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A coordinated strategic reserve to safeguard the European energy transition

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ABSTRACT

In Germany and beyond, various capacity mechanisms are currently being discussed with a view to improving the security of electricity supply. One of these mechanisms is a strategic reserve that retains generation capacity for use in times of critical supply shortage. We argue that strategic reserves have specific advantages compared to other capacity mechanisms in the context of the European energy transition. To date, however, the debate on capacity mechanisms has largely been restricted to national contexts. Against this background, we discuss the feasibility and potential benefits of coordinated cross-border strategic reserves to safeguard electricity supply and aid the energy transition in Germany and neighboring countries at large. Setting aside strategic reserve capacity which is deployed only in the event of extreme supply shortages could improve the security of electricity supply without distorting the EU's internal electricity market. In addition, overall costs may decrease when reserve procurement and activation are coordinated among countries, particularly if combined with flow-based market coupling.

1. Introduction

The massive expansion of renewable energy sources in the power sector is a cornerstone of the German energy transition (*Energiewende*). Germany aims to increase the share of renewables in gross power consumption to 40–45% in 2025, 55–60% in 2035 and to at least 80% by 2050.[1] In 2014, this share was around 27%, up from only around 3% in the early 1990s (Fig. 1). In EU 28, the respective share was 25.4% in 2013 according to Eurostat data.

Due to limited potentials of dispatchable renewable sources like hydro power, biomass, and geothermal energy in the German market area, achieving such renewable targets requires drawing on fluctuating renewable sources such as wind power and photovoltaics (PV) to a large extent. Due to the fluctuating nature of these sources, several issues of market and system integration as well as security of supply arise. In particular, additional wind turbines and PV modules cause residual load to decrease substantially in many hours of the year, but hardly contribute to firm capacity (Schill, 2014). Accordingly, other dispatchable capacities, storage, and demand response are required to ensure security of supply. Against this background, the question of how to secure adequate generation capacity—which energy economists have discussed for many years—gains importance.

The transition to a low-carbon power market is a European rather than a German policy ambition only, and the European power market integration is advancing. Likewise, the question on how to guarantee secure supply is discussed among academics and policymakers not only in Germany, but in most if not all European countries today. The regulatory toolkit to ensure power supply entails several means, among them capacity mechanisms that pay for the continuous availability of power generating capacity. An overview of capacity mechanisms is provided by FERC (2013) and CREG (2012).

Capacity mechanisms come in different forms, one of which is a strategic reserve. Conceptually, a strategic reserve aims to set aside sufficient reserve capacity—a given amount of firm generation

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[1] These targets are explicitly stated in the German Renewable Energy Sources Act of 2014, §1.

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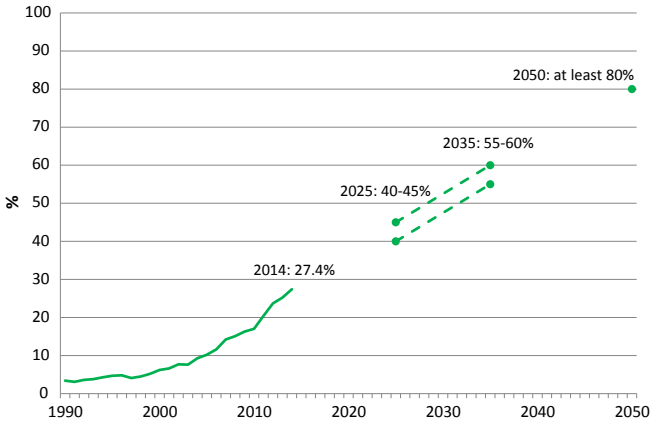

Fig. 1. Share of renewables in gross power consumption since 1990 and government targets in Germany. Data sources: BMWi/AGEE-Stat, Renewable Energy Sources Act 2014.

capacity—for exceptional situations when existing commercial capacity cannot cover demand.[2] An alternative to this are capacity markets which create a separate market segment, where capacity payments ensure that the specified firm power generation capacity is available for a defined period of time. Currently, the UK and most U.S. power markets have some form of a capacity market in place, whereas many countries in continental Europe have not.

This article gives an introduction to the debate around capacity mechanisms in the context of the German energy transition and discusses the specifics of a strategic reserve. We discuss, for instance, the definition of the capacity to be set aside, the question of how the capacity will be procured, and the trigger mechanism for activating the reserve. We also present concepts for cross-border coordination of strategic reserves. To this end, we illustrate the implications of a coordinated cross-border strategic reserve both in a two country case and multiple country setting.

We argue that installing a strategic reserve is a superior option in the context of the German energy transition compared to the introduction of capacity markets. We further propose that cross-border coordination of strategic reserves is not only feasible, but has the potential to reduce costs for guaranteeing a given level of security of supply. Amongst others, costs decrease as less reserves are needed due to balancing of supply and demand fluctuations across large areas and due to a larger sample of plants to choose from. Further, the benefits of coordination improve for flow-based market coupling.[3]

In the following, we first briefly review the academic debate on capacity mechanisms. In section three, we introduce the concepts that are discussed in Germany and argue that strategic reserves are a reasonable concept to be applied in the current situation. Section four presents a brief presentation of selected international experiences with strategic reserves. In sections five and six, we discuss important design elements of strategic reserves and how these could be coordinated and managed jointly across country borders. Section seven includes a stylized numerical model illustration on the implications of coordinated strategic reserves in a two-country and a multi-country setting. The final section concludes.

2. The debate on capacity mechanisms

The academic debate on the requirement for and the design of capacity mechanisms did not start with the German energy transition, but originated in the context of power market restructuring, which took place since the early 1990s in many countries around the world (Sioshansi and Pfaffenberger, 2006). In electricity spot markets, the price is usually determined by the marginal costs of the most expensive operating plant. Yet such prices generally only cover the marginal costs, but not the capacity costs of generators. According to peak load pricing theory, all generators cover their capacity costs at least partly not only by inframarginal rents, but also by scarcity rents in a long-run equilibrium (Stoft, 2002). Scarcity rents occur in peak hours when generation capacity is exhausted[4] and prices rise above marginal costs, only limited by price-elastic demand. A power market that draws on scarcity prices for financing generation capacities is referred to as an “energy only” market.

Yet the feasibility of energy only markets is put into question for a number of reasons (Cramton et al., 2013). Most importantly, it has been argued that the demand-side in power markets is far from robust. Most consumers cannot respond to short-term fluctuations of wholesale prices, and consumers typically cannot be curtailed selectively. Accordingly, electricity demand may not be sufficiently price-elastic in order to ensure market clearing during scarcity events (Joskow and Tirole, 2007). In addition, power markets are generally vulnerable to the exertion of market power, particularly during peak demand, and the social acceptability of scarcity prices may be low. Implicit or explicit price caps are therefore present in many electricity markets. This gives rise to a *missing money* problem, according to which the scarcity rents necessary to sustain the power plant portfolio cannot be earned by investors.[5] Accordingly, adequate capacity may have to be ensured by additional measures.

Yet in reality, the missing money problem may be mitigated by an increasingly flexible demand-side, which could be enabled, for example, by smart grid innovations and advances in information and communication technologies. What is more, spot prices may in fact be higher than short-run marginal costs in real-world power markets, for example because of market power exertion, or because actual market participants do not behave as under textbook assumptions. In addition, it may be possible for generators to cover some part of the fixed costs by additional revenues from the co-generation of heat, or from the provision of balancing reserves as well as other ancillary services. Finally, long-term contracts can mitigate spot price risks in bilateral markets. If most of the power demand is hedged for one year or even longer, as is currently the case in Germany, the practical relevance of scarcity prices in the spot market may be small, and regulatory interventions are less likely.

Germany has experienced an ongoing debate on the requirement and potential design of capacity mechanisms (compare UBA, 2012; Winkler et al., 2013; Neuhoff et al., 2013b; BMWi, 2013b; Lehmann et al., 2015). In 2015, the German government has decided to introduce a capacity mechanism in the form of a strategic reserve, officially referred to as “capacity reserve” (BMWi, 2015a).[6]

[2] Setting an optimal reserve volume would require the respective regulator to have complete information and not to be influenced by other considerations than ensuring an optimal level of security of supply (cp. Lehmann et al., 2015). Yet this kind of institutional friction applies to all capacity mechanisms.

[3] Our underlying assumption is that the large-scale integration of fluctuating renewables is best achieved by balancing renewable feed-in and electric load over a large geographic area. This point of view is in accordance with the European target model of a completed internal energy market. We do not relate to alternative perspectives that envisage decentralized balancing or local energy autonomy.

[4] In practice, scarcity rents may already occur before capacity is exhausted, e.g., in case of a contingency, or if some predetermined reserve margin is enforced by the system operator.

[5] In fact, the missing money problem may already realize without the existence of price caps, if investors only *expect* that future scarcity prices will be suppressed by regulatory interventions or technical measures by system operators.

[6] The German government also decided on a respective piece of legislation on 4 November 2015 (*Strommarktgesetz*). A parliamentary decision was pending at the time of writing.

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