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The Importance of a Sound Bidding-Zone Review for the Efficient Functioning of the Internal Electricity Market

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Highlights[1]

- An inadequate bidding zone configuration for the EU electricity market risks jeopardising the benefits of market integration for energy consumers, by increasing the need for costly remedial actions.
- According to the CACM Regulation, liquidity is one of the criteria for assessing different possible configurations in a bidding-zone review.
- The available evidence from Europe and the US does not seem to support the claim, often made, that larger bidding zones promote liquidity.
- While liquidity is important for the well-functioning of markets, it cannot promote competition if not supported by the capability of the physical network to transport flows within a bidding-zone. Therefore, what seems to be more relevant is the structure (concentration) of the sector with respect to the structure (congestions) of the network.

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Introduction

The integration of the internal electricity market has delivered and is still delivering significant benefits to European electricity consumers, in terms of greater choices and better prices. According to ACER's estimates, the economic welfare benefits of market integration – beyond any improvement in the physical integration of national systems - have exceeded 1 billion euro per year, and there seems to be more to be grabbed[2].

Unfortunately, these benefits risk being overshadowed by the increasing level and costs of remedial actions. These actions are required to maintain system security in the face of flows which, while creating congestion, cannot be adequately controlled – i.e. limited – through congestion management mechanisms, as they are scheduled within the same bidding zone, or across other bidding-zone borders in an uncoordinated way. According again to ACER's estimates, already in 2017 the cost of remedial actions exceeded 2 billion euro across the EU, with Germany accounting for approximately half of the total[3].

It is immediately to be clarified that the two monetary amounts – 1 billion euro of welfare benefits and 2 billion euro of remedial action costs - are not directly comparable, as the latter is not a welfare loss, but rather a transfer towards those providing the resources for remedial actions[4]. However, underlying these remedial action costs, there is clearly an inefficient use of the network[5], or, more precisely, a use of the network that favours intra-zonal trading at the expense of cross-zonal trading, with the distinction between these two types of trading being based on a bidding-zone configuration which reflects more the legacy of electricity systems before liberalisation than any optimality criteria applied to the new reality of energy flows.

At this point two other clarifications are necessary. First of all, while the focus here is on geographical configurations of the market based on bidding zones, one should never forget that higher efficiency and operational security could be achieved by a nodal configuration, which is however currently not envisaged in EU legislation (even though a node can always be considered as a "very small" bidding zone!).

Secondly, the bidding-zone configuration does not affect the physical ability of the network to transmit electricity from generators to loads. However, the configuration of bidding zones determines how the underlying physical limitations of the network can be imposed on market participants trading across large areas or regions, and this affects the efficiency with which the network is used, as well as the behaviour of market participants.

2. ACER/CEER, *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017 - Electricity Wholesale Markets Volume*, October 2018, par. 14. On the additional benefits of completing the deployment of market coupling to the remaining borders in the EU see also (confirming the previous year's estimates): ACER/CEER, *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2018 - Electricity Wholesale Markets Volume*, November 2019, par 156.

3. ACER/CEER, *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017 - Electricity Wholesale Markets Volume*, October 2018, Annex 3.

4. As demand response still plays a minor role in performing remedial actions, the distributional effects are likely to go from consumers, eventually footing the remedial action costs, to generators, possibly including those whose performance does not get them into the merit order.

5. However, inefficiencies might be created more widely, for example in the use of generation and demand response resources if these are activated to perform remedial action in an inefficient way. To the extent that market price signals are distorted by a sub-optimal bidding-zone configuration, investment decisions based on these signals might also be inefficient.

The current bidding zone configuration of the internal electricity market has been inherited from the times when national systems were characterised by a generation mix in which renewables played a minor role and cross-border trading was still limited. With the increase in renewable-based generation mostly located away from load centres and the growth of cross-border exchanges following liberalisation of the energy sector, this bidding zone configuration has rapidly become obsolete. Beyond the rising costs of remedial actions, the large volumes of unscheduled flows[6] are another indicator of the difficulties of controlling flows on the European electricity system in an efficient way by using congestion management on current zonal borders.

In 2018, unscheduled flows on the borders of the "Core" and "Italy North" capacity calculation regions (CCRs)[7] and on the Swiss borders totalled 128 TWh[8], up 7% compared to the previous year. The largest year-on-year increase was recorded in the Central Western Europe CCR[9], in which the problem of an inadequate bidding zone configuration seems most acute, where unscheduled flows increased by more than 60% with respect to the previous year[10].

The obsolete bidding-zone configuration and the resulting large volumes of unscheduled flows – including loop flows – in certain parts of Europe, has also led TSOs to make available for trading a level of cross-border capacity which is much lower than what could be feasible, while still maintaining system security, with a better bidding-zone structure and greater cooperation among them[11]. This aspect, repeatedly highlighted by ACER[12], has been addressed, albeit in a somewhat "crude" way, in the recast of the Electricity Regulation, which has established a 70% minimum share of cross-border capacity to be made available for trading[13]. Imposing such a minimum share, however, does not solve the problem of an inadequate bidding zone configuration; in fact, it is likely to exacerbate it, as it increases the costs of maintaining the *status quo*, as the possibility to discriminate cross-zonal flows to the

6. Unscheduled flows on a cross-zonal interconnection are the difference between physical flows and schedules, the latter representing flows from capacity allocation. Unscheduled flows comprise Unscheduled allocated flows - flows allocated on a given cross-zonal border, but scheduled on a different one – and Loop flows – cross-zonal flows originating from intra-zonal exchanges.

7. The "Core" CCR includes the borders between Austria, Belgium, Croatia, the Czech Republic, France, Germany/Luxemburg, Hungary, the Netherlands, Poland, Romania, Slovakia and Slovenia. The "Italy North" CCR includes the borders between Italy, on the one side, and Austria, France and Slovenia, on the other.

8. Mostly represented by loop flows.

9. The Central Western Europe (CWE) CCR includes the borders between Belgium, France, Germany/Luxemburg and the Netherlands.

10. ACER/CEER, *Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2018 - Electricity Wholesale Markets Volume*, November 2019, Annex 2. In the Central Western European (CWE) Region and overall, 2018 year-on-year increase was the first one since 2015. In absolute terms, unscheduled flows are the largest in the non-CWE part of the "Core" region.

11. An increase in the cross-border capacity made available for trading can clearly also be achieved by increasing the network thermal capacity, i.e. investing in an expansion of such capacity.

12. For example, in ACER/CEER, Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2017 - Electricity Wholesale Markets Volume, October 2018, Section 3.4.

13. Regulation (EU) 2019/943 of the European Parliament and of the Council of 5 June 2019 on the internal market for electricity (recast), article 16(8). Exception are envisaged if the Member State opts for an "action plan" or the national regulatory authority grants a "derogation".

advantage of intra-zonal flows will be significantly reduced.

The Importance of a Proper Bidding-Zone Configuration

A proper bidding-zone configuration is therefore essential for the security and efficiency of the EU electricity system and markets. This is recognised in the recast of the Electricity Regulation, where it is specified that *"[t]he configuration of bidding zones in the Union shall be designed in such a way as to maximise economic efficiency and to maximise cross-zonal trading opportunities […], while maintaining security of supply"*[14].

The same Regulation requires a bidding zone review to be launched, by 5 October 2019, by all relevant transmission system operators (TSOs) submitting to the national regulatory authorities (NRAs), for their approval, a proposal for the methodology, assumptions and alternative bidding zone configurations to be used for such a review. If NRAs fail unanimously to decide on the proposal within three months, ACER is called to take a decision in the subsequent three months[15].

The proposal submitted by the TSOs in October was assessed by NRAs as incomplete, as it did not include, *inter alia*, alternative configurations for some Bidding Zone Review Regions (BZRRs). NRAs therefore requested TSOs to resubmit the proposal, addressing this shortcoming. As TSOs had not been able to agree on alternative bidding zone configurations for all BZRRs for the October submission, they sought NRAs' guidance. However, even NRAs were apparently unable to agree on what they exactly wanted. As a result, the proposal resubmitted by TSOs in February 2018, while improving some aspects of the methodology, did not include an agreed set of proposed alternative bidding zone configurations for some BZRRs.

The importance of an appropriate bidding zone configuration and therefore of the bidding zone review process makes the inability of TSOs and NRAs to agree on even the alternative configurations to be used for the analysis most unfortunate.

The Important Aspects in the Bidding Zone Review: Alternative Bidding Zone Configurations and Assessment Criteria

The bidding zone review process rests mostly on two crucial aspects:

- the alternative bidding zone configurations to be considered in the review process;
- the criteria to assess the relative merits of the alternative configurations, on the basis of which the final decision can be taken.

For sure, the TSOs, in their proposal, could have been more ambitious on both accounts, and NRAs could have pushed them to be more ambitious.

In terms of the alternative bidding-zone configurations to be considered in the analysis, only a few alternatives with respect to the *status quo* were proposed. Moreover, in the Central Europe BZRR, which is the one for which most of the discussion about the appropriateness of the current configuration has taken place, TSOs were unable to agree on the set of alternative bidding zone configurations. In the end, only the TSOs of Austria, Germany, Greece, the Netherlands, Norway and Sweden proposed

14. Regulation (EU) 2019/943, article 14(1).

15. Regulation (EU) 2019/943, article 14(5).

alternative bidding zone configurations to be compared with the *status quo*[16].

In the case of Austria, the alternative configuration envisages the reunification of the current Germany/Luxemburg and Austria bidding zones, thus returning to the situation existing before October 2018. The German TSOs, on the other hand, propose three alternative configurations, in which the current Germany/Luxemburg bidding zone is split into two or three bidding zones. The Greek TSO proposes a separate bidding zone for the island of Crete as an alternative configuration. For the Netherland, the possibility of splitting its current nationwide bidding zone into three smaller bidding zones is proposed. The Norwegian TSO proposes an alternative configuration in which its northernmost bidding zone is split into two, while the Swedish TSO proposes to consider the possible merger of the two northernmost bidding zones and of the two southernmost bidding zones, while creating a new bidding zone for Stockholm, thus moving from four to three bidding zones.

All these alternative configurations are justified by the respective TSOs, even though, in the Central Europe BZRR, these justifications are apparently not sufficient to convince the other TSOs in the same BZRR. As a result, as already mentioned, they were unable to come up with a common proposal for a set of alternative bidding zone configurations.

However, the absence of one additional alternative configuration is noticeable: the one splitting the current Germany/Luxemburg bidding zone into two or three bidding zones, with the southernmost one merged with the current Austrian bidding zone, or part of it. Already in its 2015 Opinion[17], in which it recommended the introduction of congestion management procedures on the German-Austrian border, ACER identified significant congestion not only on the German-Polish, German-Czech and Czech-Austrian borders, but also on internal network elements within Germany, which were materially affected by flows on the German-Austrian border. In their criticism of that Opinion, a number of Austrian parties highlighted that the measure recommended by ACER would have reduced the ability of hydroelectric power plants in Austria to support the electricity system in the southern part of Germany. It is therefore somewhat surprising that neither the German TSOs, nor the Austrian ones proposed the alternative configuration which keeps (part of) Austria together the southern part of Germany, once the latter is split in two or three budding zone[18,19].

It is also unfortunate that no model-based bidding zone configuration, especially for the Central Europe

16. Italy recently performed a national bidding-zone review, pursuant to article 32(1)(d) of the CACM Regulation, which was launched in 2018 and resulted in a two-step reconfiguration of the Italian bidding-zones. In the first step, three of the four "virtual" bidding zones were suppressed as of 1 January 2019. In the second step, to be implemented in 2021, one administrative region (Umbria) will be transferred from the CNORD bidding zone to the CSUD bidding zone and the SUD bidding zone will be split with the separation, as a bidding zone of its own, of the Calabria administrative region, merging the remaining "virtual" bidding zone into it.

17. Opinion of the Agency for the Cooperation of Energy Regulators No 09/2015 of 23 September 2015 on the compliance of National Regulatory Authorities' decisions approving the methods of allocation of cross-border transmission capacity in the Central-East Europe region with Regulation (EC) No 714/2009 and the guidelines on the management and allocation of available transfer capacity of interconnections between national systems contained in Annex I thereto.

18. This option could not be considered by ACER in its 2015 Opinion, given that its competences were and still are limited to cross-border interconnectors.

19. The opportunity of considering such an alternative configuration is also supported by the results obtained by Tim Felling (see footnote 22).

BZRR, has been proposed. In its Final Report of the First Edition of the Bidding Zone Review[20] in 2018, ENTSO-E indicated that their efforts to come up with model-based configurations was hindered by local congestions in the 220 kV grids of some countries, which significantly impacted the nodal prices used in the cluster analysis. ENTSO-E tried to obtain more realistic overall model-based configurations by applying some form of post-processing to the clustering results. However, "*despite this post-processing exercise, the obtained nodal prices and model-based configurations [were] not considered sufficiently realistic or robust for use in the current Bidding Zone Review*"[21]. As a result, ENTSO-E committed to investigate model-based configurations further for potential use in future bidding-zone reviews. Such an objective has clearly not been achieved in time for the current bidding-zone review[22]. Given the observed inability of TSOs to agree on alternative expert-based bidding-zone configurations, it is crucial and urgent that a model and methodology is developed which could deliver a set of model-based bidding-zone configurations to be used in the review.

As regards to the criteria to assess the relative merits of the alternative configurations, to inform the final decision, article 33(1) of the CACM Regulation[23] lists a minimum set of thirteen criteria, some of which comprise sub-criteria, to be used to evaluate alternative bidding zone configurations, grouping them into three categories: network security, market efficiency, and stability and robustness of bidding zones. The challenge is however that some, if not most of these criteria are difficult to quantify, let alone monetise, and the legislative provisions do not establish any ranking among those criteria, nor a structured approach on how to appreciate their importance.

An (In)Escapable Trade-Off

In the end, as it was the case in the previous review, it is likely that the comparison of the performance of alternative bidding-zone configurations will boil down to the perceived trade-off between the efficiency of the market outcome[24] and operational security[25], on the one hand, and market liquidity[26], on the other hand[27]. As a first approximation, any configuration characterised by smaller bidding zones should improve operational security as it makes more flows subject to congestion management procedures and, therefore, managing congestion easier. By delivering a market outcome which is more likely to be

20. ENTSO-E – First Edition of the Bidding Zone Review - Final Report, 2018.

21. *Ibid*, p. 10.

22. Despite some relevant academic contributions, including those appeared since the previous bidding zone review in 2018. See for example: Felling T., *Solving the Bi-level Problem of a Closed Optimization of Electricity Price Zone Configurations using a Genetic Algorithm*, HEMF Working Paper No. 09/2019, July 2019, which also contains a reference to relevant academic literature.

23. Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

24. i.e. without the need for extensive application of economically inefficient remedial actions. Article 33(1)(b)(v) of the CACM Regulation.

25. Article 33(1)(a)(i) of the CACM Regulation.

26. Article 33(1)(b)(ii) of the CACM Regulation: "*market efficiency, including, at least the cost of guaranteeing firmness of capacity, market liquidity, market concentration and market power, the facilitation of effective competition, price signals for building infrastructure, the accuracy and robustness of price signals*".

27. This is highlighted also in recital (19) of Regulation (EU) 2019/943: "*Bidding zones therefore should be defined in a manner to ensure market liquidity, efficient congestion management and overall market efficiency*".

feasible, such configurations will also reduce the need for economically inefficient remedial actions, thus improving the overall efficiency of the market. At the same time, smaller bidding zones are often claimed to reduce market liquidity[28]. In both cases such impacts would need to be confirmed and measured in the bidding zone review. However, while the effect of different bidding zone configurations on the feasibility of the market outcome, and therefore on the need for economically inefficient remedial actions, and on operational security could be simulated, quantified and monetised (in terms of welfare losses due to remedial actions and non-served electricity), the effect on liquidity are more difficult to be assessed, let alone expressed in monetary terms. And unless and until there is a "common currency" for comparing the impact of alternative bidding zone configurations according to the different criteria, it will be extremely difficult to come up with an objective comparison and the bidding-zone review process will likely need a political "finale", with the concrete risk of an inconclusive outcome (as was the case in 2018). In this respect, a glimpse of hope is provided by the enhanced governance of the bidding-zone review process, where the Commission is now called to act as a last-resort decision-maker, in case Member States are unable to agree[29]. But even the Commission will find it more difficult to decide on the best bidding zone configuration if the comparison cannot be performed on an objective basis.

In this regard, it is important immediately to clarify that it should not be given for granted that the current bidding zone configuration is not adequate to support the internal market in electricity. However, being mostly based on the pre-liberalisation electricity system, it is far from obvious that this configuration represents the best bidding-zone structure to support an efficient electricity market now and in the future[30].

A Deeper Reflection on Liquidity

To assist in the handling of the above-mentioned trade-off, a deeper reflection on the liquidity criterion is needed. Market liquidity could be defined as "*a measure of the ability to buy or sell a product – such as electricity - without causing a major change in its price and without incurring significant transaction costs*"[31]. Despite being defined as a measure, measuring liquidity is not straightforward and a number of questions immediately arise. First of all, for a market to be "liquid", what is the volume of electricity that it should be possible to buy and sell without causing major price changes? Then how big could a price change be before it is considered

28. Although, even the conclusions reached by ENTSO-E in its First Edition of the Bidding Zone Review are far from definitive: "*The reduced size of the bidding zones in the split configurations makes a decrease of liquidity very probable, due to the reduced number and diversity of market participants and the reduced trading possibilities*"; "*The effects may be attenuated by cross-zonal capacities and related trading products, but they are not likely to be overcome*"; "*Moreover, in a coupled market, the liquidity will develop differently in the zones and the level to which the liquidity changes might be different for the individual zones. For example, a split bidding zone may lose liquidity, but neighbouring bidding zones may see an increase of liquidity due to more available cross-zonal trading capacities*". (See the Report referred to in footnote 20, page 60).

29. Another aspect which might make a positive outcome of the current bidding-zone review more likely is the increasing cost of the remedial actions required to maintain the status quo, as already indicated earlier in the text.

30. This is also the conclusion reached, at least for the Central-Western Europe (CWE) Region, by Felling and Weber in: Felling, T. and Weber, C., *Consistent and robust delimitation of price zones under uncertainty with an application to Central Western Europe*. Energy Economics 75, 583–601, 2018.

31. Definition taken and adapted from Ofgem: https://www.ofgem.gov.uk/electricity/wholesale-market/liquidity. In the Final Report on the First Edition of the Bidding Zone Review (see footnote 20), ENTSO-E defines liquidity as "*the degree to which any market party can quickly (within the time frame the market participant needs) source / sell any volume of energy (implicit) or capacity (explicit) without greatly affecting the involved market price*" (Section 5.9.1, page 57).

"major"? Also, how large should transaction costs be to be considered significant? These challenges in turning the definition of market liquidity into a measurable concept are common to all markets – markets for commodities other than electricity and financial markets – and a number of indicators are used for this purpose, including traded volumes, bid-ask spreads and churn rates[32].

The difficulties in measuring liquidity should however not undermine its importance. A well-functioning market, promoting competition and efficiency, is based on two mutually-reinforcing effects: i) the liquidity of the spot market so that market participants can trust the price formation mechanism and therefore the robustness of the electricity spot price as the underlying reference for the forward/futures market; and ii) the liquidity of the forward/futures market to allow effective hedging of the spot price risk. If one of these component is missing, the other one also suffers.

A low level of liquidity might lead to higher transaction costs, higher risks and hedging costs, which may translate into higher barriers to entry into the market. Therefore, liquidity, while not an objective in its own, is of utmost importance for the market to deliver its benefits.

That said, let's consider which evidence is available in Europe on the impact of a change in the bidding zone configuration on two of the possible indicators of market liquidity: traded volumes and churn rates.

Over the last ten years there have been two significant bidding zone reconfigurations in the EU: the splitting of Sweden in four bidding zones on 1 November 2011 and the splitting of Austria from the Germany/Luxemburg bidding zone on 1 October 2018. In both cases, day ahead traded volumes after the bidding-zone reconfiguration were higher than those recorded the previous year[33,34].

Moreover, the churn rate in the German market did not seem to have changed significantly following the split of the Austrian bidding zone from the Germany/Luxemburg one[35].

A variation in traded volumes may be due to several causes and therefore this evidence should not be considered as conclusive on the impact of bidding-zone splits on the liquidity of the electricity market measured by traded volumes. Also, churn rates might be affected by several factors, other than the bidding-zone configuration. However, at least in the case of the above-mentioned bidding zone reconfigurations, it does not seem that they resulted in a reduction in traded volumes or, in the case of the

32. While higher churn rates are typically seen as an indication of greater liquidity, they also imply higher overall trading fees for the same volume of final energy consumption.

33. In particular, Swedish day-ahead traded volumes on NordPool increased by 10% between 2011 and 2012. Day-ahead volumes on EPEX Spot for Germany/Luxemburg and Austria increased by 13% (from 230 TWh to 261 TWh) between the 12 months before the spit and the 12 months after the split. Over the same period, day-ahead traded volumes for Germany and Austria on EXAA increased by 30% (from 8.3 TWh to 10 TWh).

34. A different view is presented by EFET in a memo "A reality check on the market impact of splitting bidding zones", in which they observe that the Swedish bidding-zone splitting resulted in a reduction in the volumes of futures and EPAD (Electricity Price Area Differentials) contracts on NordPool. It is however to be observed that such a reduction in volumes started already in 2010, well before the bidding-zone reconfiguration.

35. At least in the subsequent two quarters, when the churn rate remained at around 12, approximately the same level as in the previous two quarters. A larger reduction was recorded between the first and second quarters in 2019. See European Commission, Quarterly Report on European Electricity Markets, Market Observatory for Energy, Q2 2019, where churn rate is defined as "*the ratio of the total volume of power trade (including exchange executed and OTC markets on the spot and the curve) and electricity consumption*".

Germany/Luxemburg – Austria bidding-zone split, in a lower churn rate.

More generally, there seems to be no correlation between the size of bidding zones and churn rates. In fact, while Germany, with the largest bidding zone in Europe even after the split of Austria, has traditionally shown by far the highest churn rate (above 10), the picture in other regions shows contrasting patterns. For example, the Nordic region[36] is, electrically, approx. 20% smaller than France and it is split into eleven bidding zones, while France is covered by a single bidding zone; and yet, churn rates in the Nordic region have been constantly higher than those in France, at times much higher. And the UK, approx. 30% smaller in electric terms than France, has consistently shown much higher churn rates than the French market[37].

The experience in the US seems to point in the same direction. For example, in the late 1990's, PJM, the regional electricity transmission organisation covering a large area on the eastern side of the country[38], moved from a zonal to a nodal market configuration. The latter can be considered as a configuration characterised by the smallest possible bidding zones (each coinciding with a single node). Such a move did not seem negatively to have affect liquidity, which has instead gradually increased over time[39].

Finally, if what really matters in the end is the benefits delivered to consumers, "*there is no clear evidence that retail market competition in Sweden decreased following the introduction of bidding zones in 2011. Both the number of retailers and the margins are roughly the same as prior to the reform. Furthermore, all retailers that Ei interviewed emphasised that the reform had not hampered retail competition*"[40].

Conclusions

While what is presented above cannot be considered as conclusive evidence, at least it questions the belief held by some stakeholders and commentators that a bidding-zone split and, in general, smaller bidding zones reduce market liquidity. In fact, liquidity seems to be determined more by the design of the market and the structure of the sector. And while liquidity can promote competition, the latter may impact liquidity more than the dimension of bidding zones.

Moreover, smaller bidding zones, including those resulting from a bidding-zone split, may be able to tap into the liquidity of other zones whose prices are closely correlated with theirs. In this respect, the relevant market, including for hedging purposes, might be larger than the individual bidding zone, as it is clear from the experience of Italy and of the Nordic market, where derivative contracts are offered with

36. Including Denmark East, Finland, Norway and Sweden.

37. The feedback received by ENTSO-E in response of a survey carried out in 2016 on the relationship between bidding-zone size and liquidity shows very different position among stakeholders. See the Final Report referred to in footnote 20, page 58).

38. PJM currently coordinates the movement of wholesale electricity in all or parts of Delaware, Illinois, Indiana, Kentucky, Maryland, Michigan, New Jersey, North Carolina, Ohio, Pennsylvania, Tennessee, Virginia, West Virginia and the District of Columbia.

39. On this, listen, for example, to the podcast of the Florence School of Regulation's Energy & Climate Series with Vincent P. Duane on "Zonal versus Nodal Electricity Pricing: the PJM experience" available at: https://player.fm/series/fsr-energy-climate/zonal-versus-nodal-electricity-pricing-the-pjm-experience-vincent-p-duane.

40. ACER/CEER, Annual Report on the Results of Monitoring the Internal Electricity and Natural Gas Markets in 2013, October 2014, Case Study 1, page 54.

settlement based on a multi-zonal reference price[41]. Furthermore, if a bidding-zone split, by making congestion management more efficient, allows TSOs to make more cross-zonal capacity available for trading on existing zonal borders, it will also increase the possibility for smaller bidding-zones to tap into the liquidity of neighbouring ones.

However, what seems to be more relevant for the well-functioning of the electricity market is the structure (concentration) of the sector with respect to the structure (congestions) of the network. As already indicated, different bidding-zone configurations do not change the physical ability of the network to transmit electricity from generators to loads. Larger bidding zones might appear to support greater competition in the market by allowing a larger number of market participants to compete among themselves. But, if the larger bidding zone does not reflect the actual capability of the network, local market power will inevitably emerge, at least as real time approaches. This seems a more interesting area for investigation[42] than the relationship between the size of bidding zones and market liquidity.

The available evidence and the above considerations, together with the difficulty of measuring liquidity, let alone monetising its benefits[43], strongly suggest that liquidity, as a criterion in the assessment of alternative bidding zone configurations, should have at best a complementary role, with the driving determinants being the efficiency of the market outcome and operational security.

41. In Italy, the IDEX futures are settled with respect to the PUN – Prezzo Unico Nazionale, the single price paid by those buying electricity in the day-ahead market, which is an average of the different zonal prices. These futures are also used to hedge the price risk exposure of market participants selling on the market, even though they are exposed to the local bidding-zone price risk. In the Nordic market, derivatives are offered on Elspot system price, the price for the Nordic day-ahead market which would prevail if no congestion occurred in this market. These types of products can pool the liquidity of all bidding zones of the Nordic market. In the case of congestion in this market, the system price does not correspond to any price paid by market participants, and yet it is considered as a sufficient hedge for most market participants. For those requiring a higher level of hedging, EPAD – Electricity Price Area Differential contracts are available, which are futures on the difference between individual bidding-zone prices and the system price.

42. See, for example, Graf C., Quaglia F., and Wolak F. A., *Simplified Electricity Market Models with Significant Intermittent Renewable Capacity: Evidence from Italy*, March 2020, available at: https://web.stanford.edu/group/fwolak/cgi-bin/sites/default/files/GrafQuagliaWolak_SimplifiedElectricityMarketModelsRenewables.pdf.

43. A study recently commissioned by ACER has concluded that it is not possible to monetise the benefits of liquidity of energy markets and proposed a range of indicators to characterise different markets according different dimension of liquidity. The point remains as to whether these indicators could be transposed into monetised welfare benefits. DNV-GL, Methodology to estimate the impact of a bidding zone reconfiguration on market liquidity and transaction costs, Report No.: 2020-0379, Rev. 0, Date: 2020-04-06.

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