, Capacity Obligation models, Capacity Subscription models, and Reliability Options models), and are therefore identified as first tier design choices.

A large number of European countries have implemented or are discussing the introduction of capacity mechanisms. Designs of these mechanisms varies and issues such as the participation of capacity situated outside of a country's borders are still being resolved in a number of instances. The fact that any such mechanism set up within an EU country has to conform to EU regulations, such as the rules on state aid, may lead to another set of impacts, such as designs being copied from successful applications. All of this will impact the path the EU takes towards a more integrated electricity market and a potential EU-wide capacity mechanism.

References

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[2] G. L. Doorman, "Capacity subscription: solving the peak demand challenge in electricity markets," *IEEE Transactions on Power Systems*, vol. 20, no. 1, pp. 239-245, 2005.