AMPRION MARKET REPORT 2022

THE IMPACT OF HIGH ENERGY PRICES AND THE ACHIEVEMENTS IN MARKET INTEGRATION

CONTENTS

EXECUTIVE SUMMARY

EUROPEAN MARKET INTEGRATION HAS PROCEEDED WITH SUPPORT FROM AMPRION – DESPITE A FAST-CHANGING GENERAL MARKET ENVIRONMENT.

PRICE CONVERGENCE IN CENTRAL WESTERN EUROPE (CWE) REMAINED AT HIGH LEVELS

In 2021, energy prices in Europe reached unprecedented heights of more than €600/MWh in some hours. Hand in hand with increased imports and exports, the developments on the energy markets have led to challenges for the transmission system operators (TSOs). The high price levels especially in Q4 2021 concerned the TSOs' costs, in particular, for the procurement of transmission losses and balancing as well as for redispatching. However, enhancements in market integration helped to keep price convergence in CWE at the previous year's level of around 51%. All in all, market integration contributed highly to mitigate the impact of the turbulences on the energy markets, also in 2022 where the situation is becoming even more tense.

NEED-ORIENTED GRID EXPANSION REMAINS A TOP PRIORITY

To accommodate electricity trading with low limitations, grid expansion remains a top priority. Yet, such grid enhancement needs to consider both grid and market needs. This is also shown by the analysis of trade-limiting grid elements in the context of the EU 70% transmission capacity target. The key findings of this analysis reveal the differences between offered capacities to the market based on target values and the requested capacity based on the market coupling results. The results show the importance of considering the interaction between market and grid to derive an efficient roadmap for the future grid expansion.

THE AMPRION SYSTE(M)ARKET CONCEPT PROVIDES SOLUTIONS TO KEY QUESTIONS RELATED TO THE FAST-CHANGING FUTURE MARKET ENVIRONMENT

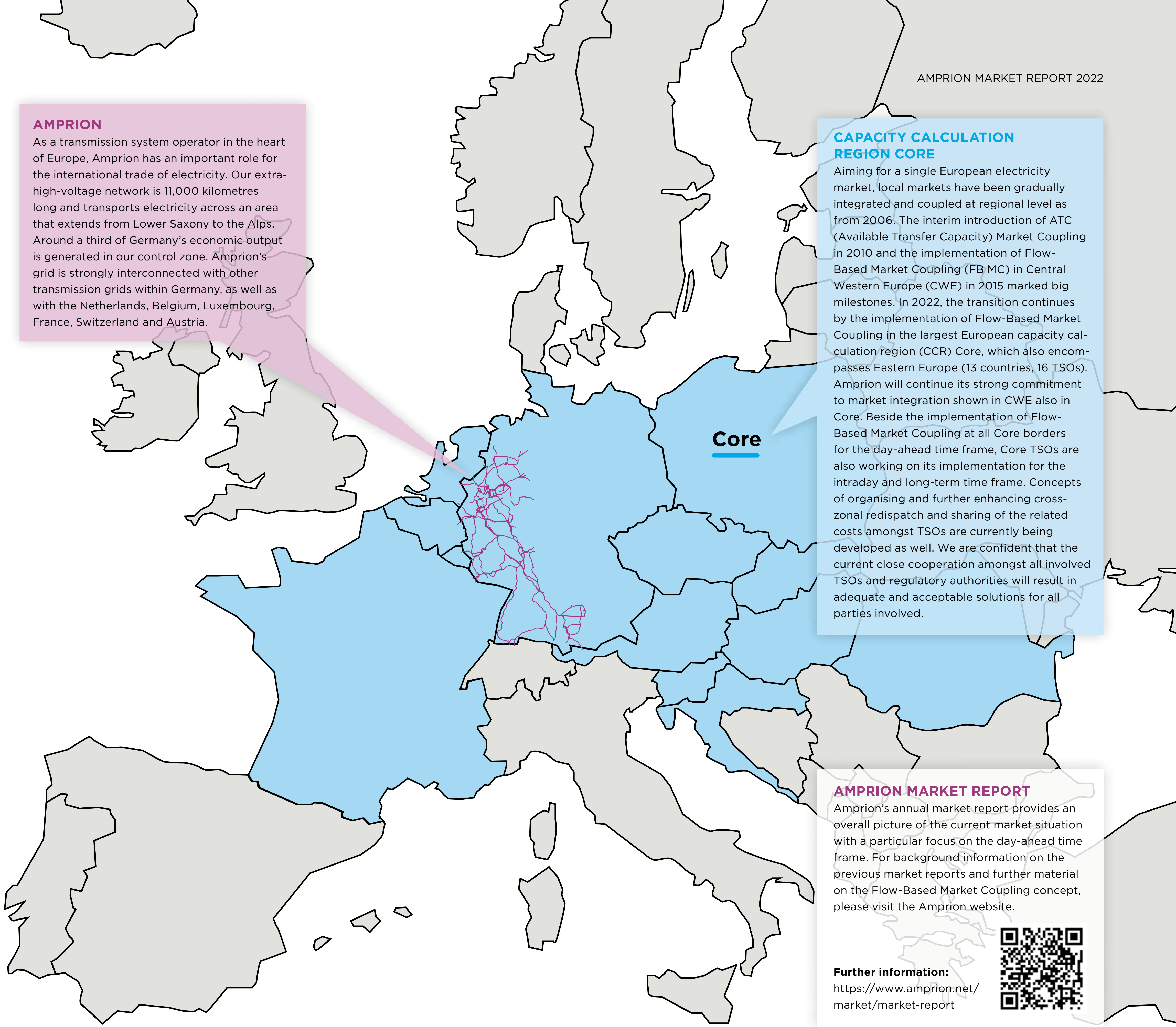
The substantial increase in energy prices, the current geopolitical situation and two system splits in 2021 (without any major disturbances of supply) stress the importance of preserving a reliable and resilient energy system. Systemic solutions consisting of accelerated grid expansion, European market integration and new ideas such as Amprion's Syste(M)arket are needed. Amprion's Syste(M)arket platform bundles all relevant system needs and ensures that they are available in sufficient quantity and at the right location. We believe that our concept of the "Syste(M)arket" can make a valuable contribution to the creation of a sustainable energy system and thus to achieving the European and national climate goals.

The war against Ukraine and the possible scarcity of fuels is expected to further strain the system. Such challenges in the current geopolitical context call for timely and systemic solutions. Amprion is highly committed to further increase market integration and to enhance its grid to make it fit for the future developments.

INTRODUCTION

As the energy infrastructure is a key enabler of the European energy transition, transmission system operators (TSOs) play an important role in reaching the European Green Deal objectives as well as in the implementation of a functioning internal energy market. Tackling climate change and achieving climate neutrality by 2050 poses significant challenges for the entire European energy system. On a national level, the German energy system is undergoing an unprecedented transformation. Electricity production from nuclear energy and coal will be phased out while an increasing share of renewable energies is integrated into the system. As generation and consumption in the transmission system must always be in equilibrium in order to keep the network stable, the task of ensuring this will become much more demanding for the TSOs. Even in times of such a dynamic and changing environment, TSOs are ensuring a 24/7 electricity supply and are thus enabling the energy transition. Efficient cooperation is a key prerequisite for this. Therefore, TSOs are jointly and cooperatively working around the clock to ensure a secure network, promoting security and cross-zonal trade within the entire European electricity system.

Amprion is – and has been for decades – an integral part of this cooperation. We have been engaged in a large number of regional and European system operation, grid planning and market integration initiatives. Our involvement in these initiatives has always been based on a close, trustful and constructive collaboration with the European TSOs, National Regulatory Authorities (NRAs), ACER (the Agency for the Cooperation of Energy Regulators), power exchanges, a vast number of market parties and our association ENTSO-E (European Network of Transmission System Operators for Electricity). In a nutshell, close mutual cooperation is in our DNA. This market report provides evidence of the dynamic electricity market environment. Besides its focus on the achievements reached in the provision of trading capacities to the market, this year's report also highlights the relevance of the very high energy prices in 2021. While the market report analyses the developments of the past year in detail, we naturally also take a look into the current political developments with an impact on the TSOs.



AMPRION

As a transmission system operator in the heart of Europe, Amprion has an important role for the international trade of electricity. Our extra-high-voltage network is 11,000 kilometres long and transports electricity across an area that extends from Lower Saxony to the Alps. Around a third of Germany's economic output is generated in our control zone. Amprion's grid is strongly interconnected with other transmission grids within Germany, as well as with the Netherlands, Belgium, Luxembourg, France, Switzerland and Austria.

CAPACITY CALCULATION REGION CORE

Aiming for a single European electricity market, local markets have been gradually integrated and coupled at regional level as from 2006. The interim introduction of ATC (Available Transfer Capacity) Market Coupling in 2010 and the implementation of Flow-Based Market Coupling (FB MC) in Central Western Europe (CWE) in 2015 marked big milestones. In 2022, the transition continues by the implementation of Flow-Based Market Coupling in the largest European capacity calculation region (CCR) Core, which also encompasses Eastern Europe (13 countries, 16 TSOs). Amprion will continue its strong commitment to market integration shown in CWE also in Core. Beside the implementation of Flow-Based Market Coupling at all Core borders for the day-ahead time frame, Core TSOs are also working on its implementation for the intraday and long-term time frame. Concepts of organising and further enhancing cross-zonal redispatch and sharing of the related costs amongst TSOs are currently being developed as well. We are confident that the current close cooperation amongst all involved TSOs and regulatory authorities will result in adequate and acceptable solutions for all parties involved.

AMPRION MARKET REPORT

Amprion's annual market report provides an overall picture of the current market situation with a particular focus on the day-ahead time frame. For background information on the previous market reports and further material on the Flow-Based Market Coupling concept, please visit the Amprion website.

Further information:
https://www.amprion.net/market/market-report

Amprion connects electricity markets across borders

1. ENERGY PRICES IN EUROPE REACHED UNPRECEDENTED HEIGHTS

RISING CO_2 AND GAS PRICES AS WELL AS AN INCREASINGLY SCARCE SUPPLY OF CONVENTIONAL/FLEXIBLE POWER PLANT CAPACITY IN EUROPE HAVE LED TO AN EXTREME INCREASE IN ELECTRICITY PRICES IN THE LAST QUARTER OF 2021. DUE TO THE TENSE GEOPOLITICAL SITUATION IN 2022, THIS INCREASE CONTINUED EVEN FURTHER IN Q1 2022.

The prices for electricity on wholesale markets have soared. Day-ahead prices regularly exceeded €300/MWh (up to more than €600/MWh) in Europe over the last months of 2021, although there were regional differences. The average day-ahead prices in Germany reached €97/MWh in 2021 (in 2020 the average day-ahead price for Germany was only €30/MWh). Also other European countries experienced a strong price increase. Figure 1 compares the average monthly day-ahead prices per bidding zone between January and December 2021. Prices have increased the most in Italy, France, Switzerland and Croatia. Nordic countries have seen the lowest price increase. However, in Sweden's and Norway's southern bidding zones prices have also increased by more than 200% over the course of the year 2021.

FOCUS ON CWE

In the CWE region, prices have been rising, particularly from September 2021 onwards. As shown in Figure 2, weekly average day-ahead prices have been the lowest in the DE-LU bidding zone and the highest in France. Whereas there is still a high degree of price convergence in the first three quarters of 2021, prices diverged significantly at the end of 2021.

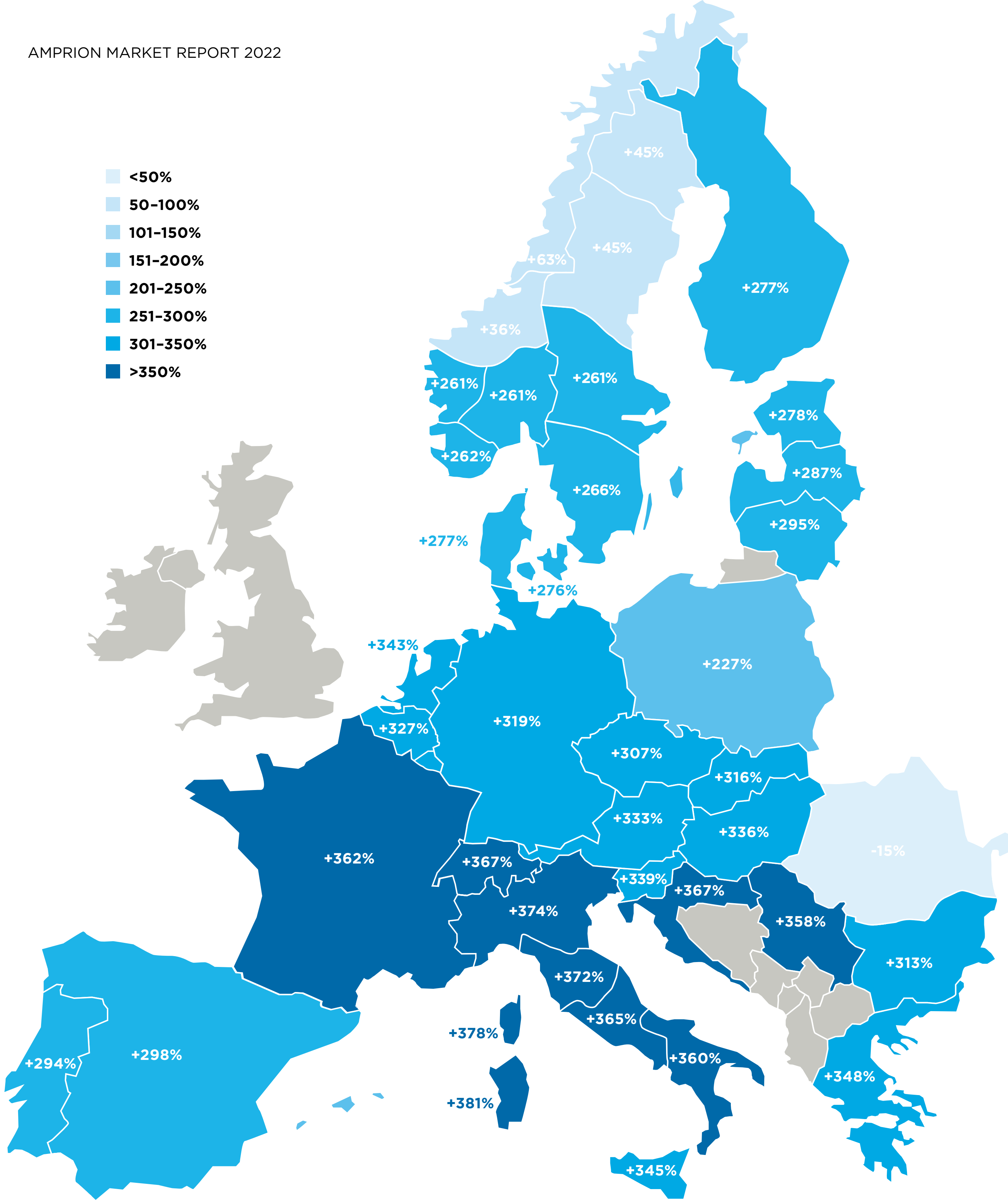


Figure 1: Relative changes of average monthly day-ahead electricity prices in European bidding zones (comparison January to December 2021 in %)[1]

[1] Source: https://transparency.entsoe.eu/

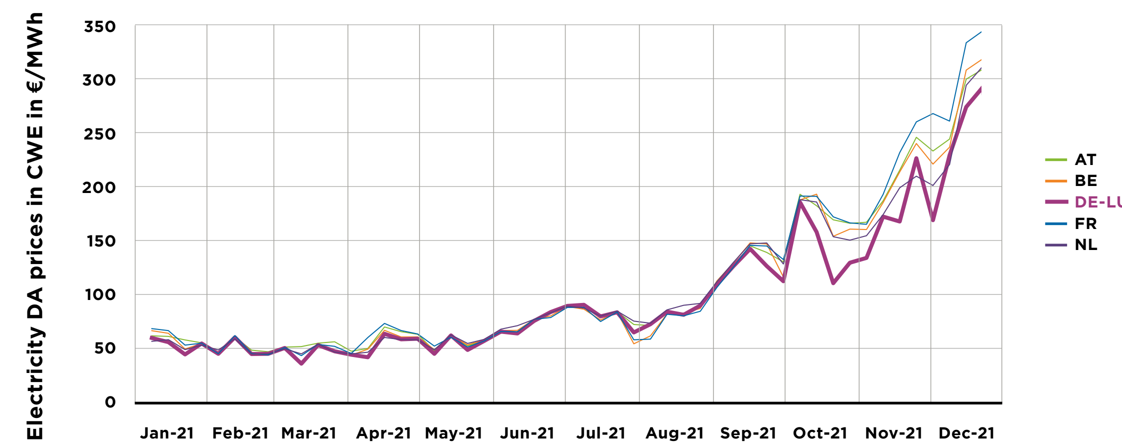


Figure 2: Day-ahead prices (weekly average) in CWE bidding zones for 2021[2]

Table 1 illustrates the development of the day-ahead average price levels in CWE over the last six years. The decrease in electricity prices in recent years (2019 and 2020) has reversed since Q3 2021 into the highest average prices since the introduction of the CWE Flow-Based Market Coupling in 2015. Therefore, the high average day-ahead price in 2021 shown for each bidding zone is composed of three quarters with rather moderate prices and one quarter with very high prices.

Bidding zone	2016	2017	Until 10/2018	From 10/2018	2019	2020	2021
AT	-	-	-	59.91	40.05	33.14	106.85
BE	36.61	44.58	49.94	71.06	39.34	31.88	104.12
DE-LU	-	-	-	52.59	37.66	30.47	96.85
DE-LU-AT	28.98	34.18	41.72	-	-	-	-
FR	36.74	44.96	45.97	62.72	39.45	32.20	109.18
NL	32.24	39.30	49.80	60.60	41.19	32.24	102.97

Table 1: Day-Ahead average price levels in CWE (in €/MWh) for 2016–2021[3]

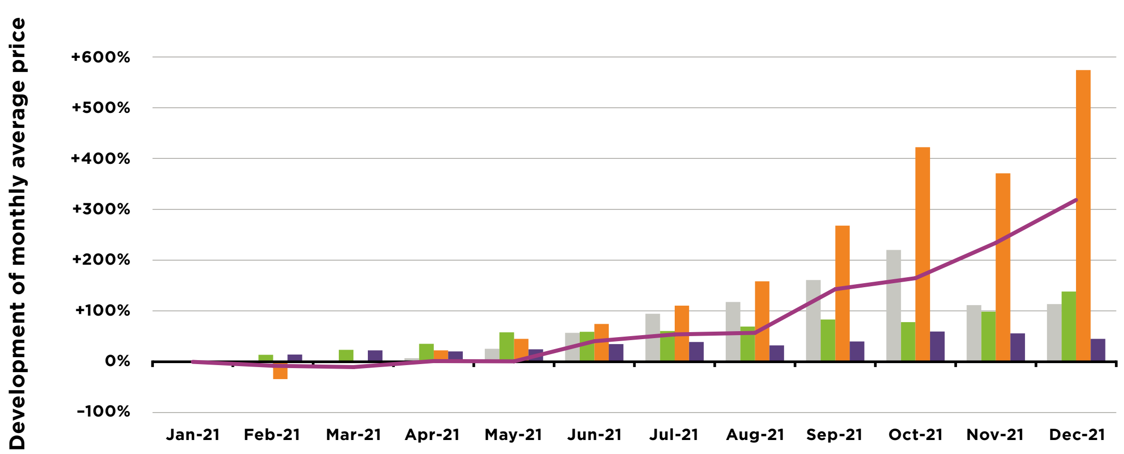
[2] *Source: https://transparency.entsoe.eu/*

[3] *Please note that due to the separation of the German/Luxembourgian and Austrian bidding zone (DE-LU/AT Split) in 2018 the table shows two columns for the year 2018 (day-ahead prices until the split in October 2018 and day-ahead prices after the split, from October 2018 onwards); source: https://transparency.entsoe.eu/*

WHY ARE ENERGY PRICES INCREASING?

The high prices are caused, in particular, by the soaring global gas prices and other factors such as lower wind and hydro generation, and high carbon and hard coal prices.

In recent months, the global economy started to recover from the Covid-19 pandemic and electricity demand has increased to pre-Covid levels. Despite the steady increase of renewable electricity generation in recent years, in 2021 over 40% of German electricity has still been produced by coal- and gas-fired power plants. Therefore, the electricity price increase was mainly caused by rising prices of natural gas, hard coal and CO_2 allowances in Europe. However, amongst other factors day-ahead prices are also driven by the availability of power plants. For example, in France the availability of the nuclear power plants has been lower in the last month of 2021 than usual[4]. Figure 3 illustrates these rising commodity prices for the example of Germany. Gas prices have been rising above all other commodities from only €19/MWh in January 2021 to €126/MWh in December 2021. A combination of factors (i.e. strong recovery in demand, weather-related factors, low storage levels as well as a tight supply situation) has led to such sharp rise in European gas prices. Regarding the demand side, a cold winter and long heating season further stressed the situation. The liquefied natural gas (LNG) production has decreased more than expected based on a series of unscheduled unavailability and other delays. Furthermore, several stakeholders emphasise Russia's reluctance to increase gas availability to Europe ensuring adequate storage levels in 2021[5]. This would have helped to ease the price situation in 2021 and also in 2022. The high gas price is one major reason that electricity prices have increased by 319% during 2021.



	Hard coal	CO_2	Natural gas	Mineral oil	Electricity
Jan 21	€8/MWh	€34/t	€19/MWh	€30/MWh	€53/MWh
Dec 21	€17/MWh	€81/t	€126/MWh	€43/MWh	€221/MWh
Difference	+113%	+138%	+574%	+45%	+319%

Figure 3: Average prices for hard coal, CO_2, natural gas, mineral oil and electricity in Germany in 2021

[4] *See: https://transparency.entsoe.eu/generation/r2/actualGenerationPerProductionType/show*

[5] *See: https://www.iea.org/news/statement-on-recent-developments-in-natural-gas-and-electricity-markets*

Due to the strong increase in the costs of fuels and CO_2 certificates, the prices for electricity futures contracts increased as well at the end of 2021 for the front year 2022. The price for the EEX Phelix Baseload[6] for the year 2022 reached the historical maximum of €324/MWh on 22 December 2021. On average, the costs of Phelix Base were €215.66/MWh in December, whereas for the same product an average price of €81/MWh was seen in August 2021. The market thus seemed to be preparing for continued high energy prices.

The still high dependency on fossil fuels with the associated high electricity prices is not limited to Germany but exists in the entire EU. This correlation between gas and electricity prices has been outlined and published also by ACER in their market monitoring report[7] which states that "in general, the higher the gas dependency and the lower the level of interconnection compared to national demand, the higher is the wholesale price of electricity in a given member state" (ACER, 2021, p. 5).

Table 2 gives an overview of the power generation by source for the years 2020 and 2021 in Germany. Due to the increasing gas prices, gas-fired electricity production dropped by 2% in 2021, while coal-fired generation increased by 6%. Increasing coal-fired electricity production partly also replaced the lower wind electricity production during 2021 (–3% compared to 2020).

	Coal	Natural gas	Nuclear	Wind on-shore	Wind off-shore	Solar	Bio-mass	Hydro	Others
2020	24%	12%	12%	21%	5%	9%	8%	5%	2%
2021	30%	10%	13%	18%	5%	9%	8%	5%	3%

Table 2: Overview power generation by source in Germany for 2020 and 2021[8]

[6] *Phelix – reference price for power: The Physical Electricity Index (Phelix) refers to the base load (Phelix Base) and peak load (Phelix Peak) price index published daily on the power spot market for the German/Austrian market area. The Phelix is established by EPEX SPOT and constitutes the underlying asset for the EEX Phelix Future. For further information please see: https://www.eex.com/en/*

[7] *https://extranet.acer.europa.eu/Official_documents/Acts_of_the_Agency/Publication/ACER's%20Preliminary%20Assessment%20of%20Europe's%20high%20energy%20prices%20and%20the%20current%20wholesale%20electricity%20market%20design.pdf*

[8] *Source: https://transparency.entsoe.eu/*

HOW DO HIGH ENERGY PRICES IMPACT TSOs?

Obviously, rising energy prices impact all sectors and households. For TSOs such as Amprion, high energy prices imply several effects.

HIGH INCREASES IN ENERGY PRICES ALSO IMPACT TSOS – ALTHOUGH EUROPEAN MARKET INTEGRATION PARTLY REDUCES THE NEGATIVE IMPACTS

While the price levels concern the TSOs' costs, in particular for the procurement of transmission losses and balancing as well as for redispatching, ensuring the optimal functioning of the European electricity markets is at the heart of the TSOs' activities. The effective functioning of the market is essential for TSOs. An interconnected, integrated and reliable European electricity market ensures the use of the most efficient resources and is key to safeguarding the security of supply at the lowest cost for consumers. It should be emphasised that the advanced level of market integration has mitigated the negative effects and that an undistorted wholesale price formation is key to the functioning of the internal energy market and to the security of supply.

EXCURSUS: PRICES IN THE BALANCING ENERGY MARKET

HIGH PRICE LEVELS HAVE BEEN OBSERVED ALSO ON THE BALANCING CAPACITY MARKET

In 2021, high prices notably occurred in the German balancing capacity market. The costs for the procurement of balancing capacity in Germany attributable to Amprion amounted to €210.4 million – the second-highest annual total since 2012 (see Figure 4).

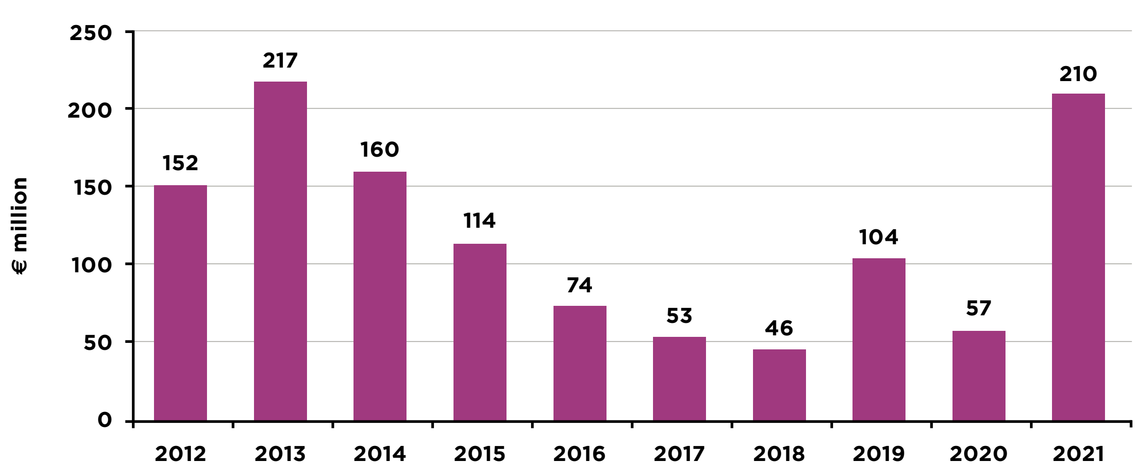


Figure 4: Historical and planned annual Amprion costs for the procurement of balancing capacity (2012 to 2021)

The following Figure 5 shows the daily average balancing capacity prices per procured frequency restoration reserves (FRR) product separated by reserve type and by direction. Across all products, significant price spikes, especially in May and October, reached levels of 1,683.34 (€/MW)/h on 13 October 2021 for positive aFRR and 2,437.50 (€/MW)/h on 15 April 2021 for positive mFRR.

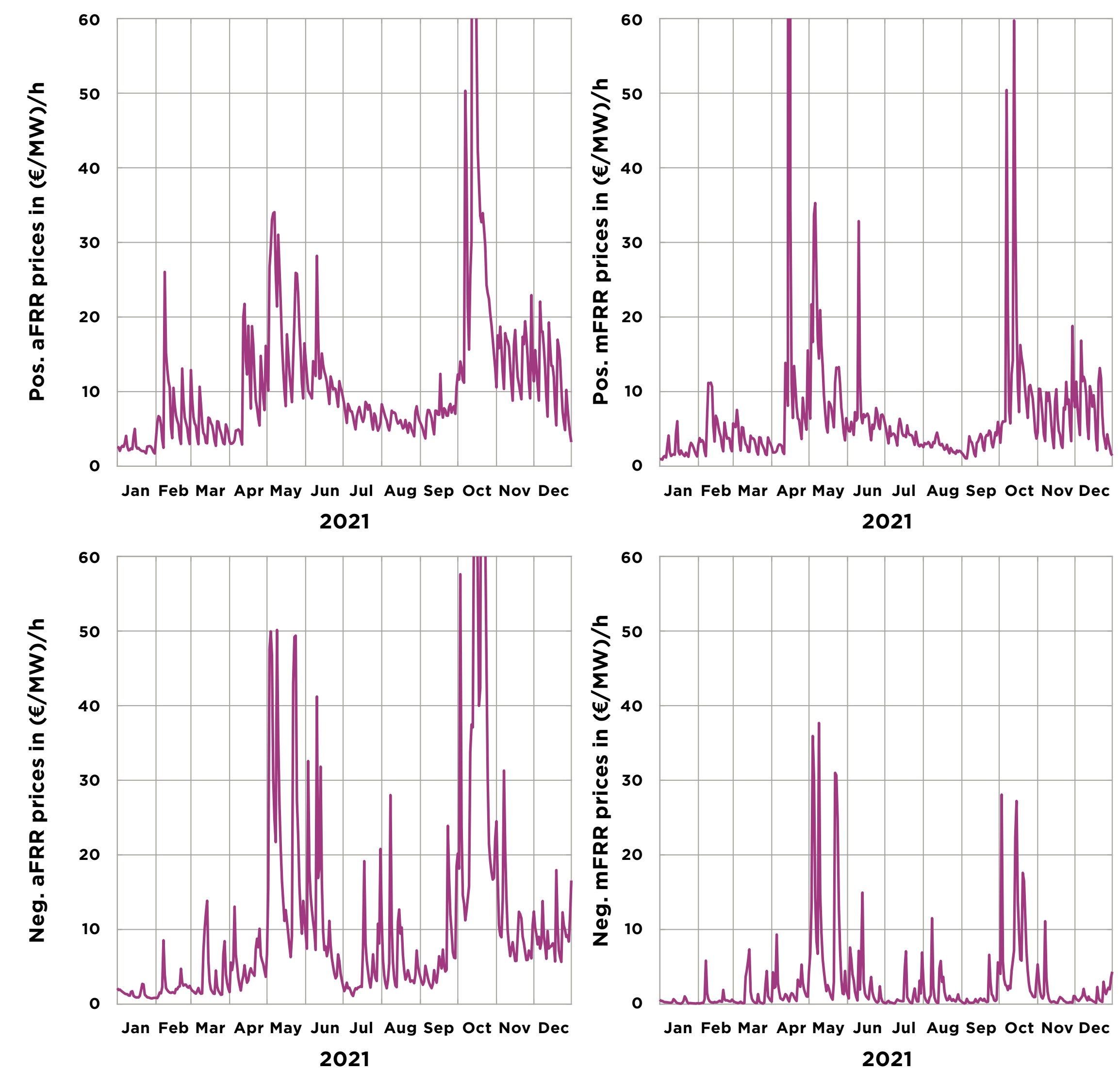


Figure 5: Daily average balancing capacity prices per procured FRR product 2021

Analyses of Amprion, together with the other German TSOs, have identified that there are several underlying reasons for the observed price increases. One reason was the decreased availability of pumped storage power plants (PSPPs) occurring during 2021 which significantly impacted the balancing capacity market outcomes. PSPPs typically provide the most competitive offers in the aFRR market. During their non-availability times, PSPPs had to be replaced by other technologies with significantly higher underlying costs resulting in higher prices. Furthermore, competition in the German balancing capacity market appears to be low in more general terms: in 2021, more than 50 auctions could not clear without the help of the largest supplier. This is supported by the indicators concerning conditions of the German FRR market in the 2021 market power report on the electricity generation sector[9] published by the German Federal Cartel Office. It concludes a high market concentration, especially for positive aFRR (35 to 40% market share of largest supplier) and a strong dependency on the availability of PSPPs of the market.

In order to enhance the competition in the FRR markets, Amprion, together with the other German TSOs and the Austrian TSO, is striving to increase the quantities for the exchange of balancing capacity between Germany and Austria. Mid- and long-term market design adaptations are being investigated to foster competition. In all these initiatives, and in order to monitor market developments, German TSOs are in continuous exchange with the responsible national and European authorities.

[9] https://www.bundeskartellamt.de/SharedDocs/Publikation/DE/Berichte/Marktmachtbericht_2021.pdf;jsessionid=AA9A-58DE4188169D2FB1DDCFD9B6DC07.2_cid378?__blob=publicationFile&v=3

2. MARKET ANALYSIS 2021

PRICE CONVERGENCE IN CWE REMAINED AT THE PREVIOUS YEAR'S LEVEL DESPITE HIGH PRICE SPREADS IN Q4 2021. HIGH IMPORT AND EXPORT FLOWS RESULT IN A HIGHER UTILISATION OF THE EUROPEAN TRANSMISSION GRID. IN 2021, HIGHER EXCHANGES LED TO MORE COMPLEX GRID SITUATIONS. THEREFORE, GRID EXPANSION CONTINUES TO BE A TOP PRIORITY.

This chapter seeks to analyse and explain our main observations and the key trends in the electricity wholesale market in 2021. Beside the indication of increased exports and imports in 2021, insights into the ongoing market integration are given. One of the main advantages of the coupling of markets is the reduction of price differences. Although 2021 has been characterised by a situation of significantly higher energy prices, still in around 51% of the hours in 2021 full price convergence in CWE was reached. The convergence rate is even higher than 2020 when considering only Q1 to Q3. High imports and exports led to a higher utilisation of the transmission grid and more complex grid situations with a high number of market-limiting grid elements. Grid expansion remains a top priority and has to be need-oriented – as our analysis of trade-limiting grid elements in the context of the EU 70% transmission capacity target shows.

EXPORTS AND IMPORTS IN CWE

Since the commissioning of the first interconnection between the German and Belgian transmission grid in 2020, Amprion is now interconnected with every adjacent bidding zone in CWE. Electricity exports and imports to and from these bidding zones are represented by their day-ahead net positions. These net positions are the difference between all flows out of a particular bidding zone (exports) or into a particular bidding zone (imports). A positive net position indicates a (net) exporting bidding zone, while a negative net position shows a (net) importing bidding zone. In compliance with the day-ahead electricity wholesale market, net positions are represented for the day before the actual production and consumption takes place (day-ahead). Figure 6 illustrates the moving weekly average of CWE net positions in 2021. The net position of the German/Luxembourgian (DE-LU) bidding zone has been high during winter months and low during summer months. This is because bidding zones with a high share of wind power generation like Germany tend to export during winter due to weather-related generation. In terms of their availability over the year, solar and wind power usually complement each other. The peak power generation of solar is seen in summer, while wind power generation is higher during winter. Due to the higher full load hours, and more production during the night time and base load hours, wind power generation has a higher impact on imports and exports than solar. The French bidding zone, with predominantly nuclear-based electricity production and major exports in summer and imports in winter, counterbalances the German net positions. However, this is always dependent on the respective availability of the nuclear power plants as well as on the wind generation in the respective year.

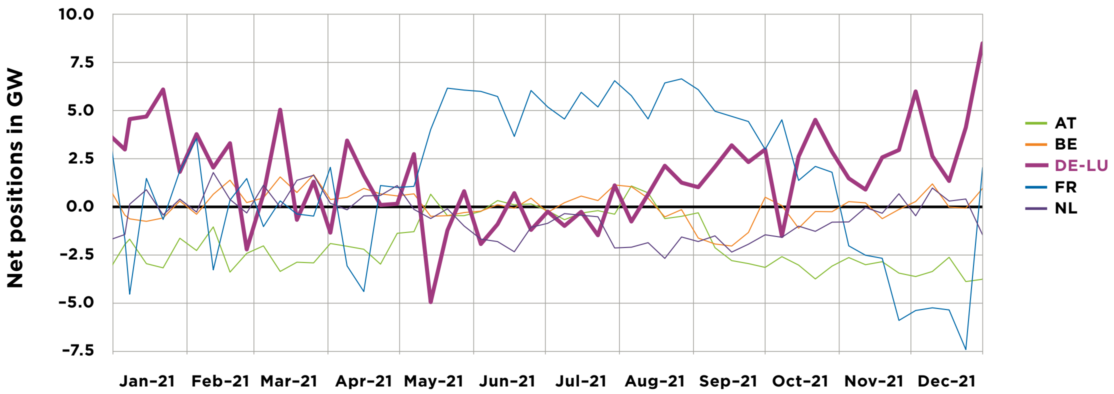


Figure 6: Comparison of day-ahead net positions in CWE in 2021[10]

HIGH IMPORT AND EXPORT FLOWS LED TO A HIGHER UTILISATION OF THE EUROPEAN TRANSMISSION GRID

In overall terms and in comparison to 2020, both the day-ahead electricity imports and exports of Germany increased in 2021 to a total of around 60 TWh exported and 36 TWh imported. However, as Figure 7 shows, the German/Luxembourgian net position remained on a constant level of around 24 TWh. Important indicators are also the maximum day-ahead exports and imports as presented in Table 3, which shows a significant increase for the German/ Luxembourgian bidding zone compared to 2020. The maximum export in 2021 amounts to 18.4 GW.

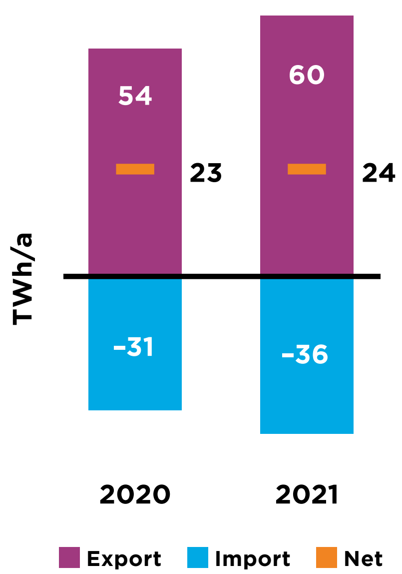


Figure 7: Yearly day-ahead exports and imports of the German/Luxembourgian bidding zone for 2020 and 2021[11]

[10] Source: https://transparency.entsoe.eu/
[11] Source: https://transparency.entsoe.eu/

AMPRION MARKET REPORT 2022

Year	Maximum day-ahead export of DE-LU	Maximum day-ahead import of DE-LU
2020	16.7 GW	–12.6 GW
2021	18.4 GW (+10% compared to 2020)	–14.4 GW (+14% compared to 2020)

Table 3: Maximum day-ahead exports and imports of the German-Luxembourgian bidding zone in 2020 and 2021[12]

RENEWABLE POWER GENERATION IN GERMANY

The German net position depends, to a large extent, on the variable wind and solar generation. In 2021, the share of electricity generated from renewable energies has slightly decreased (43% in 2021) in comparison to 2020 (49%). This can be explained by the reduced wind generation (–16 TWh compared to 2020) and by the increased consumption following the recovery from the Covid-19 pandemic crisis.

The fluctuating pattern of renewable energies remains a major challenge for system and market operation. Their availability varies significantly across daytime, season and general weather conditions. Figure 8 illustrates this by comparing the generation pattern for the day with the highest share of fluctuating (i.e. wind and solar)[13] hourly renewable energy production in 2021 amounting to 72% of net electricity generation on 29 July 2021 at 11 a.m., to the day with the lowest hourly fluctuating renewable energy production (1% of net electricity generation on 26 June at 2 a.m.). Considering also non-fluctuating[14] renewable energy sources, their share of hourly net electricity generation[15] reached its maximum of 80% on 29 July at 11 a.m. and a minimum of only 21% on 26 June.

Although the renewable energies contribute significantly to the electricity generation in Germany, situations with comparably low wind and solar power generation can occur not only for single hours but for days and even weeks at a time.

In total, during 856 hours in 2021 the share of fluctuating renewable energies was below 10% of the current generation (in comparison there were only 769 hours with a share below 10% in 2020) and 30 hours above 70% (in 2020 this was the case during 53 hours).

[12] *Source: https://transparency.entsoe.eu/*
[13] *Fluctuating renewables are wind (onshore and offshore) and solar.*
[14] *Non-fluctuating renewables are biomass, hydrogen and other renewables.*
[15] *These values refer to aggregated electricity generation of all renewable energy sources including wind, solar, biomass, hydro and other renewables.*

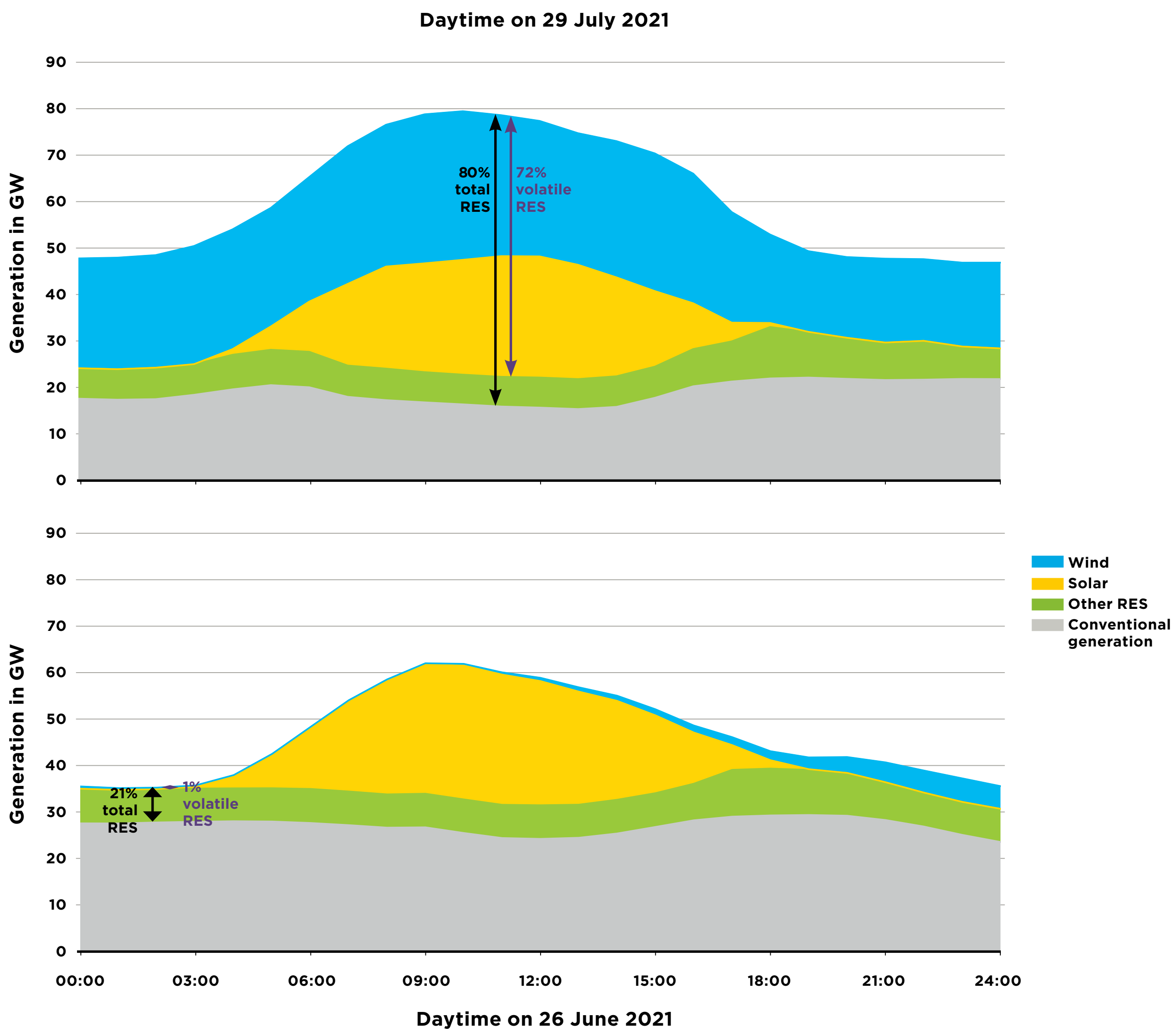


Figure 8: Days with the highest and lowest renewable power generation in Germany in 2021[16]

The fluctuating pattern of renewables observed during the last years shows the need for appropriate flexible generation capacities which must be available during times with low renewables infeed. Aspects of system stability must be consistently taken into account in system design.

[16] *Source: https://transparency.entsoe.eu/*

AMPRION MARKET REPORT 2022

FOCUS ON PRICE CONVERGENCE AND MARKET-LIMITING GRID CONSTRAINTS

IN 2021, PRICE CONVERGENCE IN CWE REMAINED AT A HIGH LEVEL – ALTHOUGH HIGH PRICE DIFFERENCES OCCURRED IN Q4 2021

The reduction of price differences and increasing price convergence[17] within a region is one of the main targets of market coupling. Sufficient cross-zonal transmission capacities are a crucial prerequisite for achieving this target.

The high level of price convergence in CWE – even in times of exceptional fuel market developments during 2021 – provides evidence for the large extent of transmission capacities provided to the market. Without market integration in place, energy price differences would have been even higher.

As shown in the previous chapter, both maximum electricity import and export of the German/Luxembourgian bidding zone have increased while the net positions[18] remained similar to 2020. The overall traded day-ahead volume of electricity in Germany went up to around 96 TWh in 2021, which means an increase of 12 TWh.

In the case of sufficient cross-zonal exchange capacities, prices between CWE bidding zones converge. In the opposite case, if commercial exchanges are limited by transmission constraints, prices between CWE bidding zones diverge. The price convergence rate is therefore an indicator for the level of market integration in the CWE region.

In around 51% of the hours in 2021, prices have been fully converging in the CWE region (+/– €1/MWh[19]). This observation follows a general trend of increasing price convergence over the last years. It is only in comparison to 2020 (52%) that price convergence has slightly decreased by about 1%. This decrease is caused mainly by the exceptional developments in fuel markets explained in Chapter 1. The significant increase of oil, coal and gas prices especially in Q4 of 2021 has led to an unprecedented situation in the European electricity markets. In order to illustrate this exceptional situation in Q4 of 2021 further, Figure 9 represents the price convergence rates per quarter in 2021 and in comparison to the total year of 2020. While price convergence has been above the 2020 total average during Q1 to Q3 of 2021, it significantly decreased in Q4 of 2021 to only 32% of full price convergent hours. As shown in Figure 9, the reduced price convergence in the last quarter of 2021 is accompanied by an increase in the average price spread between CWE bidding zones.

[17] *Full price convergence is reached if prices are equal across all bidding zones of a region.*
[18] *Net position = exports – imports*
[19] *Note: Same definition as ACER: Full price convergence: <€1/MWh difference (see: https://extranet.acer.europa.eu//Official_documents/Acts_of_the_Agency/Publication/ACER%20Market%20Monitoring%20Report%202020%20%E2%80%93%20Electricity%20Wholesale%20Market%20Volume.pdf)*

There was a reduction in price convergence in Q4 2021 due to the significant increase of fuel prices by the end of the year.

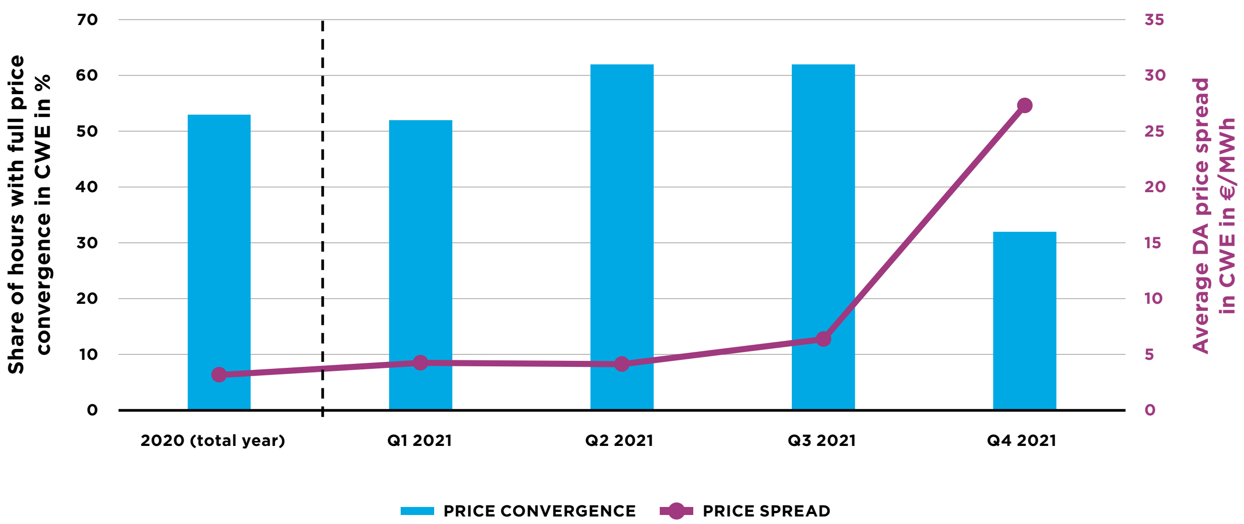


Figure 9: Price convergence and average price spread in CWE in 2021 by quarter compared to 2020[20]

The overall price convergence indicated for 2021 was 51% and therefore differs from the 48.8% in Figure 10. The reason for this difference is that price convergence is defined as the share of hours with a maximum price difference of +/–€1/MWh between bidding zones. While in 48.8% of the hours the market was limited by grid constraints – yet, leading to market differences in the range of +/–€1/MWh. During the time of price divergence, grid constraints limited the full exchange between CWE bidding zones.

Transmission capacity has been constraining these exchanges and prices could therefore not be equalised across the CWE region.

High imports and exports led to a higher utilisation of the transmission grid and more complex grid situations with a high number of market-limiting grid elements occurring at the same time.

Figure 10 illustrates the different market situations further. In 48.8% of the time, there was no limitation of trade and full price convergence in CWE. For the rest of the time, the following reasons caused a limitation of trading impeding full price convergence in 2021:

- During 9.2% of the time (corresponding to approx. 800 hours) the capacity of interconnectors between bidding zones in CWE was insufficient to accommodate unlimited electricity exchanges.

[20] *Source: https://transparency.entsoe.eu/*

- During 37.3% of the time (corresponding to approx. 3,300 hours), both interconnectors and internal network elements constrained exchanges. In comparison to 2020, such situations have increased significantly, amongst other reasons through modifications (such as the introduction of Flow Based Plain as well as the extended inclusion of long-term allocated capacities) in the market coupling process[21].
- Internal network elements solely have been constraining CWE market exchanges during 4.7% of the time (corresponding to approx. 400 hours), with a 0.5% Amprion share and other TSOs' internal network elements constraining during 4.2% of the time.

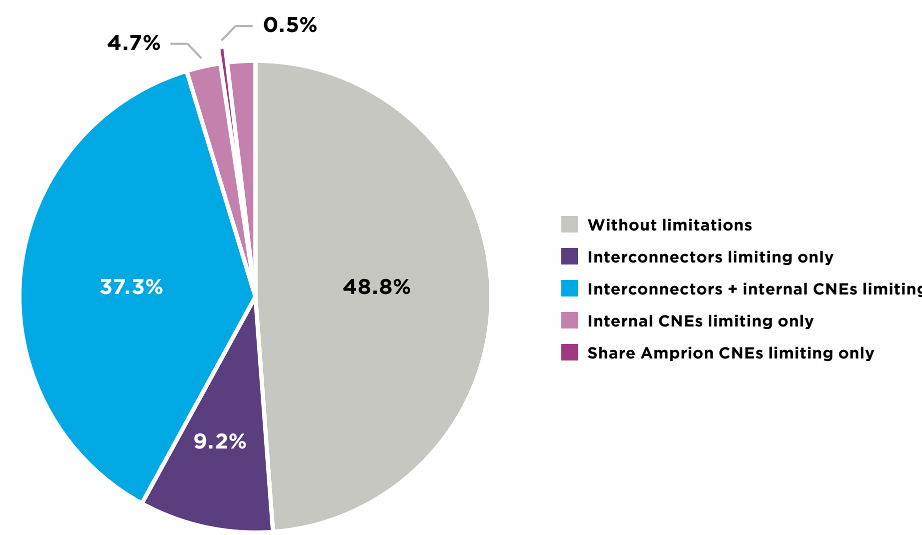


Figure 10: Share of active constraints in the CWE domain per TSO control area and cross-zonal elements in 2020[22,23]

The analysis gives rise to the questions of whether transmission capacities are insufficient to accommodate an appropriate level of electricity exchange, where constraining network elements are located and how their transmission capacity can be increased to appropriate levels in future.

[21] *Please note that recently some fundamental modifications in market coupling were implemented, for example the introduction of Flow-Based Plain as well as the extended inclusion of long-term allocated capacities. More information on these changes can be found here: https://www.jao.eu/sites/default/files/2021-05/CWE%20FB%20plain%20Explanatory%20Material_v1.0.pdf and here: https://www.jao.eu/sites/default/files/2021-05/CWE%20FBMC%20AP%20Annex%2014.30%20Pedagogical%20information%20on%20Extended%20LTA%20formulation%20v20200710.pdf. With regards to the future, please also be aware that the "switch" from CWE to Core will also result in several changes in the applied capacity calculation method and the resulting flow-based market coupling.*

[22] *Please note that allocation constraints are not considered.*

[23] *The general information about the critical branches can also be downloaded via the Utility tool available via JAO, see https://utilitytool.jao.eu/*

APPROPRIATE LEVEL OF TRANSMISSION CAPACITIES AND THE EU 70% TRANSMISSION CAPACITY TARGET

Providing a sufficient and appropriate level of transmission capacity for European electricity trading is an essential goal of joint European energy policy. Amprion shares and fully supports this target of further market integration. European legislation[24] defines firm minimum targets of transmission capacity which have to be made available for cross-zonal electricity trading. The level of these general target values may require some further analytical assessment. When evaluating these required transmission capacities and the related margin available for cross-zonal trade, it is important to analyse if this offered capacity to the market is actually utilised or not. As illustrated in Figure 10, during 48.8% of the time transmission capacities in CWE were sufficient to completely accommodate all exchanges requested by the market. Further capacity increases during these times would not have had any positive impact. Additional transmission capacity will only increase welfare in times of diverging prices where the market requires further exchanges between bidding zones. Yet, extending capacity (via so-called virtual capacities) in order to meet these market requirements imposes costs which would also have to be considered.

Amprion shares and fully supports the target of further market integration. Yet, the provision of significant amounts of virtual trading capacity would not necessarily create economic welfare gains, as redispatch costs have to be considered appropriately.

GEOGRAPHICAL LOCATION OF LIMITING AMPRION ELEMENTS

Our control area is located in the heart of Europe and we are interconnected with every adjacent bidding zone in CWE. This particular role in Germany and CWE requires our strong commitment to CWE/Core and the overall European electricity market. Therefore, our strategy for the optimal operation and extension of the grid has a high relevance on the whole electricity market. As stated already, simply increasing transmission capacity during every hour everywhere in the grid will not automatically increase the overall welfare. It needs to be focused on those parts of the grid that will create the highest added value to both market and the grid.

Against this background, Figure 11 illustrates the top 10 of Amprion's critical network elements with the lowest capacity offered to trading (pink) as well as the top 10 of Amprion's network elements that most often limited trade in 2021 (blue). Grid enhancement, in particular, should be done in areas where trading limitations occur (i.e. blue). Here, obviously more trading is requested by the market and could be realised by grid extension. To significantly improve the current grid situation, Amprion foresees to implement several grid reinforcement measures (see example on page 29). On the contrary, the grid elements with the lowest capacity offered to trading (pink) are not always the best indicator for grid development. Lower trading margins might be acceptable here – in case the market does not request more trade possibilities. In order to provide incentives for an efficient grid expansion, both the offered and actually used capacity have to be evaluated together. Consequently, network elements that stand out in both categories are an indicator that their expansion will most likely result in welfare gains.

[24] *Article 16 of Regulation (EU) 2019/943 on the internal market for electricity*

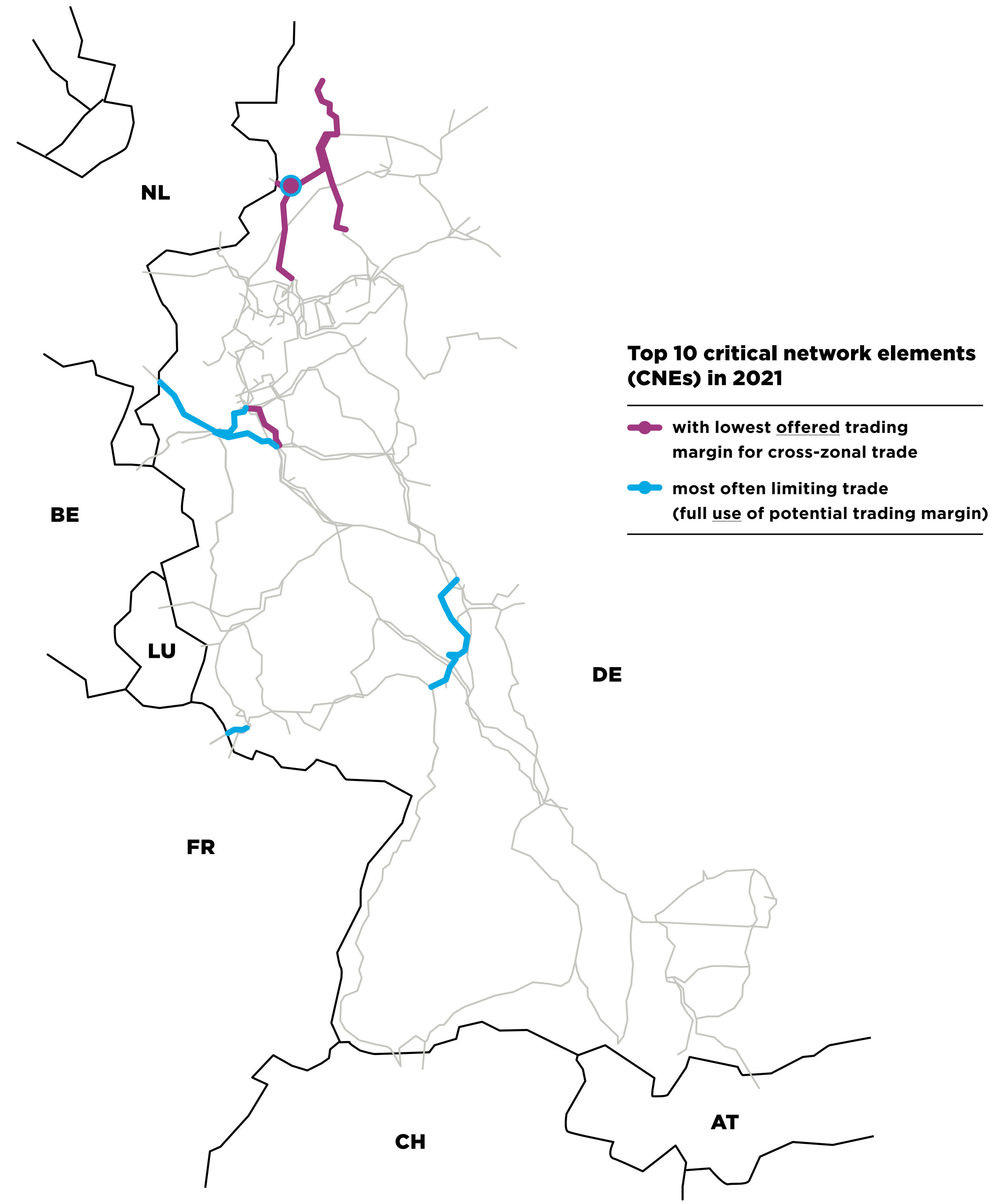


Figure 11: Location of major (top 10) active critical branches in Flow-Based Market Coupling of Amprion as well as the ones with the lowest offered trading margin in 2021

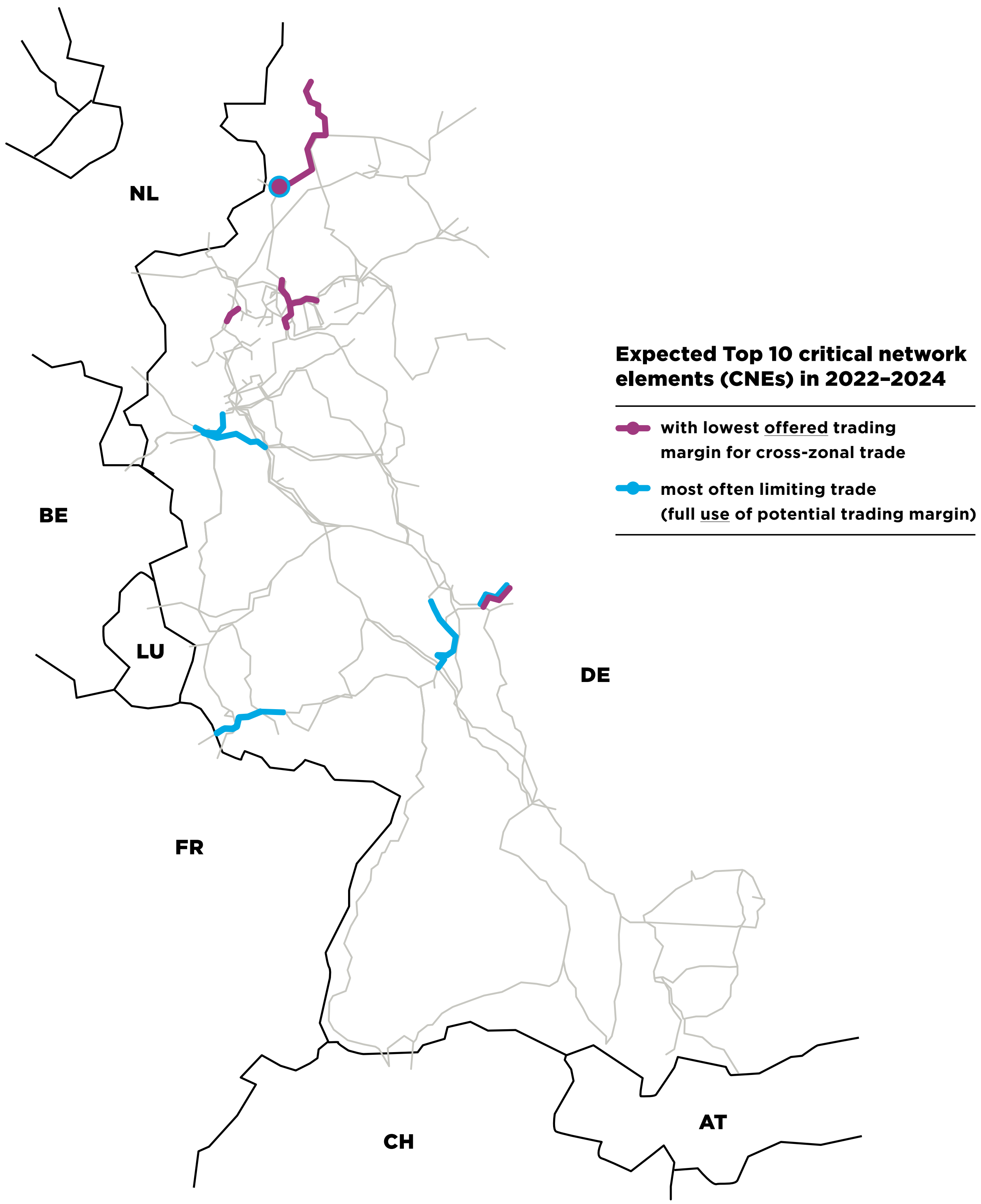


Figure 12: Location of major (top 10) active critical branches in Flow-Based Market Coupling of Amprion as well as the ones with the lowest offered trading margin in 2022–2024[25]

[25] Based on simulation results

In addition to the location of critical elements analysed in 2021, we have also taken a look at the expected future critical network elements in 2022-2024. Based on simulation results Figure 12 shows the geographical location of the future critical network elements with the lowest offered trading margin (pink) and the elements that probably will most often limit trade (blue). Even if there are some shifts in the related network elements, the general regions where these elements are located are similar to the monitored results in the previous figure. Slight shifts of some elements can for example be attributed to the underlying flow-based market simulation related to the Core instead of the CWE region.

Grid expansion remains a top priority and has to be need-oriented – as the analysis of trade-limiting grid elements in the context of the EU 70% transmission capacity target shows.

To provide an example of such need-oriented grid expansion, we would like to focus on the area around the phase shifter Gronau, indicated by the big dot located in the north of Amprion's control zone in the Figures 11 and 12. This area has been identified as one of the top 10 grid elements most often limiting trading in 2021 (and likely in 2022–2024).
To significantly improve the current grid situation, it is foreseen to implement several grid reinforcement measures. In detail, this means an increase in transmission capacity through the use of high temperature low sag conductors (HTLS) and the construction of two new 380 kV lines. This will involve an upgrade from 220 kV to 380 kV, whereby the existing phase-shifting transformer in Gronau will be replaced by two new 380 kV transformers.

While the objective of achieving climate neutrality in Europe by 2050 was already increasing the pressure on accelerated grid development, the war in Ukraine and the dependence on fossil fuels further intensified the pressure to accelerate the transformation of the energy system, with even more ambitious targets for the deployment of renewables and energy efficiency. In the context of the recent developments, grid development has become a moving target. Therefore, Amprion (together with other German TSOs) continuously updates its national grid development plan to be sure that the grid is made fit for future challenges and developments.

AMPRION IS HIGHLY COMMITTED TO FURTHER INCREASING MARKET INTEGRATION AND TO ENHANCE ITS GRID TO MAKE IT FIT FOR THE FUTURE DEVELOPMENTS

[42] Report on the result of monitoring the margin available for cross-zonal electricity trade in the EU in the first semester of 2020

[43] E.g. focus only on the day-ahead timeframe without consideration of long-term, intraday and balancing capacity; no full consideration of electricity exchanges with non-EU countries; exclusive focus only on some particularly low-margin network elements

[44] Reaching full price convergence [i.e. 100% of all hours] is not an objective as such, because it would require overinvestment in network infrastructures', ACER Market Monitoring Report 2020 on page 23

3. GRID OPERATION ANALYSIS 2021

SIGNIFICANT INCREASE OF REDISPATCH VOLUMES AND COSTS, IN PARTICULAR AT THE END OF 2021.

In Chapter 2, the impact of transmission capacities on the electricity market has been analysed and described. The actual availability of these transmission capacities has to be ensured in real-time grid operation, which is discussed in Chapter 3. The overloading of grid elements and critical voltage situations have to be avoided by applying remedial actions, i.e. changing the grid topology and taking redispatch measures.

REDISPATCH

The generation of electricity at particular locations in the grid causes electrical load flows. In the event that such load flows exceed the technical limitations on particular network elements, the power generation pattern has to be changed. This process is called redispatch, where TSOs must reduce power generation at dedicated locations in the grid in order to alleviate the power flow on constrained network elements[26].

The two main driving forces of the German redispatch are usually wind infeed and the load as well as the supply situation in the south of Germany, with significant power flows into this southern area.

AT THE END OF 2021, REDISPATCH VOLUMES AND COSTS IN GERMANY INCREASED SIGNIFICANTLY COMPARED TO 2020 VALUES

Redispatch volumes and corresponding costs are usually higher in the winter months, influenced in particular by high wind generation, simultaneously high demand and transits to southern Germany and other European countries, which leads to high load flows and congestions. In 2021, however, some additional developments led to further increasing redispatch costs.

As already mentioned at the beginning of the report, those developments included rising commodity prices and increasing fuel costs for redispatching power plants. Low water levels in rivers (in particular the Rhine) increased coal transport difficulties to power stations. Redispatching coal-fired power plants was therefore partly impossible and less effective power plants from abroad often had to be contracted. Another aspect leading to an interim increase of redispatch volumes is the necessity for interim changes in the grid in order to realise new projects or reconstruction measures. Such corresponding short-term releases of grid elements lead to situations in which additional redispatch is required.

[26] In order to keep electricity generation and demand in balance, power generation has to be increased in other less constrained areas.

Figure 13 illustrates the monthly redispatch volumes and costs for Germany with a focus on the Amprion share for the year 2021. For the whole of Germany as well as for Amprion, from October 2021 onwards redispatch volumes and costs have increased significantly.

For the Amprion grid operation, congestions on the northern transmission lines (e.g. Emsland transmission lines, which are very sensitive to wind power generation in northern Germany as shown in Chapter 2) play a significant role.

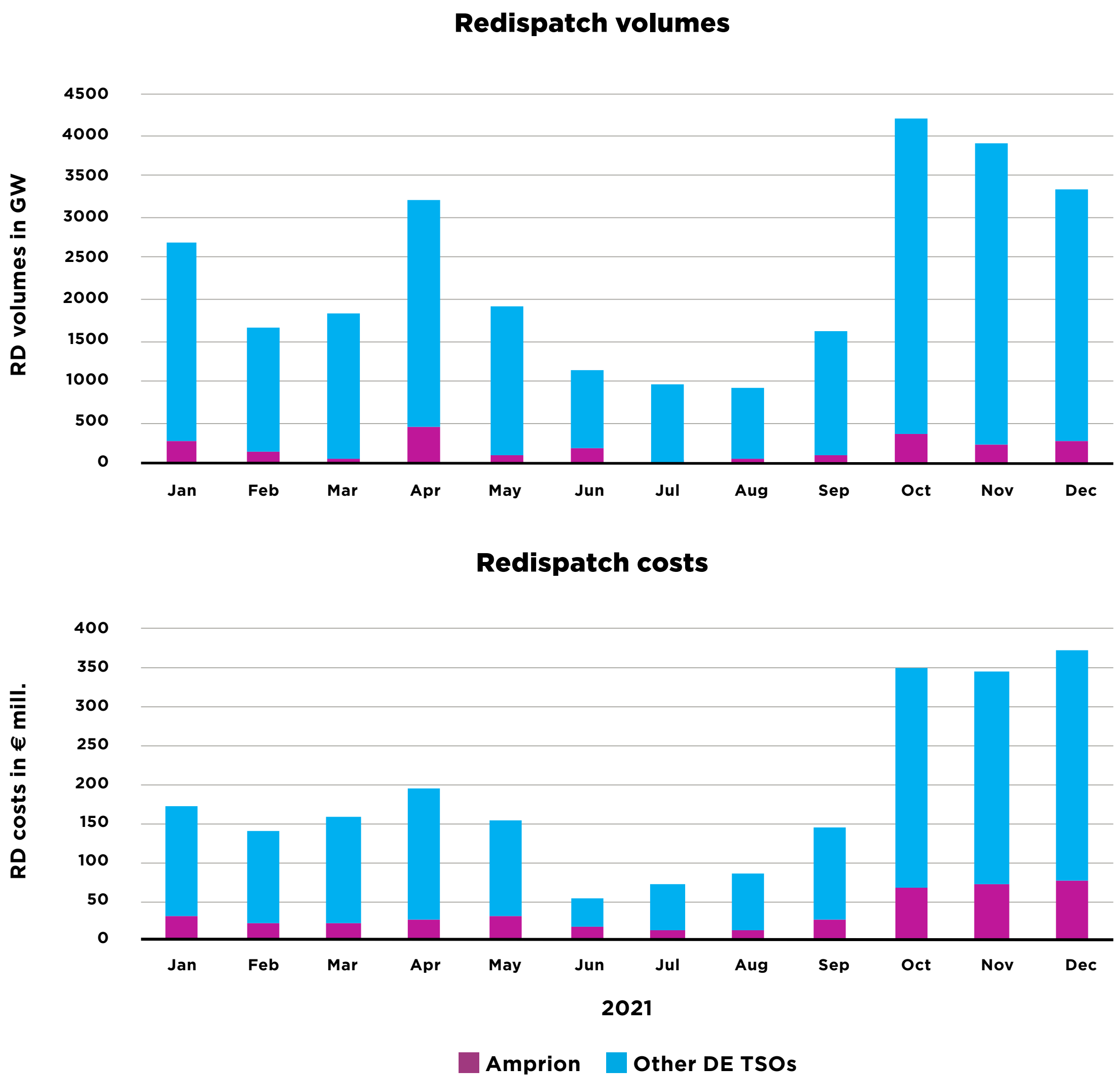


Figure 13: Total monthly redispatch volumes and costs[27] for Germany (including RES curtailment)[28]

[27] *Volumes are presented according to the instructing principle (i.e. in which control area power plants have been started in order to cure redispatch. Amprion does not instruct RES curtailment and this data is therefore missing in the volumes for Amprion). Costs are presented according to the requester principle (i.e. what costs did incur in order to cure the requested redispatch).*

[28] *Disclaimer: The data shown in the graph may differ from redispatch figures published elsewhere (e.g. EMFIP report), as other sources sometimes contain assumptions for additional costs for recent changes in remuneration of remedial actions with larger power plants that have not yet been invoiced. The graph published here contains only the additional costs actually invoiced for remedial actions with larger power plants. The costs of RES curtailment also include assumptions in case of invoice delay.*

AMPRION MARKET REPORT 2022

EXCURSUS: SYSTEM SPLITS

In 2021, two system splits occurred in the continental European power system. Although the splits were cleared quickly without major impact on customers, they have shown the crucial importance of system security for security of supply in Europe.

SYSTEM SEPARATION OF BALKAN PENINSULA ON 8 JANUARY 2021

On Friday, 8 January 2021, at around 14.05 CET, a system separation occurred in the continental European power system. Due to a cascaded release of several transmission lines in the Balkans, the synchronous area was separated into two areas, which can be seen as the north-western and south-eastern grid areas in Figure 14.

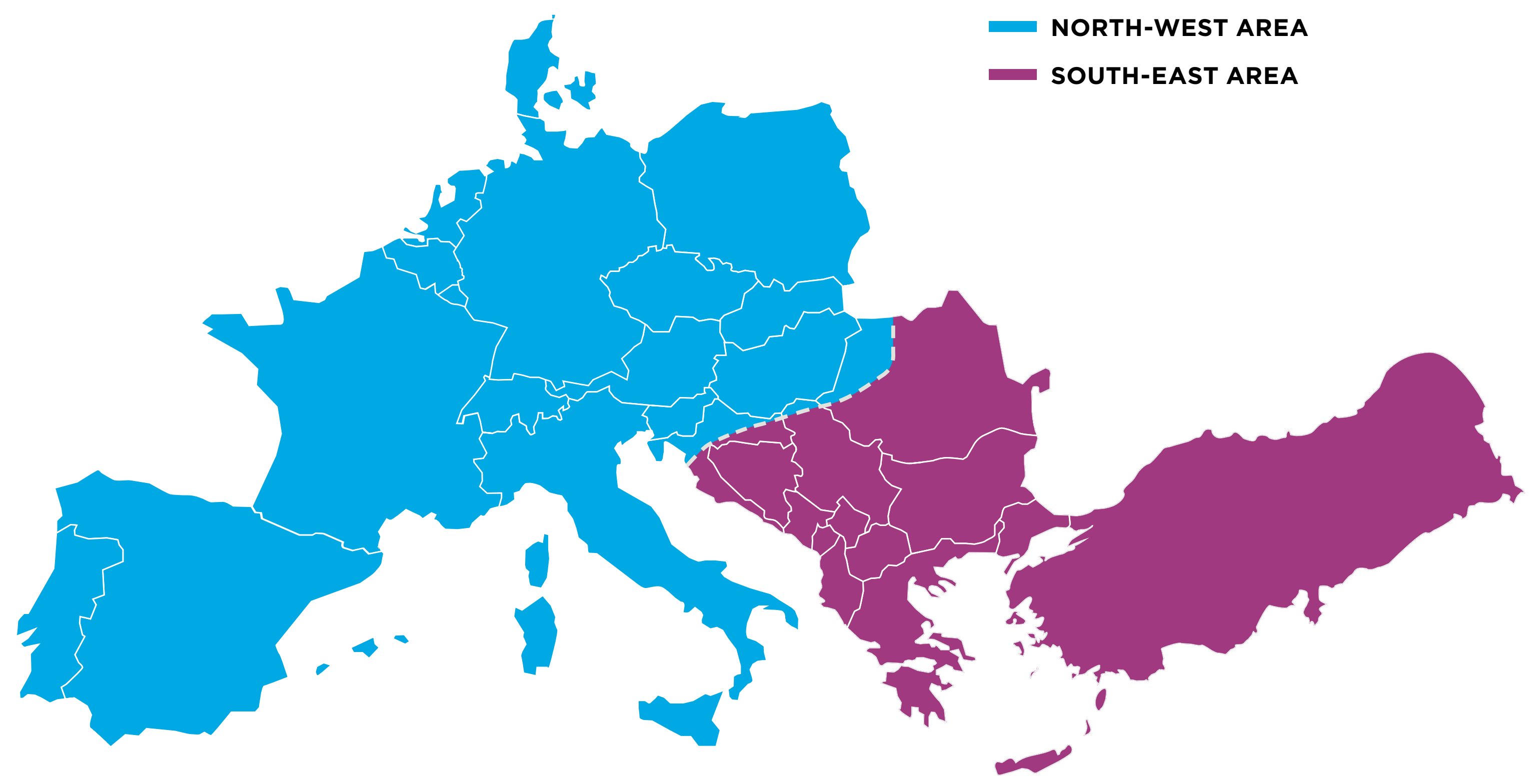


Figure 14: Resulting two synchronous areas after the system split[29]

[29] *https://eepublicdownloads.azureedge.net/clean-documents/SOC%20documents/SOC%20Reports/Continental%20Europe%20Synchronous%20Area%20Separation%20on%2008%20January%202021%20-%20Main%20Report_updated.pdf*

Immediately before the incident, the continental European power system had a high power flow of about 5.8 GW from the south-eastern area towards the north-western area. This high power flow also led to a high power flow through the Croatian substation Ernestinovo, which caused a busbar coupler to trip due to it being overloaded. This interrupted the power flow from the south-east to the north-west direction in the substation, which was then shifted to surrounding lines. This finally caused the separation of the system.
Due to the system separation and the interruption of the power flow, the frequency in the north-western area dropped to 49.74 Hz at its minimum, while it peaked at 50.6 Hz in the south-eastern area. Immediately after the incident, automatic and manual measures were conceptually activated, which stabilised both areas. The disconnection of a few consumer loads was only needed in Romania. Thus, the continental European power system could be resynchronised after just over an hour at 15.08 CET. As the responsible Synchronous Area Monitor for continental Europe, Amprion coordinated the common approach of the European TSOs. Amprion also played a key role in the follow-up processing of the incident, the technical analysis[30] and the derivation of measures to prevent similar incidents in the future.

SYSTEM SEPARATION OF IBERIAN PENINSULA ON 24 JULY 2021

On Saturday, 24 July, at around 16.36 CET, another system separation occurred in the continental European power system. The Iberian Peninsula was separated from the rest of the continental European power system as shown in Figure 2. Prior to the system separation, severe forest fires in southern France in the immediate vicinity of two cross-border 400 kV transmission lines took place. At that time, about 2.5 GW of power were exported from France to Spain. Due to the forest fires, the two transmission lines in the vicinity of the forest fires tripped in quick succession. These outages then caused overloads on parallel cross-border lines, which also tripped accordingly, ultimately resulting in system separation.

[30] https://www.entsoe.eu/news/2021/01/26/system-separation-in-the-continental-europe-synchronous-area-on-8-january-2021-2nd-update/; reports:
https://eepublicdownloads.azureedge.net/clean-documents/SOC%20documents/SOC%20Reports/Continental_Europe_Synchronous_Area_Separation_on_08_January_2021_-_Executive_Summary_updated.pdf
https://eepublicdownloads.azureedge.net/clean-documents/SOC%20documents/SOC%20Reports/Continental%20Europe%20Synchronous%20Area%20Separation%20on%2008%20January%202021%20-%20Main%20Report_updated.pdf

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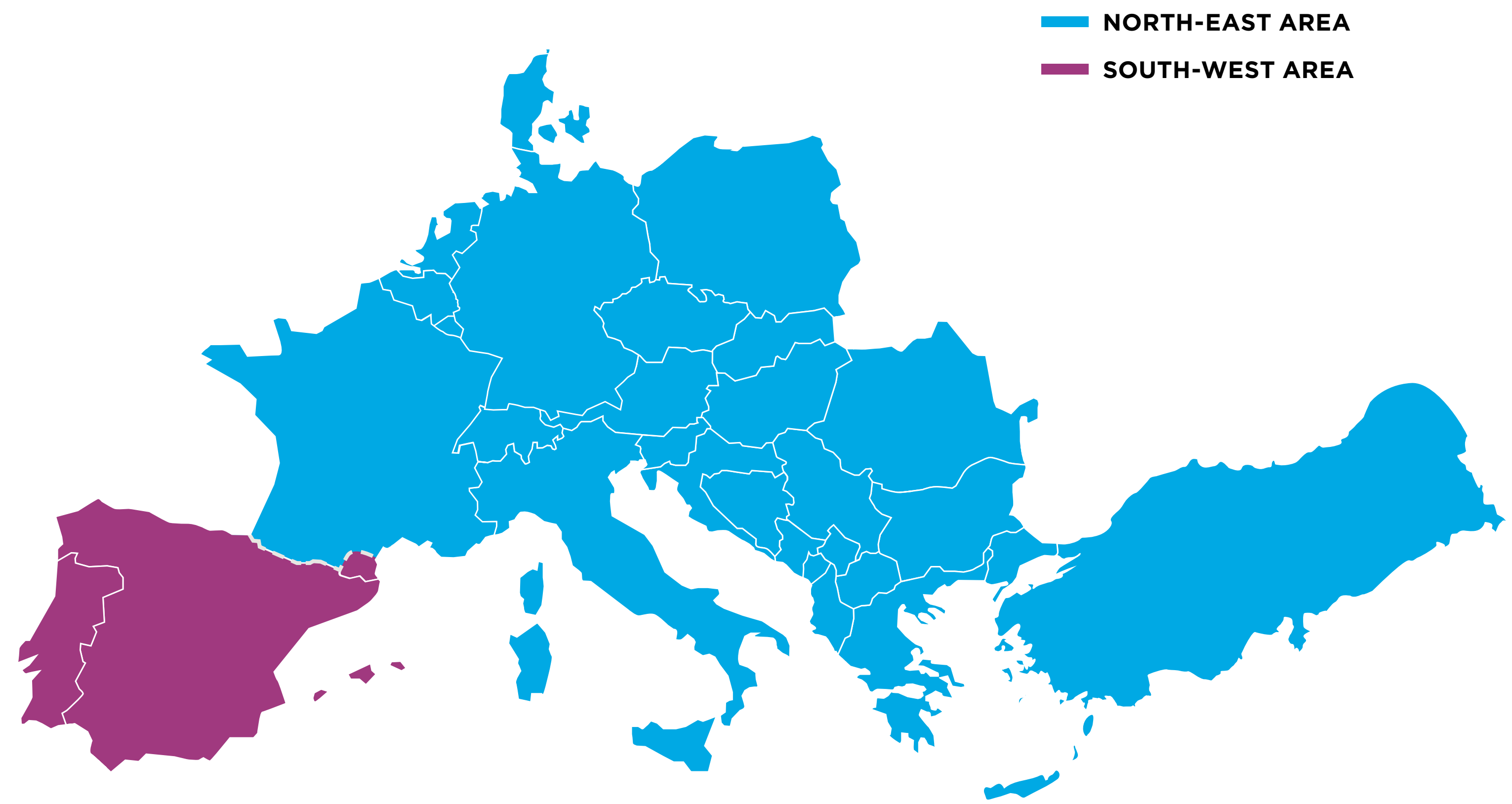


Figure 15: Resulting two synchronous areas after the system split[31]

As a result, the frequency on the Iberian Peninsula dropped to a minimum of 48.68 Hz. To stabilise the south-western grid area, 4.8 GW of loads and 2.3 GW of hydraulic pumps had to be disconnected from the system. Together with further measures, the area was finally stabilised. At 17.09 CET, the Iberian Peninsula was then resynchronised with the continental European interconnected system. In this regard, Amprion again coordinated the common procedure of the European TSOs as the Synchronous Area Monitor.

[31] https://eepublicdownloads.azureedge.net/clean-documents/SOC%20documents/SOC%20Reports/entso-e_CESysSep_210724_211112.pdf

4. FUTURE DEVELOPMENTS

THE MASSIVE INCREASE IN ENERGY PRICES, THE CURRENT POLITICAL SITUATION AND TWO SYSTEM SPLITS IN 2021 STRESS THE IMPORTANCE, MORE THAN EVER, OF A RELIABLE AND RESILIENT ENERGY SYSTEM. SYSTEMIC SOLUTIONS CONSISTING OF ACCELERATED GRID EXPANSION, EUROPEAN MARKET INTEGRATION AND NEW IDEAS SUCH AS AMPRION'S SYSTE(M)ARKET ARE NEEDED.

Further development and improvement of the existing electricity grid is the core business of TSOs, and in particular, an increase in transmission capacity, a reduction in congestions and an enhancement of trading capabilities. However, the market system must also be adapted to the changing framework conditions. New ideas must be brought forth to create a sustainable energy system.

AMPRION HAS A KEY ROLE IN BOTH GRID EXPANSION AND EUROPEAN MARKET INTEGRATION – AND IMPULSES FOR A NEW SYSTE(M)ARKET

CORE DAY-AHEAD FLOW-BASED MARKET COUPLING

TSOs are committed to ensuring that market integration moves forward. In 2022, another key milestone will be reached: the implementation of Flow-Based Market Coupling in the Core capacity calculation region (Core CCR). The Core Flow-Based Market Coupling project aims to develop and implement the daily operation of a Flow-Based day-ahead market coupling across the whole Core CCR in the framework of the single day-ahead coupling (SDAC). The Core CCR consists of the bidding zone borders between the following EU member states' bidding zones: Austria, Belgium, Croatia, the Czech Republic, France, Germany, Hungary, Luxemburg, the Netherlands, Poland, Romania, Slovakia and Slovenia.

Besides the implementation of a flow-based capacity calculation and allocation at all Core borders for the day ahead, the Core TSOs also develop capacity calculation methods for the intraday and long-term time frames. Furthermore, the Core TSOs work on concepts for organising and further enhancing cross-zonal redispatch and sharing of the related costs amongst TSOs. Amprion is confident that the current close cooperation amongst all TSOs and regulatory authorities involved will result in adequate and acceptable solutions for all parties. Amprion is highly committed to realising market integration in the Core CCR and actively contributes to this by developing adequate approaches with TSOs colleagues and discussing these with stakeholders, or for example by providing conveners to lead project groups in Core.

ENHANCED MARKET INTEGRATION IS CORE TO THE ENERGY TRANSITION

The energy transition towards a carbon-free electricity supply is a European challenge that requires the use of the European electricity system to the full extent. Weather-dependent supply and increasing demand response will lead to a different and more intense use of the grid. The Core market integration project is aiming to create operational preconditions to optimise the use of the system from a regional perspective and make the single European market a reality[32].

EUROPEAN RESOURCE ADEQUACY ASSESSMENT

ENTSO-E published the first ERAA (European resource adequacy assessment) report in November 2021. The ERAA is a pan-European monitoring assessment of power system resource adequacy and is the successor of the Midterm Adequacy Forecast (MAF). Due to the scope and complexity, the ERAA report is unique in the world. Furthermore, it is the key tool in terms of the detection of adequacy concerns at a European level and an important element in supporting qualified decisions by policymakers on strategic matters such as the introduction of capacity mechanisms.

The framework for a common European methodology to assess the resource adequacy consistently is set by Regulation (EU) 943/2019 and Regulation (EU) 941/2019, adopted as part of the Clean Energy Package (CEP). Due to the complexity of these methodology requirements and to ensure a consistent implementation, ENTSO-E is striving for a stepwise implementation until 2024. However, the ERAA 2021 already represents a leap forward as compared to its predecessor MAF.

The ERAA 2021 consists of bottom-up scenarios ("National Estimate"), based on TSOs' data considering their latest national energy and climate plans, as well as scenarios that take into account the effect of economic forces impacting capacity in Europe ("EVA"). In the EVA (Economic Viability Assessment) scenarios, the conventional power plant fleets are optimised by an investment model which decides about commissioning and decommissioning based on economic reasons. The EVA in ERAA 2021 has led to an overall reduction in thermal capacity of around 75 GW in Europe compared to the National Estimate scenario for 2025. Meanwhile, the anticipated economic commissioning of 13 GW (which mainly appears in Turkey) is much lower. However, it should be noted that the ERAA cannot predict the future, but rather identifies potential shortages in the system which should be addressed proactively by member states.

The significant decommissioning of thermal capacity in Europe resulting from the EVA leads to an increased resource adequacy risk. While no adequacy risks are identified for Germany and its neighbouring countries in the National Estimates scenario, the LOLE value for Germany (6.8 h/a) exceeds the national reliability standard (5.25 h/a) in the EVA scenario. An additional analysis taking into account capacity mechanisms brings Germany close to its reliability standard (5.3 h/a). It should be noted that the ERAA 2021 report highlights the importance of regional coordination, as adequacy issues in one country are highly dependent on decisions in neighbouring countries. Hence, any capacity investment in one country can have an impact on the resource adequacy situation of its neighbours.

According to the regulation, the ERAA shall be approved or amended by the regulating authority ACER. In February 2022, ACER decided to neither approve nor amend the ERAA 2021 due to deviations from the target methodology stated in the CEP. In this context, it should be noted that the ERAA 2021 is the first edition of a new ENTSO-E product and further improvements following ENTSO-E's intended road map are anticipated. Amprion carries on supporting ENTSO-E in 2022 to further improve the ERAA. Three key improvements are the implementation of flow-based market coupling in the reference scenario, modelling improvements in the EVA and a more accurate modelling of demand-side response. In January 2022, the German Federal Ministry for Economic Affairs and Climate Action and the Luxembourg Regulatory Institute published a new reliability standard of 2.77 h/a for the common market area DE-LU. This new standard will be considered in ERAA 2022 for the first time.

[32] Please see for further information: https://www.jao.eu/core-fb-mc

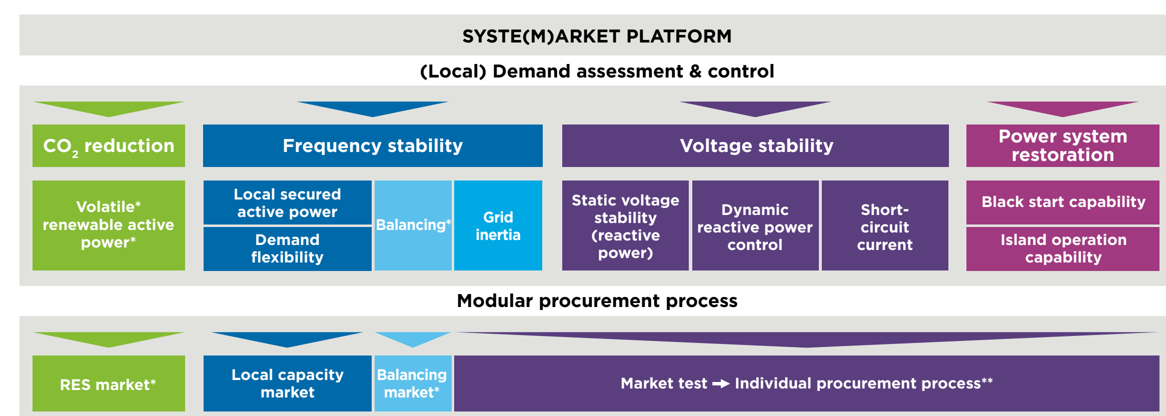
SYSTE(M)ARKET

THE "SYSTE(M)ARKET"[33] IS A KEY INSTRUMENT WHEN IT COMES TO ACHIEVING CLIMATE OBJECTIVES

Germany has set itself the objective of becoming climate-neutral by 2045, and Amprion has likewise committed itself to this objective. We believe that Amprion's concept of the "Syste(M)arket" can make a valuable contribution to the creation of a sustainable energy system and thus to achieving the country's and Europe's climate goals.

The "Syste(M)arket" is an integrated and, at the same time, modular market design, which is represented by an integrated demand assessment and procurement platform for ensuring system security and security of supply. This platform reflects all essential needs of our energy system in a transparent manner and coordinates their procurement process. Thus, it is a necessary addition to the existing spot and futures markets and will ensure the long-term realisation of essential demands of the energy system.

THE "SYSTE(M)ARKET" AS A PLATFORM WITH A COORDINATION FUNCTION



* Currently not considered due to the existing market framework
** In line with the processes currently developed for market-based procurement of non-frequency ancillary services

Figure 16: Syste(M)arket as a platform reflecting system needs

[33] Based on the German word "Systemmarkt" which describes a systematic market (design) build on a systemic view on the entire (energy) system

AMPRION MARKET REPORT 2022

The “Syste(M)arket” creates a holistic framework to increase transparency between the markets, to leverage synergy effects and to ensure a lack of any bias towards new technologies. It is up to the market participants to decide whether, and with which technologies, they will serve the technical need put out to tender. The “Syste(M)arket” platform bundles as many system needs as possible and ensures that they are available in sufficient quantity and long term.

THE “SYSTE(M)ARKET” SETS MARKET INCENTIVES FOR SYSTEM-SERVING INVESTMENT DECISIONS

Climate change and its consequences are requiring us to transform our energy system at an unprecedented rate while, at the same time, maintain the foundations of a secure energy supply. As we work to bring about climate neutrality, we are replacing central elements and former pillars of our energy system. Conventional power generation is rapidly being phased out and we will need to develop and install new types of power plants in the very near future in order to ensure a secure power supply as well as flexibility in the system. In view of the increasing level of utilisation of the grid infrastructure, new power plants and flexible loads must be located at the right locations in the grid if the system is to function reliably and effectively. The same applies to essential ancillary services, which today are for the most part provided by conventional power plants, often even inherently and free of charge. In future, increasing local demand for these ancillary services will also have to be covered, but by renewables, flexible consumers or storage facilities, for example.

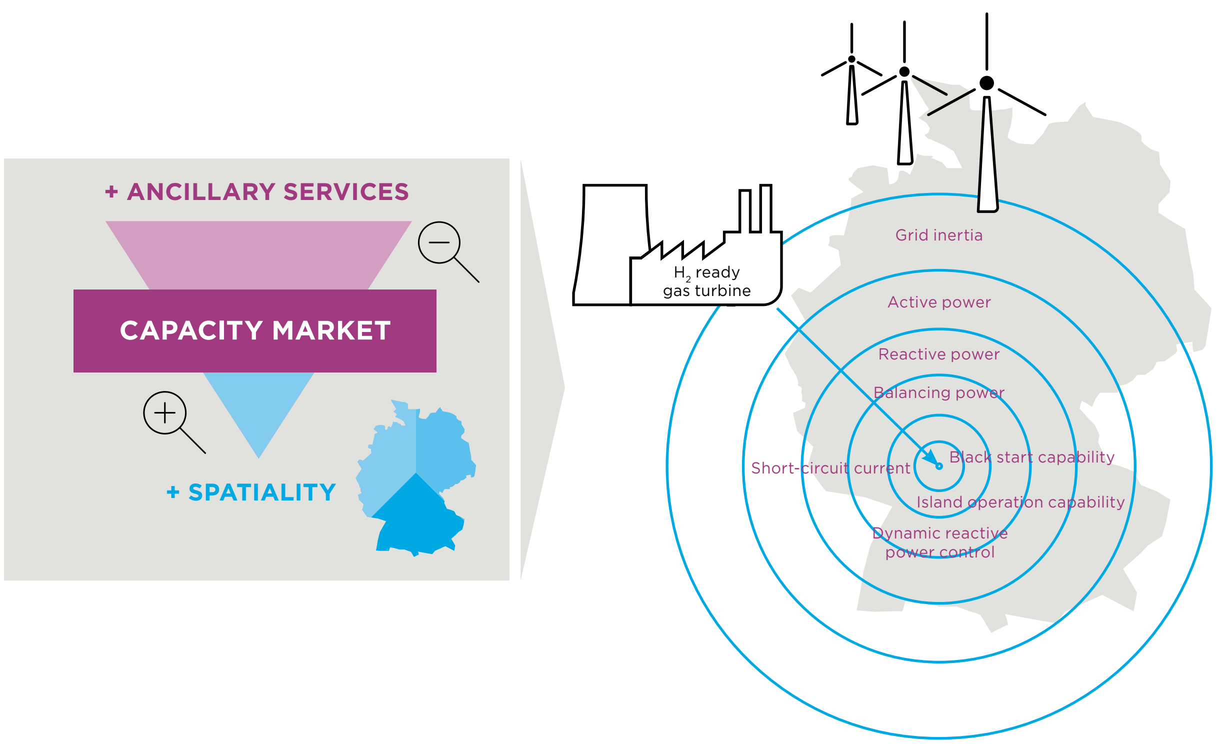


Figure 17: Concept of a local and systemic capacity market for addressing the different effective range of each system need

In its current format, today’s market offers inadequate economic incentives to promote a design that serves the system and allows market participants to choose the best location for conducting their business. Today, the overall system costs (e.g. for grid expansion) are usually not adequately taken into account in the investment and operating decisions of market participants. The “Syste(M)arket” addresses this problem through the use of geographically and objectively differentiated payments and consequently generates market incentives that serve the system. Thus, its basic approach works similar to a central capacity market, but with a higher spatial granularity and enhanced by the consideration and implementation of ancillary services.

The “Syste(M)arket” as a complement to the energy-only market is designed to be unbiased and be open to every new technology. Firstly, the needs of the system in order to maintain system security and security of supply are precisely determined (e.g. local reactive power demand or inertia). On this basis, the future, geographically differentiated requirements for each module of the “Syste(M)arket” are regularly and systematically quantified by the TSOs. Taking procurement and provision periods into account, the most effective and efficient procurement processes are then determined and implemented for each individual system need.

In the case of an investment decision on the construction of a power plant, for instance, the various payments made by the “Syste(M)arket” could positively influence whether this power plant is

- **a)** built at all (“Missing Money Problem”),
- **b)** built at the location where it offers genuine advantages from the system’s point of view,
- **c)** designed such that it is also capable of covering other system needs.

TO SUMMARISE, THE AMPRION SYSTE(M)ARKET CONCEPT PROVIDES SOLUTIONS TO KEY QUESTIONS RELATED TO THE FAST-CHANGING FUTURE MARKET ENVIRONMENT

5. CONCLUSION AND OUTLOOK

ELECTRICITY MARKET DESIGN IS KEY TO TRANSFORMING THE ENERGY SYSTEM TOWARDS CLIMATE NEUTRALITY AND GREATER GEOPOLITICAL INDEPENDENCE.

The year 2021 was a year full of challenges. The rising energy prices and the system splits have shown that a reliable and resilient energy system is more important than ever. Further strain on the system is expected from the war against Ukraine and possible scarcity of fuels. Systemic solutions such as an accelerated grid expansion, European market integration and new solutions such as Amprion's "Syste(M)arket" will strive to keep pace with, and actively shape, the transition of the energy system.

THE EVOLVING CHALLENGES IN THE CURRENT GEOPOLITICAL CONTEXT CALL FOR TIMELY AND SYSTEMIC SOLUTIONS

The developments in the European energy market in 2021 once more show the need for a sustainable energy system. In spring 2022, the need for transforming the energy system has stepped up even further. While the coronavirus crisis and the objective of achieving climate neutrality in Europe by 2050 were already increasing the pressure on European economies to transform, the war in Ukraine and the dependence on fossil fuels that it has revealed have further intensified the pressure to accelerate the transformation of the energy system with even more ambitious targets for the deployment of renewables and energy efficiency. This becomes even more important with regard to coupling and integration of sectors. An integrated system needs a holistic system planning process that combines the current individual planning processes for energy infrastructure in a multi-sectoral way to ensure an affordable, effective and efficient energy transition in line with the European climate goals.

Our plans for a climate-neutral energy system are still valid. At the same time, we need to speed up the transformation even more. In order to drive forward decarbonisation and cope with Europe's greater geopolitical independence, holistic and timely solutions are needed. Therefore, Amprion is intending to invest 12 billion euros in the transformation of the energy system until 2026. Already during the 2021 financial year, Amprion invested a record amount of 1.2 billion euros in expanding the grid infrastructure. Amprion sees it as its responsibility to develop solutions for making the transformation of the energy system as secure and efficient as possible. As a transmission system operator in the centre of Europe, we therefore work with all market participants to keep the European power grid stable.

As the market report has shown, the electricity market environment is very dynamic. The progress in European market integration with the involvement of TSOs has helped to mitigate the negative impact of energy price increases. Thus, price convergence in CWE remained at a high level in 2021. However, the high prices in the fourth quarter in particular led to a significant increase in Amprion's costs for the procurement of energy.

In addition, the volatility of energy prices reached new records in March 2022: While on 7 March 2022, electricity prices in Germany hit a record of €700/MWh for delivery between 7 p.m. and 8 p.m. on March 8, three days later the MWh cost only eight cents for a midday hour. Furthermore, on 4 April 2022 a new price peak in CWE was reached. For the first time, the day-ahead price in France nearly reached the technical price cap of €3,000/MWh.

Increased import and export flows led to higher utilisation of the European transmission network and more complex grid situations. In order to reduce the impact of situations that restrict market trade, need-oriented network expansion considering both network and market needs remains a top priority. Our analyses of trade-limiting grid elements in the context of compliance with the 70% requirements of Regulation (EU) 2019/943 highlight important demand indicators for the Amprion network.

A SUITABLE MARKET DESIGN FOR CLIMATE PROTECTION AND SYSTEM STABILITY IS NEEDED

Nevertheless, the tremendous increase in energy prices, the current political situation and the two system splits in 2021 have clearly shown the crucial importance of security of supply and system security for Europe. New solutions such as Amprion's "Syste(M)arket" are needed to create a sustainable energy system.

The path to a secure supply at all times begins with system security. Guaranteeing system security is the core task of the TSOs. To Amprion, the transformation of the energy system is not just about transporting electricity in a climate-neutral way. The system requirements are much more complex.

The "Syste(M)arket" concept developed by Amprion contains the advantages of the current electricity market and reliably implements the aforementioned tasks. The principle of market-based procurement as well as the needs of the energy system are central to this.

Our concept combines both elements in a modular way and exploits previously unused synergies in the system. In doing so, the system market reflects the increasing complexity of the energy system and reconciles security of supply with system security, while preserving today's electricity market.

A short-term revision to the electricity market design could lead to uncertainties and jeopardise the balanced framework of the Clean Energy Package. Possible options to optimise the future market design in the light of tackling high energy prices under the EPowerEU plans, which the EC intends to present together with the member states in May 2022 and ACER is currently analysing, need to be carefully considered and assessed.

LIST OF ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators
aFRR	Automatic Frequency Restoration Reserve
ATC	Available Transfer Capacity
CCR	Capacity Calculation Region
CEE	Central Eastern Europe
CEP	Clean Energy Package
CNE	Critical Network Element
CWE	Central Western Europe
DA	Day-Ahead
EC	European Commission
EEX	European Energy Exchange
ENTSO-E	European Network of Transmission System Operators for Electricity
ERAA	European Resource Adequacy Assessment
EVA	Economic Viability Assessment
EU	European Union
FB MC	Flow-Based Market Coupling
FRR	Frequency Restoration Reserve
HTLS	High Temperature Low Sag Conductors
LOLE	Loss of Load Expectation
MAF	Midterm Adequacy Forecast
mFRR	Manual Frequency Restoration Reserve
NRA	National Regulatory Authority
PSPP	Pumped Storage Power Plants
RE	Renewable Energy
RES	Renewable Energy Sources
SDAC	Single Day-Ahead Coupling
TSO	Transmission System Operator

AMPRION MARKET REPORT 2022

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