SPLITTING PRICE ZONES:

THE IMPACT OF THE GERMAN-AUSTRIAN BREAKUP ON EUROPEAN ENERGY OBJECTIVES

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1 Abstract

Since 2002, Germany and Austria have a common power price zone which is commonly referred to as the German-Austrian bidding zone, or price zone[1]. Today, this bidding zone and its potential breakup is subject to a debate of some controversy. Independent of the interests of different participants, this paper investigates the market effects a breakup would entail.

The paper analyses the market outcomes with respect to the energy policy objective triangle of (i) affordability, (ii) security of supply, and (iii) sustainability[2]. It aims to answer key questions regarding the price development one can expect in the affected countries (affordability), if there will be supply shortages (security of supply), and which power plants will be deployed (sustainability). A fundamental model is used for the computations, from which different scenarios of a breakup and a continuation of the common price zone are modelled. The analysis shows that the German energy policy objectives of affordability and sustainability are influenced positively by a breakup of the common bidding zone, whilst the same objectives are impacted negatively for Austria. Some of the neighbouring countries could expect slightly positive effects on affordability and others slightly negative effects. However,

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1 Occasionally, also referred to as bidding zone Germany/Austria/Luxembourg (DE/AT/LU).

2 The Energy Triangle, which is sometimes also referred to as Energy Trilemma illustrates the three competing energy policy objectives (i) affordability, (ii) security of supply, (iii) sustainability. These objectives appear to be in competition with each other as a government can usually only promote one or two of the three objectives at the expense of the other objective(s) (Keppler, 2009, pp. 194–195; World Energy Council, 2013, p. 5). These objectives are an integral part of the EU energy policy and have just been reaffirmed in the most recent EU energy package for 2030 (European Commission, 2016a, p. 7).

BACK TO INDEX

the largest neighbouring markets stay virtually unaffected by a breakup of the German-Austrian bidding zone. Altogether, the results indicate that a price zone split would result in overall cost savings and lower CO_2 emissions.

2 Background

Whilst the deployment of renewables in Germany is progressing rapidly, grid expansion is behind schedule. Northern Germany offers worthy conditions for onshore and offshore wind. However, on windy days it is increasingly difficult to transport generated electricity to southern demand centres. The existing German transmission network capacities are often insufficient to handle these flows, which is why cross border flows into neighbouring countries (called loop-flows) and congestions are becoming more frequent. These congestions are not supposed to exist within bidding zones and it is a subsequent matter of dispute whether the congestions amount to what is perceived as structural (rather than intermittent) congestions.

A result of these insufficient network capacities is that significant electricity flows through the networks of some neighbouring countries are being registered (ČEPS et al., 2013). The Transmission System Operators (TSOs) of the Czech Republic, Hungary, Poland and Slovakia publicly express their discontent with these flows. They argue that these endanger the network security of their systems, limit their cross-border trade capacity and cause their systems to be excessively loaded by large scale unplanned flows, which are not controlled by any market mechanism (ČEPS et al., 2012, pp. 2–3).

Following a request by the Polish regulator Urząd Regulacji Energetyki (URE), the Agency for the Cooperation of Energy Regulators (ACER) published a recommendation in September 2015, which concluded that the mentioned congestions were indeed structural and recommended a splitting of the price zone (ACER, 2015). This (legally non-binding) statement fuelled the debate and resulted *inter alia* in E-Control taking legal action against ACER at the European General Court (EGC)[3] (E-Control, 2015).

In October 2016, the German regulator Bundesnetzagentur asked the TSOs in Germany to prepare the introduction of congestion management on the German-Austrian border, targeting 3 July 2018 as the implementation date (Bundesnetzagentur, 2016a). Even though this has not been officially described as a split-up of the price zone, it effectively lays the groundwork for an end to the common zone in 2018 and has been described by analysts as such (Falker, 2016).

> The Agency for the Cooperation of Energy Regulators (ACER) concluded that the congestions were structural and recommended a f zone

According to those in favour of a continuation of the common bidding zone such as E-Control, congestions within Germany are the core problem and an inner German price zone split, rather than a split at the German-Austrian border, ought to be discussed (Graf and Irschik, 2016, p. 6). However, dividing Germany into two or more price zones has been described as "political dynamite" and appears barely feasible in political terms (Schlandt, 2015). It has been argued that this constitutes an acknowledgement of a failed energy policy and threaten the public acceptance of the energy transition (Graf and Irschik, 2016, p. 6). In contrast, a split along the German-Austrian

3 The European General Court eventually rejected the legal action by E-Control to annul the ACER statement as inadmissible given the legally non-binding nature of opinion statements (EGC, 2015, 2016; European Energy Journal, 2016, p.13)

border should be feasible and communicable (Wetzel, 2015).

To be published in the fourth quarter of 2017, the bidding zone review by the European Network of Transmission System Operators for Electricity (ENTSO-E) may give the debate a new direction, as could potential legal action by E-Control or the Austrian TSO APG. Legally, the Bundesnetzagentur sees itself in line with the requirements of the European law and the intended measures as necessary since the excessive trade between Germany and Austria threatens system security and stability in other countries (Bundesnetzagentur, 2016, p. 2). Nonetheless, if current European processes on the bidding zones such as the ENTSO-E bidding zone review come to the conclusion that the planned measures will have no positive effect in this respect, then the transmission system operators will cease the preparatory work on congestion management (Bundesnetzagentur, 2016, p.2).

Altogether, a likely outcome remains a splitting of the bidding zone along the German-Austrian border in 2018 and it is therefore relevant to analyse the expected market outcome of this transformation.

3 Methodology

The Bundesnetzagentur is yet to officially quantify the net transfer capacity (NTC) it would set for the German-Austrian border following the breakup of the common bidding zone. However, in a recently published study it determined the threshold underneath which the trade can be safely managed without the need to perform countermeasures such as redispatching. This can therefore be seen as a first indication, the (n-1) secure value set for the transfer capacity in the study is 2500MW for 2019/2020 and 5500MW for 2024[4] (Adamek and Ahlhaus, 2016, p. 19).

Consequently, these values and the years 2020 and 2024 are used as the basis for the calculations in this paper. In order to assess the outcomes of a price zone split along the German-Austrian border, the split is simulated in the fundamental model Green-X[5], using the NTC values in the respective years provided by Adamek and Ahlhaus. The calculations of the fundamental model for the years 2020 and 2024 provide (i) yearly average wholesale power prices, (ii) hourly prices, and (iii) hourly expected power plant dispatch.

> While the focus is set on Germany and Austria, the research includes the markets of all fourteen neighbouring countries

These results enable an in-depth examination of the compatibility of a price zone split with the energy policy objective triangle: the average yearly power prices indicate the (i) affordability of a system, the hourly prices reveal price

4 Following the discussions and call of the Bundesnetzagentur on the TSOs to prepare the introduction of congestion management on the German-Austrian border, there have been several studies researching the expected developments with different methodologies and a range of distinct NTC values. The NTC value chosen for this paper rests upon the work of Adamek and Ahlhaus from the Bundesnetzagentur. The last indicative NTC value set by ENTSO-E for the border in 2011 was 2200MW and thus close the value of 2500MW chosen here for 2020 (ENTSO-E, 2011, p. 1). In comparison with other studies, the NTC values used here are rather on the conservative, i.e. lower, end (see Energy Brainpool, 2016; Bloomberg New Energy Finance, 2016; Aurora Energy Research, 2016, p. 9)

5 Green-X is a fundamental power model covering the EU-28 and selected EU neighbouring countries. It allows for investigation of future deployments in the power and renewable sector including accompanying costs and benefits. It enables the derivation of a detailed quantitative assessment of the renewable electricity sources deployment in a real-world policy context on a national and European level for the power, heat and transport sector. It has been successfully applied for the European Commission within several tenders and research projects to assess the feasibility of '20% renewable electricity sources by 2020' and for assessments of its developments beyond that time horizon. In addition, Green-X can be used for a detailed quantitative assessment of the hourly market prices of the European power markets (Huber et al, 2004; Everts et al., 2016).

spikes which represent a degree of (ii) security of supply, and the expected power plant dispatch shows the utilisation of the different generation technologies and consequently sets the (iii) sustainability of the system.

Aside from Germany and Austria, the subject of research includes all neighbouring countries, i.e. Belgium, the Czech Republic, Denmark, France, Hungary, Italy, Luxembourg, the Netherlands, Poland, Slovakia, Slovenia and Switzerland as well as Sweden and Norway which are directly connected to the German grid. Given the significant size of the German-Austrian bidding zone and the interconnectivity of the networks in central Europe, all of these markets are potentially affected by a breakup. The focus of the analysis is, however, set on Germany and Austria and the calculations also show the most significant effects there.

In the Czech Republic, Hungary, Slovakia, Slovenia and Switzerland yearly average wholesale prices rise as a result of a split of the German-Austrian bidding zone

4 Results and analysis

The fundamental model Green-X was used to calculate (i) yearly average wholesale power prices, (iii) hourly prices, and (iii) expected power plant dispatch. In order to obtain comparable results, the calculations were taken once with the NTC values set as proposed by Adamek and Ahlhaus from the Bundesnetzagentur (2500MW for 2020; 5500MW for 2024) and once without a NTC limitation (Adamek and Ahlhaus, 2016, p.19).

4.1 Affordability

Within the context of the energy policy objective triangle, the objective of affordability is also referred to as competitiveness or, simply, costs. Generally speaking, the objective relates to the expenses consumers and the industry have to cover for their energy consumption. An ideal energy policy delivers energy to consumers and businesses at affordable or reasonable costs.

From a policy perspective, affordability is key for multiple reasons. First of all, businesses and especially energy intensive industries need affordable electricity in order to be competitive in a globalised world. In terms of private consumers, it is important to underline that electricity is a vital good and needs to be affordable for everyone within society. For policy makers, it is therefore also relevant in regards to voting behaviour and party support among the electorate. This was illustrated with the proposed price freeze by the British Labour party during the last United Kingdom general election campaign (Wintour, 2013).

It has to be noted at this point that the results from the model presented above portray wholesale power prices, whereas the policy objective of affordability refers to prices for consumers and businesses.

The retail prices or tariffs consumers and business pay for their electricity differ substantially from the prices on the wholesale markets. Wholesale power prices are very volatile and fluctuate every hour depending on supply and demand. In contrast, the electricity tariffs that consumers pay are independent from daily market developments. Consumers usually pay a fixed and somewhat regulated rate per consumed unit of electricity, independent of the current wholesale market price. These tariffs or retail prices for consumers vary depending on country, region, consumption volume and electricity supplier. Next to the actual electricity procurement costs, it contains different taxes and fees as well as grid costs and, nowadays, also often includes a charge to finance the deployment of renewables.

In Germany for example, energy procurement and supply costs account for the largest share that amounts to 26 per cent. The EEG surcharge used to finance feed-in and feed-in premium tariffs for renewables takes the second largest share with 21 per cent, closely followed by network charges with another 20 per cent. Different forms of taxes as well as charges for metering and other surcharges complete the picture (Bundesnetzagentur, 2016b, p. 200).

In Austria, energy procurement costs take the largest share with 31.5 per cent, followed by a composition of different taxes and fees (27.5 per cent). Grid costs make up 27.3 per cent and the surcharge for renewables accounts for 13.6 per cent – according to E-Control (E-Control, 2016).

The energy policy objective of affordability is clearly affected negatively in Austria

Altogether, one has to note that retail prices or tariffs for electricity and their composition are very diverse even within countries, which makes them an ill-fitted parameter for comparing the effects of a price zone split. However, the generation of procurement costs and consequently the wholesale power prices are always a crucial part. Therefore, they are used here as an indicator for affordability.

Generally speaking, retail prices for electricity tend to be relatively stable, whereas wholesale power prices are volatile. If there is a sustained rise or fall of average wholesale power prices, the additional costs or savings arising are not necessarily directly passed on to the consumers and so, certain market participants along the value chain either benefit or lose out. Within the energy industry, generators profit from higher prices whereas suppliers might suffer if the additional costs cannot be passed on to consumers. Altogether, high electricity prices tend to have negative effects on the overall economic growth of a country (Wiegert et al., 2013; NRECA, 2015). The subsequent conclusions are that higher electricity prices in a country resulting from the price zone split affect the policy objective of affordability negatively. Vice versa, lower prices have a positive effect on affordability.

Austria

The most substantial effects are observed In Austria as the computations show that wholesale power prices rise significantly as a result of the new situation. The NTC restriction enables less electricity from sources with low marginal costs (such as renewables or coal- and lignite-fired power plants) in Germany to flow to Austria, leading to rising prices in the new Austrian zone. In the breakup scenario, the yearly average power prices are higher by 1.00€/MWh in 2020 and 0.85€/MWh in 2024 compared with those same years without a NTC limitation which equals a change of roughly 3 per cent.

Consequently, the energy policy objective of affordability is clearly affected negatively in Austria. It becomes obvious why the Austrian regulator E-control and Austrian industry associations such as Wirtschaftskammer Österreich and Industriellenvereinigung are opposing the price zone split and contesting it on multiple levels. Aside from the aforementioned legal actions there are also academic studies and position papers arguing in favour of a continuation of the common price zone or addressing problems arising from a price zone split (see E-Control, 2015; Graf and Irschik, 2016; Klotz and Hofman, 2015).

Germany

The opposite effect would take place in Germany. Indeed, calculations indicate lower power prices in Germany in the case of a price zone split. The drop in Austrian demand reduces the overall load, while the low marginal cost generation units in Germany remain in place. The yearly average power prices drop by almost

0.50€/MWh in 2020 and by 0.25€/MWh in 2024 in relation to a scenario without a bidding zone split. This represents a change of around 1.5 and 0.75 per cent respectively.

The decrease of wholesale power prices in Germany following a price zone split along the German-Austrian border should in theory have a positive effect on the policy objective of affordability in the two countries. However, given the high penetration of renewables along with the support scheme mechanism funded by a surcharge on the electricity prices for final consumers, the situation is in fact more complex than one might initially assume. Renewable plant owners commonly receive a somewhat fixed remuneration per injected unit of electricity in the grid through a feed-in or feed-in premium tariff.

To incentivise investments in renewable plants and reduce risks for investors, these tariffs are set well above current price levels. The surcharge electricity consumers pay for the deployment of renewables is largely used to finance the gap between the price at which electricity is sold on the wholesale market and fixed renewable remuneration levels. Lower wholesale prices consequently increase the overall sum required to finance renewable deployment and might therefore trigger a higher renewable surcharge for electricity consumers, potentially mitigating the price-decreasing effect of lower wholesale prices but not fully offsetting it. However, the precise effects of this phenomenon are yet to be researched.

Matters are complicated further by the fact that the energy intensive industry and large industrial electricity consumers in Germany are largely exempted from the renewably levy and other surcharges[6]. Since the policy objective of affordability encompasses by definition the costs for both businesses and households, one cannot make a valid general statement on the effects of lower average wholesale prices on the policy objective of affordability. Large industrial consumers exempted from the renewable levy and other surcharges are likely to profit whilst non-privileged consumers might have to face some additional costs.

All other countries

In Belgium, Denmark, Luxembourg, Norway and Sweden, the calculations show a slight decrease in yearly average wholesale power prices (see Figure 1). The policy objective of affordability is thus positively affected by a split of the German-Austrian price zone. Luxembourg is split into three price zones of which the largest by far is the portion of the German-Austrian price zone, and it is assumed that it would remain part of the German zone in the event of a breakup. The phenomenon observed in Germany, where the positive effects of the price decrease may be partially offset by potential rise of the renewable levy, could in part also apply to Belgium, Denmark, Luxembourg, Norway and Sweden.

In the Czech Republic, Hungary, Slovakia, Slovenia and Switzerland yearly average wholesale prices rise as a result of a split of the German-Austrian bidding zone (see Figure 1). The increase is less significant than in Austria but still notable and causes the policy objective of affordability to be negatively affected by the price zone split.

> In Germany industrial consumers exempted from the renewable levy are likely to profit whilst non-privileged consumers might face additional costs

It should be noted at this point that the TSOs of the Czech Republic, Hungary, Poland and Slovakia pushed for the price zone split (ČEPS et al., 2013, p. 5). Interestingly enough, the regulators of the four countries also support

6 For a closer discussion on the exemptions and the subsequent redistribution effects see (Cludius et al., 2014).

this position (ERO et al., 2015). This means that unlike in Austria where the regulator E-Control strongly opposes the price zone split, the regulators in the Czech Republic, Hungary, Poland and Slovakia lobby in favour of the German-Austrian price zone split. This may seem odd, given that in the Czech Republic, Hungary and Slovakia the policy objective of affordability is affected negatively as a result of the price zone breakup. However, they place greater value on other factors:

"The splitting of the German-Austrian bidding zone will significantly mitigate the blackout risk, enhance business opportunities for energy companies in the V4 countries, and make German and Austrian partners begin participating in the payment of the costs caused by the loop flows" (ERO et al., 2015, p. 1).

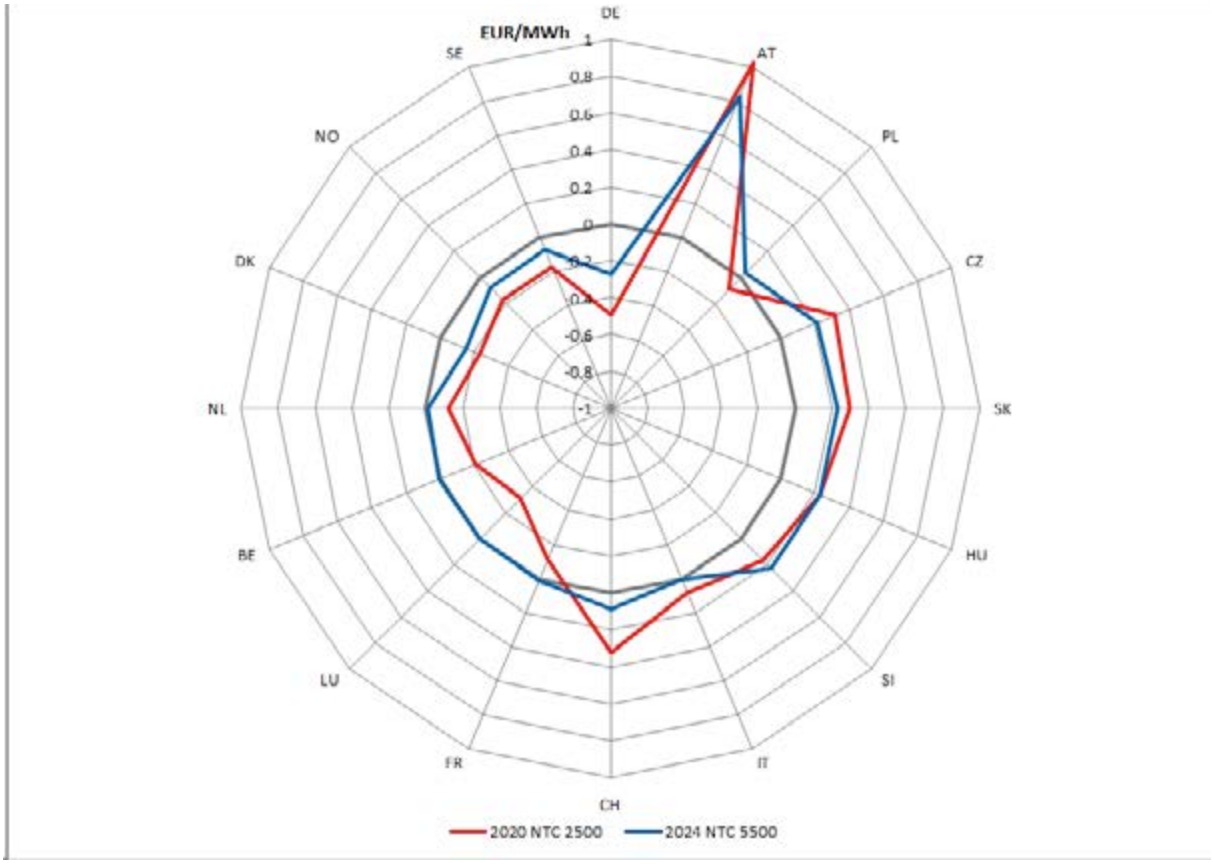
Interestingly enough, the statement explicitly mentions the objective of supporting local energy companies. Energy producers do in fact profit from higher wholesale power prices yet the overall economic effects of higher power prices are seen as negative.

According to the model calculations, the yearly average wholesale prices in France, Italy, the Netherlands and Poland would be virtually unaffected by a split of the German-Austrian bidding zone. Changes of less than 0.5 per cent between the breakup scenario and continuation of the common zone are hereby seen as insignificant, and France, Italy, the Netherlands and Poland fall into this category. The energy policy objective of affordability therefore remains neither positively nor negatively affected by a breakup of the German-Austrian price zone.

Overview

Figure 1 illustrates the yearly average wholesale price changes as a result of the German-Austrian price zone split in a radar chart. The red line shows the price changes in €/MWh for the year 2020 and the blue line the changes for 2024. It can be observed from the radar chart that the changes in 2020 with the smaller NTC value are more significant than in 2024 with the larger NTC value.

Figure 1: Yearly average wholesale power price changes



One can use the changes in the yearly average prices to measure additional costs or savings arising from the price changes. In a simplified calculation, the expected consumption was multiplied by the modelled price change for every country. This gives an approximate estimation of the expected yearly costs or savings as result of a price zone split. Austria is expected to face additional yearly costs of around €80 million (2020) and €65 million (2024) through the price increase. In Germany, the yearly savings due to the price zone split are roughly €265 million in 2020 and €150 in 2024. Considering all the countries that were researched, the yearly overall cost savings would be around €250 million in 2020 and €60 million in 2024.

4.2 Security of Supply

In addition to yearly average prices, the fundamental model also calculates hourly prices from which one can derive a level of security of supply. It is the objective of every energy policy to guarantee a high degree of security of supply and minimise the risk and duration of power cuts. Blackouts do not only cause substantial economic harm and hinder everyday human activities, but they also represent a serious catastrophe scenario if they are not fixed in a timely fashion. The European Commission also underlines the importance of the security of supply in its latest energy package (the Winter Package) (European Commission, 2016a, p. 5). In this discussion, the role of security of supply in the national security policy of a state should not be underestimated. In political realism, a low level of security of supply represents a threat to national security and within this context, states strive to strengthen security of supply and minimise risks and dependencies (Baumann, 2008).

The level of security of supply can be measured in a number of ways. For the purpose of this paper and the analysis within the energy policy objective triangle, a price signal is used to measure a degree of security of supply. Once prices reach a high level that can be classified as clear price spike level, they serve as an indication of scarcity and peak power plants, often existing only to serve demand in times of scarcity, ramp up production. In Europe, there are power plants with very high marginal costs that are only used in times of highest demand and corresponding price peaks. During high price spikes, even inefficient, polluting and often ageing oil-fired generation plants or gas turbines are included on the market.

This methodology of a high price signal to measure security of supply relates to the other policy objectives of affordability and sustainability, since the deployed peak power plants are polluting and commonly characterised by the highest marginal costs.

> A splitting of the price zone would not affect the security of supply, if one takes price signals (not grid stability) as a meaningful indicator

It must be noted that this methodology has its down sides. It neither provides a realistic assessment of how close a system is to a blackout nor addresses the questions of autarky and self-sufficiency, i.e. how much of the generation takes place in the observed country. Furthermore, congestions within countries, such as certain congestions within Austria and the described congestions between northern and southern Germany, are not portrayed. Nevertheless, in the scope of this paper and in the context of an interconnected Europe, the price signal can act as a meaningful indicator of the security of supply and how this is affected by a breakup of the common German-Austrian price zone.

To this end, the hours that can be classified as clear price spikes are calculated once without and once with a price zone split along the Ger-

man-Austrian border. They are then compared and analysed for all countries that are subject to this research. An increase in the number of hours indicates a lower level of security of supply, affecting the policy objective negatively. Vice versa, a lower number of these price spikes shows an increased security of supply.

All Countries

The fundamental model calculations do not predict any clear price spikes in the researched countries for the years 2020 and 2024. Any hours that could be classified as high price spikes are neither recorded in the breakup scenario nor in the scenario with a continuation of the common zone. In fact, the highest priced hours that the model finds are virtually the same in the different scenarios and far from what could be seen as clear price spikes. These comparable low prices indicate that there are no scarcities in the researched countries for the given years.

Consequently, a splitting of the German-Austrian price zone would not affect the security of supply as defined above. In terms of the policy objective one can note that the states can see their security of supply neither enhanced nor diminished as a result of the price zone split.

It should be clarified at this point that a different definition of security of supply may deliver other results. The Czech, Hungarian, Polish and Slovakian TSOs call for splitting the German-Austrian bidding zone in order to tackle the issue of unplanned flows that affects the ability to manage the security of supply of their networks (ČEPS et al., 2013, p. 5).

Thus, they expect a price zone split to result in an enhanced security of supply. However, this aspect of security of supply (referring to grid stability) is not included in the price spike methodology used for this paper.

For a closer examination, it is worth looking at the price duration curves of Austria and Germany which are shown in Figure 2 and Figure 3. The figures show the price duration curves of Germany and Austria for the years 2020 (Figure 2) and 2024 (Figure 3) with the corresponding NTC limitations of 2500MW and 5500MW as well as the price duration curve without a breakup of the zone. The prices are shown in relation to the yearly average price in case of a continuation of the common zone. It can be observed from Figure 2 that the most expensive 1,000 hours are priced lower in Austria, following the price zone split. The lowest priced 5,000 hours are then, however, significantly higher priced than in Germany or in the event of a continuation of the common price zone. This causes the discussed increase of the yearly average wholesale price and altogether, the gap between the highest and the lowest priced hours decreases, which may undermine the economic viability of some pumped hydro power plants. The decrease of yearly average prices in Germany is caused by the slightly lower prices of the lowest priced 4,000 hours.

Figure 3 shows that the price changes in 2024 are generally of a smaller magnitude than those in 2020, predominately due to the higher NTC value. The highest priced 1,000 hours are now virtually the same in Austria and Germany – the lowest priced 4,000 hours are however still more expensive in Austria than in Germany or in the event of a continuation of the common zone.

The price duration curves in both figures show that even the highest priced hours are not in the range of what could be considered as high price spikes or critical from a security of supply perspective.

Figure 2: price duration curve 2020

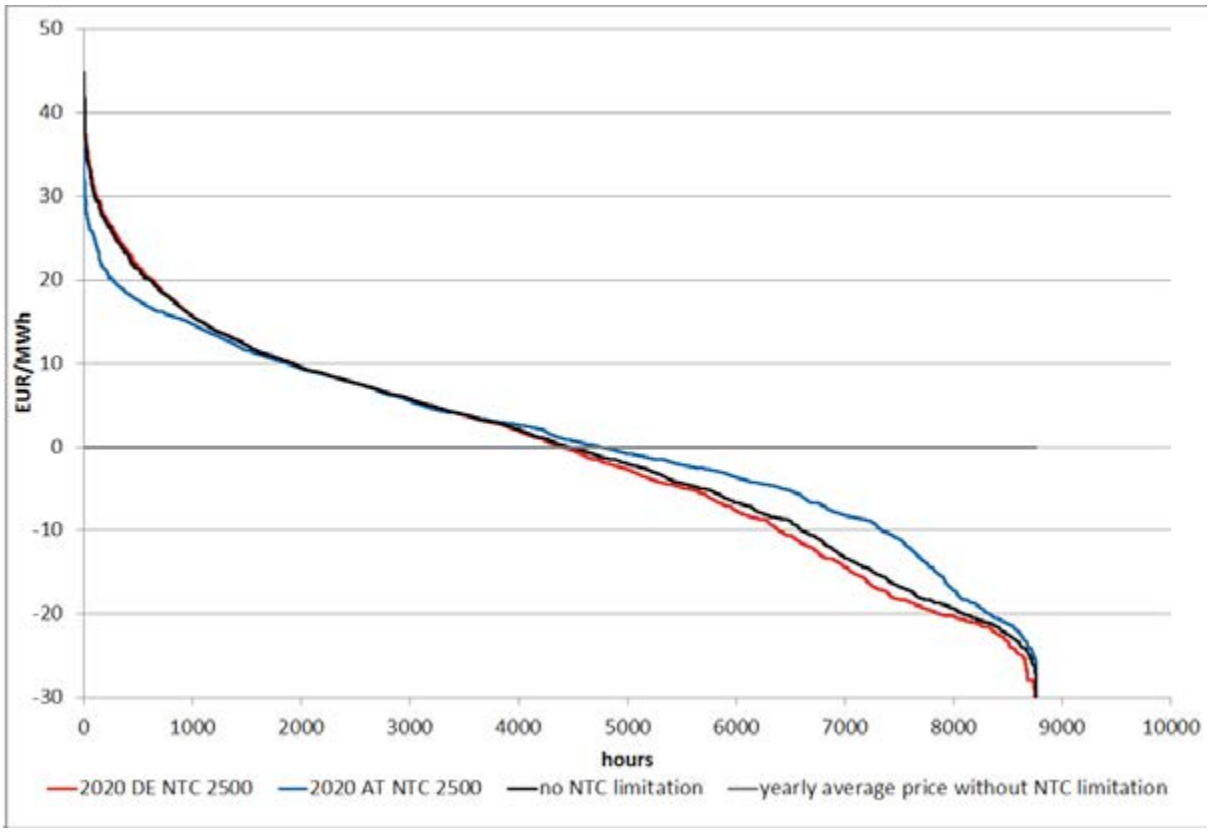
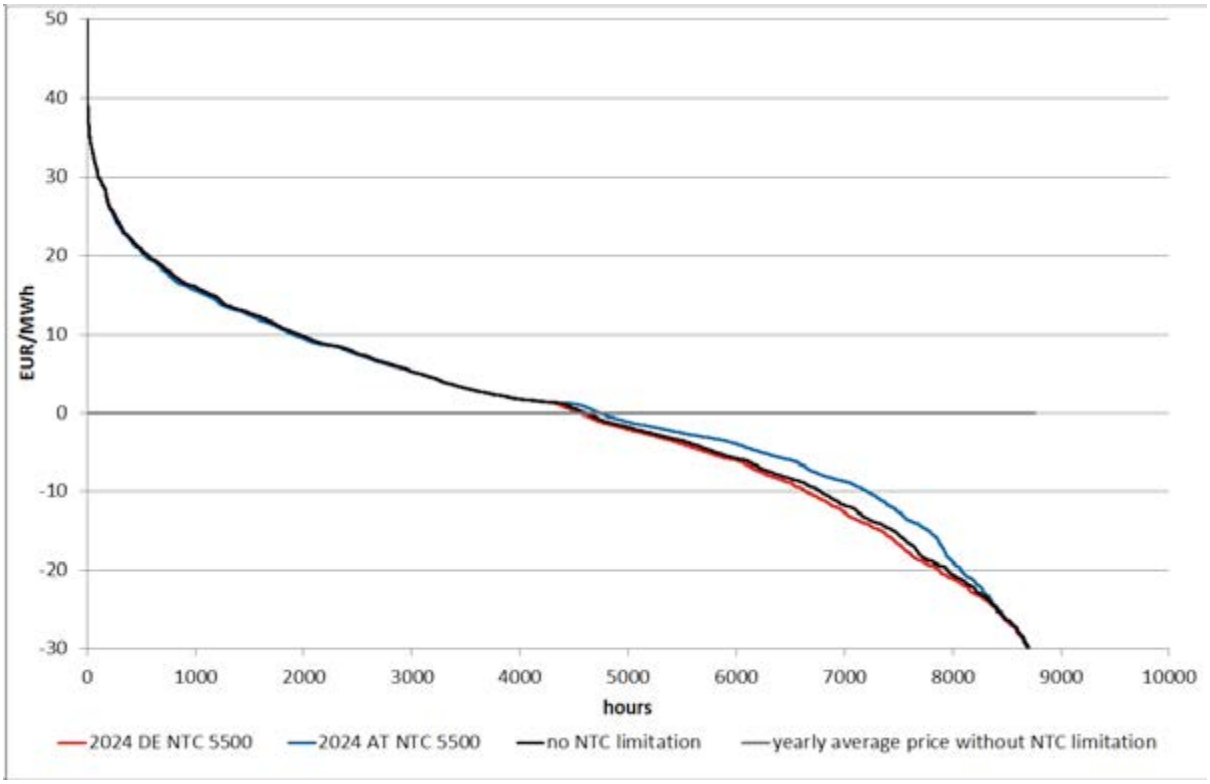


Figure 3: price duration curve 2024



Last but not least, one should note that the model does not speculate or incorporate any events that may cause large shares of the generation capacities to be unexpectedly unavailable (which in turn would result in higher prices and scarcity price spikes). However, such events can occasionally occur as exemplified by the recent French nuclear power crisis during which up to 19 of the 58 French reactors were offline in late October 2016[7], or by the German 'Atom-Moratorium' in March 2011 following the Fukushima nuclear disaster.

4.3 Sustainability

In addition to the average yearly prices and hourly prices, the fundamental model also computes the expected power plant dispatch for every hour of the years 2020 and 2024, once with the price zone split and corresponding NTC values and once without. From this expected power plant dispatch, the subsequent CO_2 emissions can be calculated and the resulting level of sustainability. To this end, the model Green-X utilises an up-to-date power plant list to determine exactly which power plants will be generating electricity at any given hour by providing power plant-specific emission data.

The sustainability of the power sector has become an ever more important factor in recent decades. The Paris agreement illustrates the global efforts to fight climate change and reduce emissions. It is the objective of any energy policy to minimise negative externalities such as particulate matter pollution and NOx as well as CO_2 emissions. Indeed, CO_2 emissions have become a common standard to measure levels of sustainability and are hence used as the benchmark here.

The decarbonisation of the electricity sector takes a central role in the global fight against climate change. There are two main reasons for this: firstly, there is the significant contribution of the sector to overall emissions and secondly, it is a sector where there are already mature low-emission or emission-free technologies on the market. The EU and European states see themselves holding a leading role in the clean energy transition and seek to achieve global leadership in renewable energies (European Commission, 2016a). Drastic steps are necessary in order to achieve the ambitious targets of the Paris agreement, which is why Miguel Arias Cañete, Commissioner for Climate Action and Energy, sees Europe on a brink of a clean energy revolution (Arias Cañete in European Commission, 2016c, p. 1).

The calculations of the yearly average prices and hourly prices have shown that by far the most significant changes resulting from a breakup of the common German-Austrian bidding zone are set to take place in Germany and Austria. Given this finding and the complexity of calculating power-plant specific CO_2 emissions, the policy objective of sustainability is only analysed for Germany and Austria.

As a final aspect, and in relation with the first policy objective of affordability, it is important to mention the concept of carbon leakage[8]. Higher wholesale prices for business do not only correspond with a loss of competitiveness but might even persuade some to move production abroad due to the additional risk of carbon leakage. Even though the term carbon leakage is predominately used with reference to the emission pricing systems such as the EU Emissions Trading System, the principle also applies to electricity prices for electricity intensive industries.

Austria

The CO_2 emissions in Austria would rise as a result of the breakup of the German-Austrian bidding zone. Following the breakup, there is less electricity flowing from Germany to Austria and consequently, the Austrian generation rises. Indeed, the use of gas-fired power plants

7 See Eckert and Vukmanovic, 2016

8 The European Commission defines carbon leakage as "the situation that may occur if, for reasons of costs related to climate policies, businesses were to transfer production to other countries…This could lead to an increase in their total emissions. The risk of carbon leakage may be higher in certain energy-intensive industries" (European Commission, 2016b).

would increase, which in turn leads to rising CO_2 emissions. The calculations show that the CO_2 emissions of the power generation sector would be a remarkable 5 per cent higher (for 2020; and 3 per cent for 2024) in a breakup scenario, compared with a continuation of the common price zone. The policy objective of sustainability would thus clearly be negatively affected in Austria.

Germany

In Germany, CO_2 emissions would drop in the event of a breakup of the common bidding zone. Due to the reduced load from Austria, less generation is necessary and the generation from CO_2-intensive lignite and coal-fired power plants decreases slightly.

The model computations show that the CO_2 emissions in Germany would be around 0.4 per cent (2020) and 0.3 per cent (2024) lower, compared with the scenario of a continuation of the common price zone. Hence, a breakup of the zone would have positive effects on the policy objective of sustainability in Germany.

Considering CO_2 emissions reductions and increases, in Germany and Austria respectively, it can be shown that the overall CO_2 emissions would decrease by 0.2 per cent. This is due to the relative size of the German market compared with the Austrian market. A breakup of the common zone would thus result in lower total emissions, influencing the policy objective of sustainability positively. Interestingly enough, this finding contradicts statements by the German Chamber of Commerce in Austria (DHK), which supports a continuation of the common zone and lists higher overall CO_2 emissions as an argument against the breakup of the common zone (in Hundt, 2016).

5 Conclusion

One can surmise that a split of the German-Austrian bidding zone would have a wide range of consequences, not only for Germany and Austria but also for a number of neighbouring countries. This paper analysed the market effects of this price zone split with respect to the energy policy objective triangle of (i) affordability, (ii) security of supply and (iii) sustainability. A fundamental model displayed the breakup of the common zone with two set NTC values for the years 2020 and 2024. The subsequent step was to compare these results with a continuation of the common bidding zone scenario.

The yearly average prices were used to analyse the consequences for the policy objective of affordability. The most significant results by far were observed in Germany and Austria. Austrian prices rise significantly with the price zone split, which in turn affects the policy objective of affordability negatively. Germany experiences the reverse effect. Lower yearly average prices have a positive influence on the affordability even though a share of this might be diminished due to the potential rise of the renewably levy. Slight but still notable positive effects on affordability are found for Belgium, Denmark, Luxembourg, Norway and Sweden. In the Czech Republic, Hungary, Slovakia, Slovenia and Switzerland the price zone split is set to affect the policy objective of affordability in a negative way. There are no or only minimal changes for affordability in France, Italy, the Netherlands and Poland.

The hourly prices calculated by the model enabled an analysis of the policy objective of security of supply. High price spikes indicate a scarcity situation which in turn is a threat to security of supply. The results of the computation show that there are no significant changes in high price spikes for the years 2020 or 2024. Consequently, no effects on the policy objective of security of supply are found with the methodology used here. The price duration curves of Germany and Austria (Figure 2 and Figure 3) show that there are fewer high priced hours in Austria in 2020 following a breakup of the common price zone. Moreover, this is not in a price area that could be regarded as critical from a security of supply perspective.

The policy objective of sustainability was ana-

lysed with the expected power plant dispatch and corresponding CO_2 emissions. It is shown that the breakup of the common zone has significant negative effects on the sustainability of Austrian power generation. More gas-fired power plants are used resulting in higher CO_2 emissions. The opposite effect can be observed in Germany where the CO_2 emissions decline slightly. Due to the relative size of the German market compared with the Austrian one, overall emissions drop. The price zone split therefore has, in sum, positive effects on the policy objective of sustainability.

With respect to the energy policy objective triangle, the same weight is usually attributed to the three objectives and they are often considered to be competition with each other. A breakup of the common German-Austrian bidding zone as an energy policy measure appears to be compatible with multiple objectives. Indeed, the breakup would enhance the German energy policy objectives of affordability and sustainability, whilst not affecting security of supply negatively. However, for Austrian energy policy, the splitting of the common bidding zone would bring about negative implications not only for affordability but also for the sustainability of the system.

CO_2 emissions of the Austrian power generation sector would increase by 5%, but decrease by 0,2% in the much larger German market

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