Annual Market Update 2021

Electricity market insights

12 April 2022

Introduction

Annual Market Update 2021, an electricity market review focused on the Netherlands and Germany, including wider European trends.

This Annual Market Update (AMU) is focussed on relevant developments in the Central Western European (CWE) electricity markets, and the Dutch and German electricity markets in particular. This is the fourth edition of the TenneT Annual Market Update. Previous editions of the AMU and its predecessor the TenneT Market Review can be found here.

The developments in the Annual Market Update are structured alongside several main topics:

- The chapter **Wholesale market prices** discusses the wholesale day-ahead market and intraday markets and identifies price and volume trends.
- As our electricity system is still highly dependent on fossil-fuelled power, the chapter **Fuel prices & generators** describes developments in hard coal, natural gas and CO_2 emission allowance prices, as well as the margins for generators.
- The chapter **Capacity & generation** focuses on the supply side of the electricity system and discusses developments in installed capacity and generation.
- Support for renewables in the Dutch and German system are discussed in the chapter **RES support schemes**, by looking at budget distribution, awarded capacity and expected generation in the subsidy schemes.
- In the chapter **Wholesale market integration** the storyline includes the interactions of the Dutch and German electricity system with neighbouring systems. Additionally, the ongoing efforts of coupling EU electricity markets are discussed in this chapter.
- The last two chapters focus on mechanisms in place to ensure the stability and functioning of the electricity system for both the Netherlands and Germany: **Balancing** measures, to ensure supply and demand is equal at all times; and **Congestion management**, to resolve congestion in the grid.

Main Findings (1/3)

Higher wholesale electricity prices across Europe in 2021 due to exceptionally high gas prices.

Wholesale electricity prices across Europe increased in 2021. The annual average day-ahead electricity price within the CWE region increased with 225% to 103 €/MWh. Since April monthly average gas prices were increasing. Gas prices peaked around 4 times higher than the 10-20 year average with a monthly average gas price in December of around 90 €/MWh_{th}. In that same period day-ahead prices increased from 50 €/MWh to around 250 €/MWh due to the strong correlation with gas prices. Additionally the tight market conditions in France in the last few months of 2021 also had a price lifting effect. The French market was more tight due to planned and unplanned unavailability of their nuclear power plants.

The annual average CO_2 price increased in 2021 to 53 €/tCO_2 and closed 2021 at a record high of around 80 €/tCO_2.

The annual average carbon emission allowance (EUA) price increased to 53 €/t CO_2, a 116% increase compared to 2020. This increase in wholesale electricity prices across Europe is mainly explained by a significant increase in annual average natural gas (340%) and coal prices (119%). For the increased gas prices several causes are considered as price lifting forces, including: increased demand driven by rapid economic recovery, fierce LNG competition with Asia's gas market, lower supply of Russian gas in wholesale markets, and relatively low storages at the end of the 20/21 winter. The increase in coal prices was caused by a combination of more demand for coal globally (mainly in china) and tight supply of coal. After October prices started to decline when coal mines increased supply of coal.

The effect of these changes in fuel and carbon prices resulted in gas-to-coal switching due to higher generator margins for coal-fired power plants compared to gas-fired power plants in both the Dutch and German markets. Since November also gas-fired power had high positive margins, despite the record high gas prices, resulting in higher generating outputs. This to a certain extent the result of a tight market in France, due to significant nuclear unavailability, that has lifted prices in neighbouring countries above national marginal generation costs.

Introduction

Main findings

Wholesale market prices

Fuel prices & generators

Capacity & generation

RES support schemes

Wholesale market integration

Balancing

Congestion management

Main Findings (2/3)

In the Netherlands solar and wind output increased with 17% to 28 TWh. Overall wind generation in Germany decreased despite increased wind capacity.

Generation from wind and solar in the Netherlands increased with 17% to 28 TWh. As a consequence of gas-to-coal switching, generation based on natural gas significantly decreased and generation based on coal significantly increased. Additionally around 6,3 TWh of biomass co-firing in coal-fired power plants was certified, meaning that this share of total generation in coal-fired power plants can be attributed to biomass co-firing.

Total generation in Germany increased with 3% to 13 TWh over 2021. Generation from hard coal increased with 30% to 11 TWh, lignite with 20% to 17 TWh and nuclear with 4 TWh (7%). Solar generation increased with 2 TWh and hydro with 5 TWh. Despite the growth in capacity the output from wind energy decreased with 17 TWh.

Full price convergence within Central Western Europe reached 48%. Netherlands returning to a net import position.

Wholesale prices convergence within the CWE region was around 6 percentage point higher than in 2020 and 2019 reaching a full convergence of 48%. For the Netherlands the amount of hours with full price convergence increased with most neighbours and reached 53% full convergence with Germany, which was 4 percentage point more than in 2020. For Germany full convergence with most of its neighbours increased as well.

The Netherlands decreased its annual net position in 2021 shifting towards a net import compared 2020 by an increased amount of hours with a negative net position (which reflects a net import of electricity). France had a decreased annual export position in 2021 compared to 2020 and 2019. Their export position is still dominantly exporting, but with an increase in the amount of hours with a negative net position which reflects a lot more imports. Nuclear unavailability in Q4 2021 have resulted in France having the highest average DA price and increased imports.

Main Findings (3/3)

Increased capacity prices for Dutch FRR in 2021 compared to 2020. Introduction of 4-hour products for FCR and a decrease of the common price.

Capacity prices for Dutch Frequency Restoration Reserves (FRR) increased in 2021. This effect can mostly be contributed to the increase in electricity prices. Capacity prices in Germany seem to be much less affected by the higher energy prices. Capacity prices in Germany peaked in May and October 2021 due to unavailability, especially pumped hydro storage.

Capacity prices for Frequency Containment Reserves (FCR) for the common and Dutch region increased in 2021 compared to 2020. Additionally, the Dutch and common price almost fully converged with the common price since May 2021, reducing the premium for Dutch procured and connected FCR capacity.

An analysis of the development of the Balancing Energy Demand in the Netherlands from 2001-2020 shows an increasing demand of Balancing Energy. This trend is observed to be strongly correlated with the increase in solar and wind generation combined.

Dutch congestion management costs increased 338% in 2021 compared to 2020, whereas German costs remained comparable to 2020.

Costs for congestion management in the Netherlands increased to €339,7 million in 2021(+338%). The cost increase is a combination of higher energy prices, more redispatched volumes and increased restriction contracts. Across the border in Germany, cost for congestion management in the first three quarters (Q4 data unavailable yet) of 2021 were in the order of 1 billion comparable to the last two years. Due to higher energy prices in Q4 2021 it is expected that Q4 costs are higher than previous years.

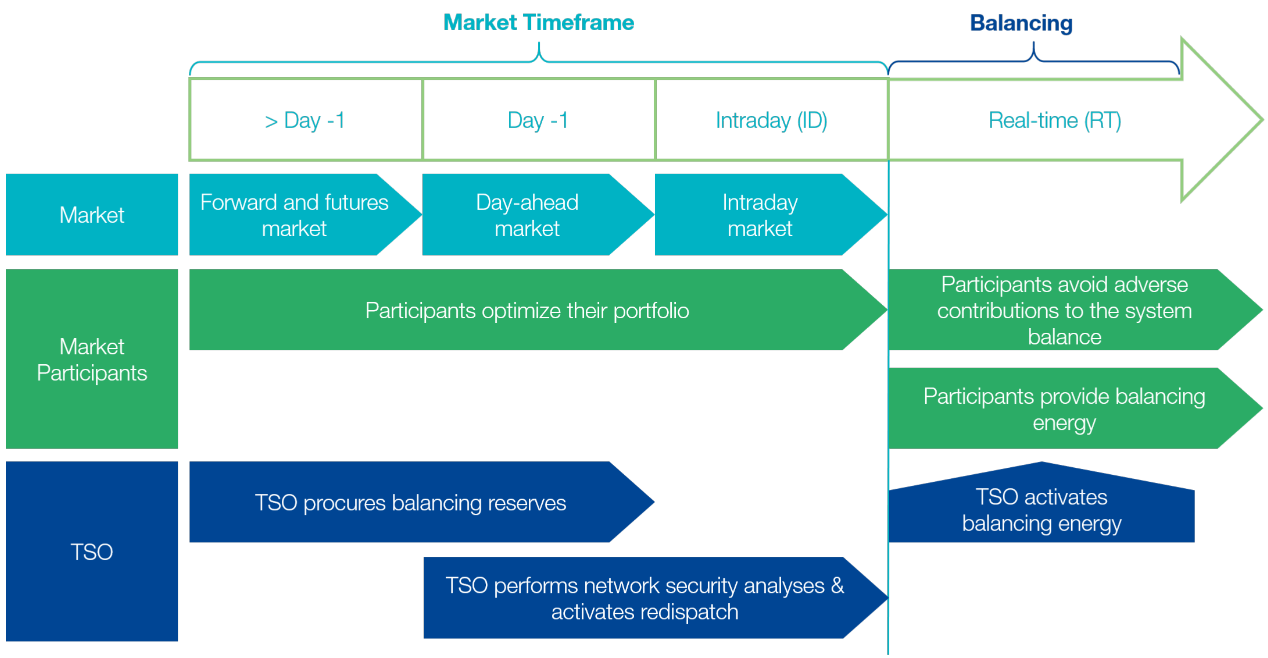
286 GWh of redispatch volume was contracted through the GOPACS platform in 2021 which is 22% of the total redispatched volume in 2021. GOPACS is a TSO-DSO coordinated market-based congestion management platform that enables intraday bids with a geo-tag to be used for congestion management as well (see for more info www.gopacs.eu).

Wholesale market prices

Market Timeframes

The wholesale market consists of several sub-markets

Market Timeframe and Balancing

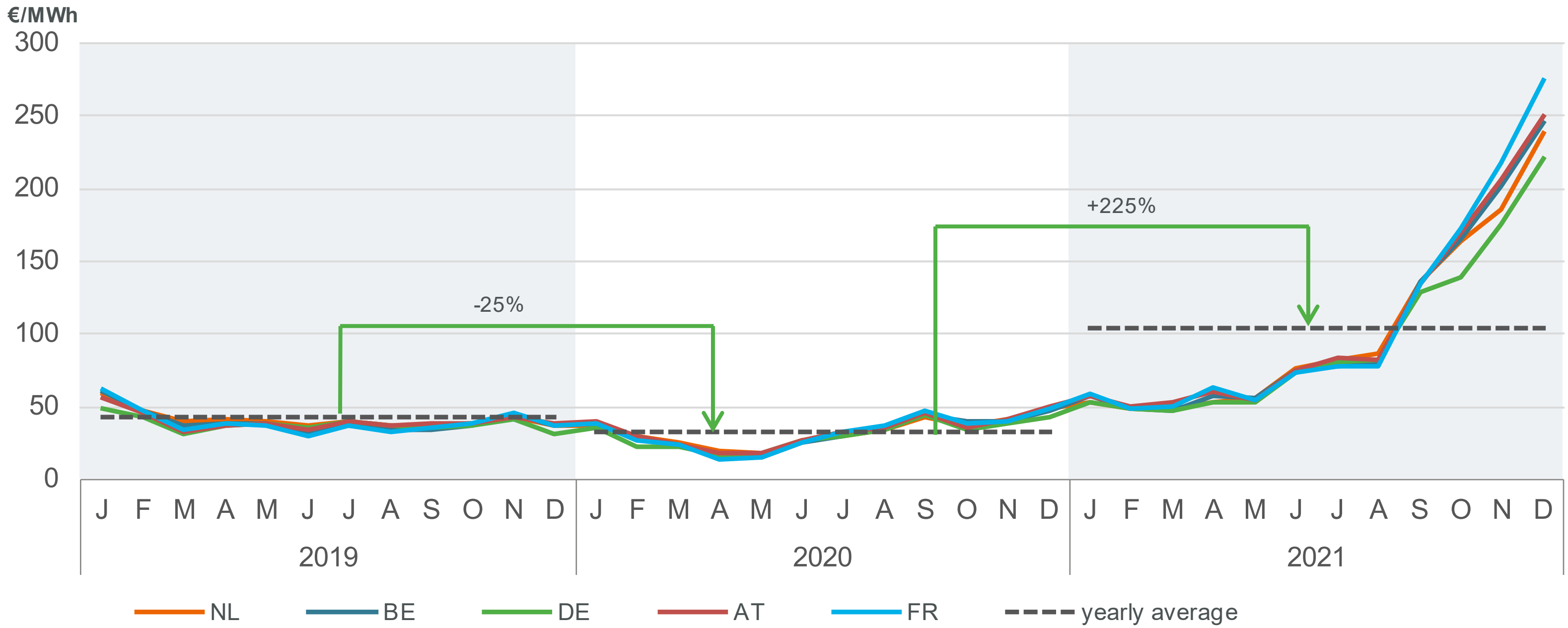


- The figure above shows the relation between the different timeframes of the wholesale market and the balancing market. In wholesale markets, electricity generators sell electricity to large industrial consumers and electricity suppliers. The electricity suppliers sell electricity to the final consumer in retail markets. The scope of this Annual Market Update is on wholesale markets, balancing and congestion management.
- Balancing and redispatch are system services that are important features of the electricity system. TSOs procure balancing reserves that can be activated in real-time to resolve disruptions in system balance. Also, TSOs perform network security analyses to identify congestion, which is resolved by activating redispatch.

Day-ahead prices CWE

Higher prices in 2021 with sharp rises after the summer as a consequence of high gas prices

Monthly Average Day-ahead Wholesale Prices in the CWE region



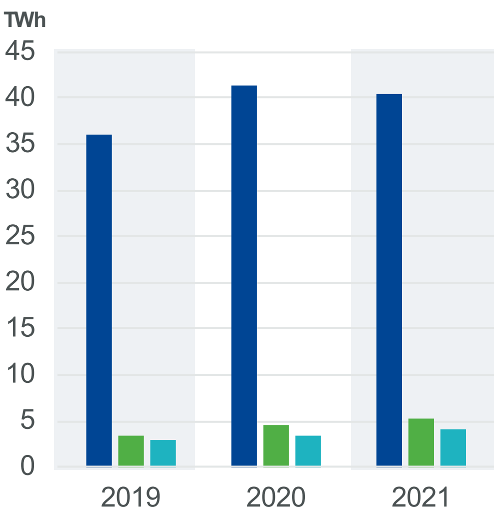
- The average day-ahead electricity price increased within the Central Western European (CWE) region by 225% to 103 €/MWh. Additionally within the CWE region day-ahead prices had a high level of convergence up to September, since October the divergence increased.
- Overall, day-ahead prices in the CWE region increased, mainly due to effects of the higher fuel and CO_2 prices *(see chapter Fuel prices and Generators).*
- A combination of planned and unplanned outages of nuclear power plants in combination with typical higher winter loads in France resulted in highest prices in France because of tight availability.

Source: ENTSO-E Transparency Platform

NL Spot + Imbalance prices and volumes

Intraday traded and Imbalance settled volumes have increased since 2019
Average Imbalance and Intraday prices strongly correlated with Day ahead

Annual volumes traded or settled



Weekly average prices

** For the BRP imbalance volume an absolute sum is made between the volume off-take and feed-in divided by 2 In order to compare with the DA and ID, where volume buy = volume sell.*

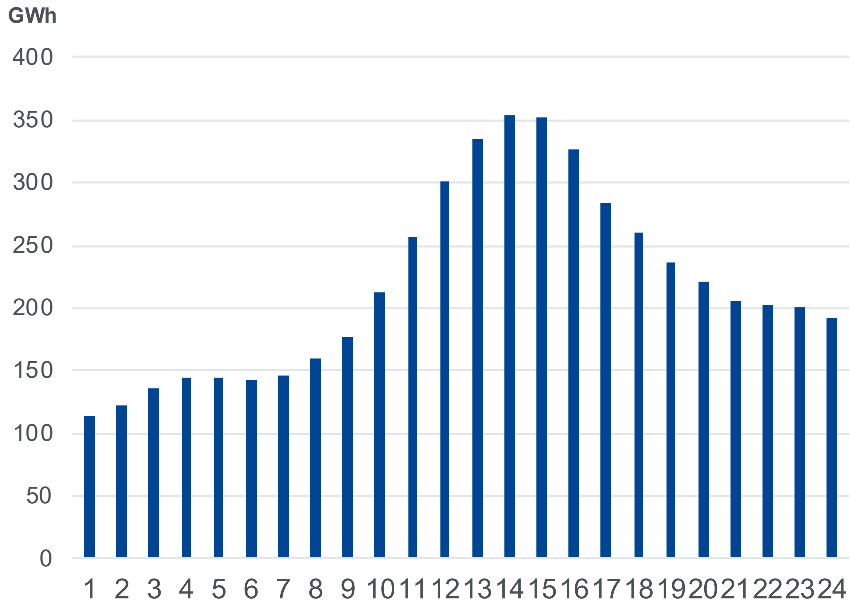
- Since 2019 the Intraday and imbalance settlement volumes show an increasing trend. Intraday Continuous 60min increased from 3,3 TWh in 2019 to 5,2 TWh and the Imbalance volumes settled rose from 2,9 TWh to 4,1 TWh in the same period. This trend suggests that there is an increased deviation between the day-ahead forecasts and real-time.
- Day-ahead volumes seem to stabilise in 2021. They decreased compared to 2020, but are still higher than in 2019.
- Weekly average Intraday and imbalance settlement prices are relatively similar to Day-ahead prices which makes the Day-ahead price a good proxy for the real-time value of electricity.

Source: EPEX Spot, Nordpool, ENTSO-E Transparency Platform, TenneT NL

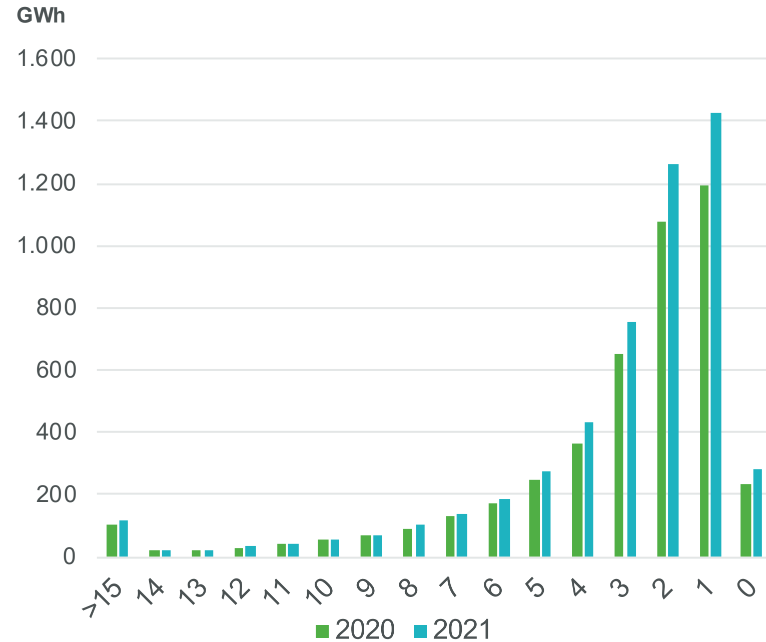
Intraday NL – Hourly continous trades

Most Intraday volumes are traded during the middle of the day
Most Intraday trades are made in 1-3 hours before delivery

Total ID continuous volume 60min traded per delivery hour in 2021



Total ID continuous volume traded in time before delivery hour



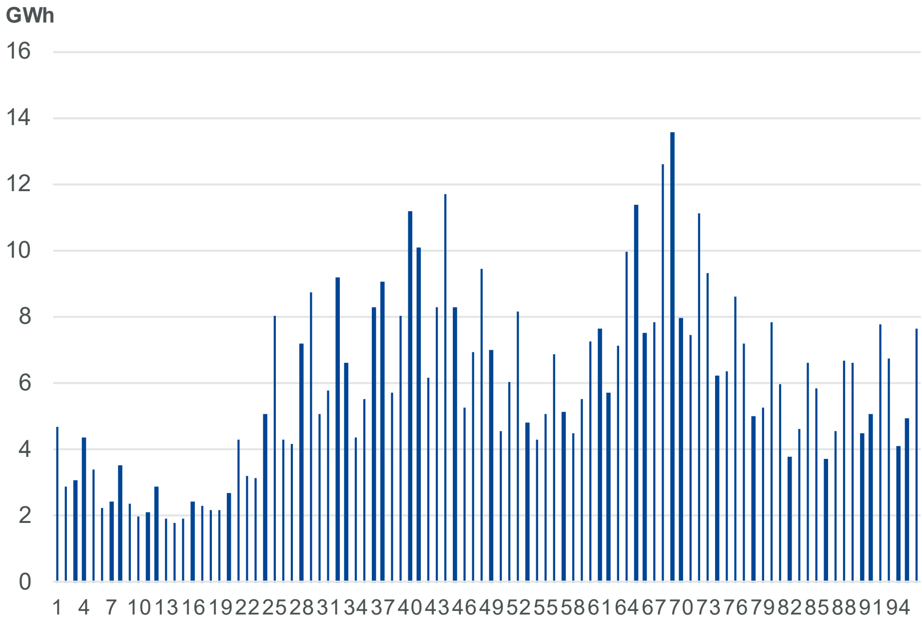
- The left figure shows that more intraday volumes are traded for hours later during a day of delivery, this is likely because forecast error deviations from day ahead are lower for the first hours of the day, compared to the last.
- Additionally the Intraday trades are highest during the middle of the day this could partly be the result of the additional day-ahead solar infeed forecast error as well as an higher absolute consumption level during the day.
- The right figure shows that most Intraday volumes are traded in 1-3 hours before delivery.

 Source: EPEX Spot, Nordpool

Intraday NL – Quarter hour continuous trades

Quarter hour trades mainly used for shaping profiles

Total ID continuous volume 15min traded per delivery quarter in 2021



and aggregated per quarter hour

- Quarter-hourly products are traded in the intraday market which enable a better approximation of the real demand ramps and generation variability (e.g. from solar or wind power generation) than the hourly products at the more liquid day-ahead market. This is especially important since imbalance settlement periods are on a quarter-hourly basis.
- The load ramps are typically in the morning and the afternoon. The left figure shows that during ramping hours there is a higher volume traded for the 15 min intraday products.
- The right figure shows higher volume traded for the first and fourth quarter-hour within an hour, and lower volumes for the second and third quarter-hour. This is a consequence of typical higher difference of the forecasted profile from the first and fourth quarter-hour between the portfolio profiles based on hourly traded blocks.

Source: EPEX Spot, Nordpool

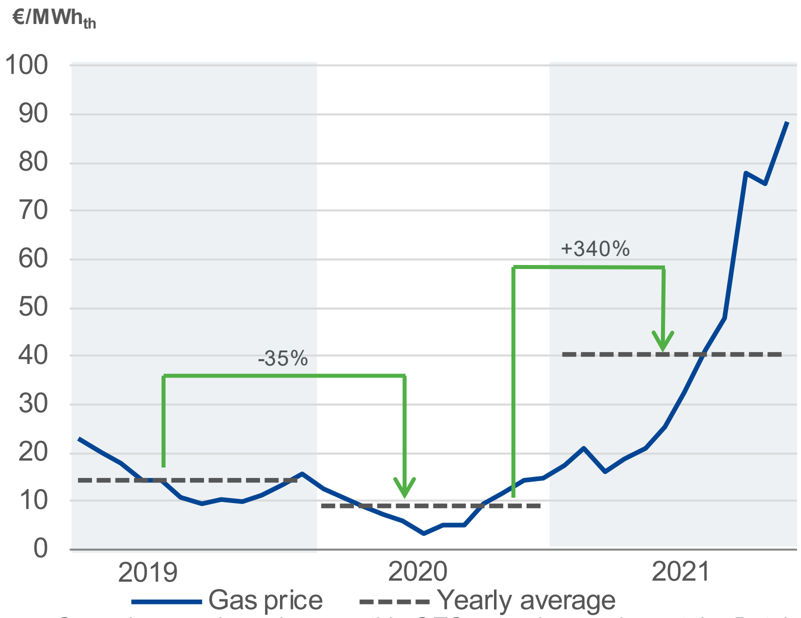
Fuel Prices & Generators

TenneT

Fuel Prices

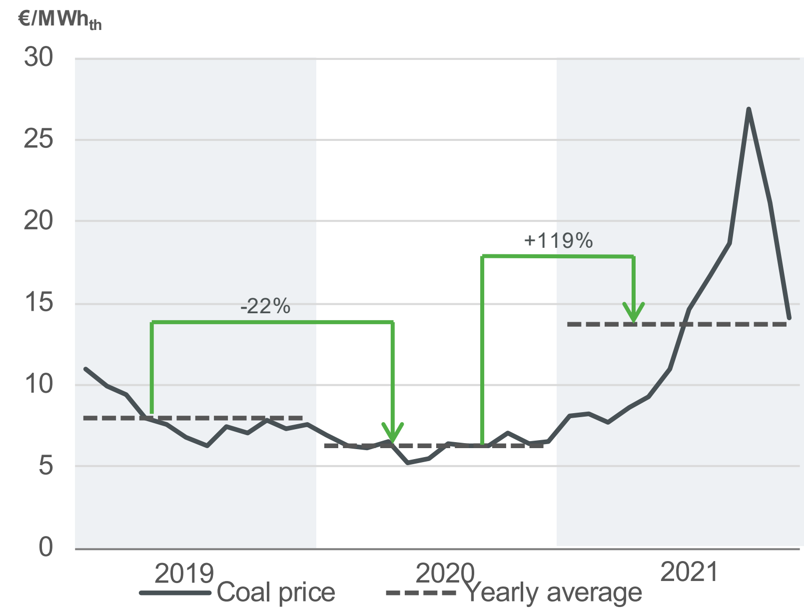
Natural Gas Prices increased with 340%; Coal prices increased with 119% on average compared to 2020

Natural Gas Prices



Gas prices are based on monthly OTC natural gas prices at the Dutch virtual exchange Title Transfer Facility (TTF).

Coal Prices



Coal prices are based on the over the counter monthly API#2 price index.

- Natural gas prices increased 340% year-on-year, exceeding a 20 year historic average bandwidth of 10-20 €/MWh$_{th}$. Several causes are considered as price lifting forces including: increased demand driven by rapid economic recovery, fierce LNG competition with Asia's gas market, lower supply of Russian gas in wholesale markets, and relatively low storages at the end of the 20/21 winter.
- Coal prices increased with 119%. Coal prices started to rise when the margins for coal-fired power plants became positive around May 2021 *(see Generator Margins NL and DE).* The increase in coal prices was caused by a combination of more demand for coal globally (mainly in china) and tight supply of coal. After October prices started to decline when coal mines increased supply of coal.

Source: energate

Carbon Prices

Year-on-year carbon prices increased from 25 €/tCO_2 towards 53 €/tCO_2 in 2021
A record high carbon price of around 89 €/tCO_2 was reached

CO_2 Emissions Allowance (EU ETS) Prices

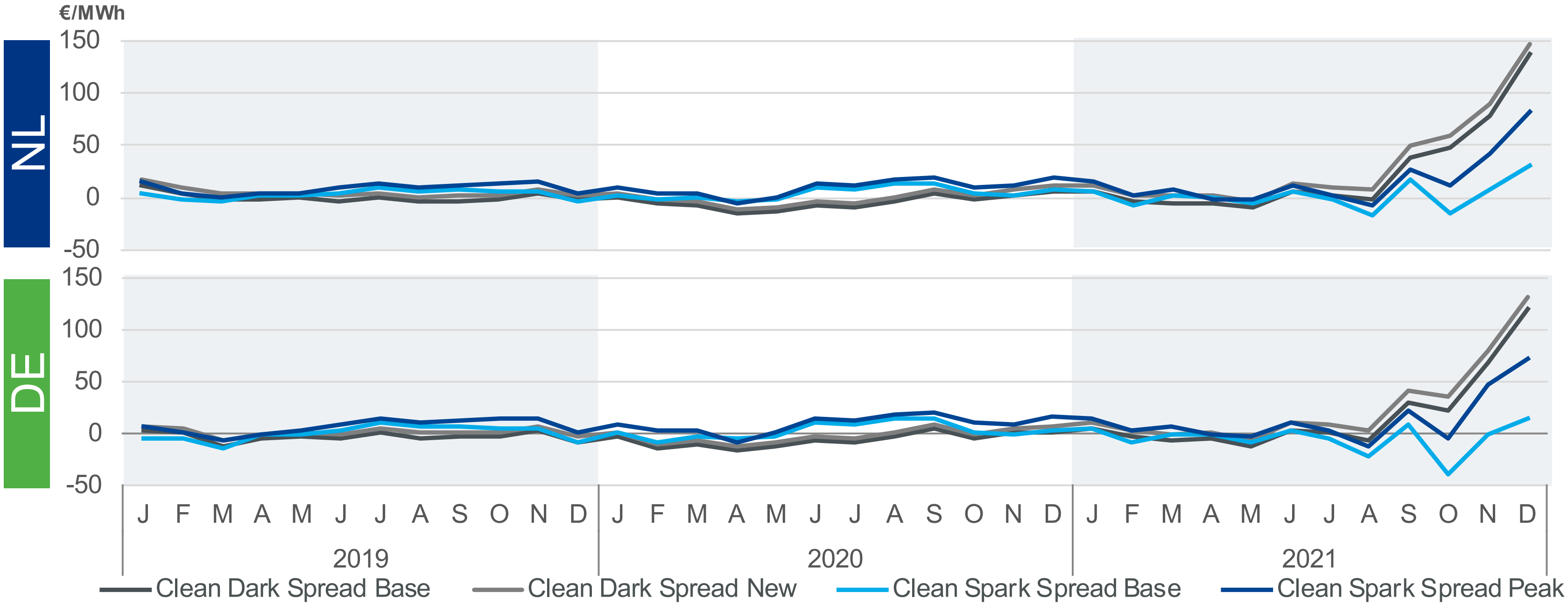
- After the CO_2 Emission Allowances price stabilised around 25 €/tCO_2 during 2019 and 2020, the yearly average price for 2021 increased with 116% to a yearly average price of 53 €/tCO_2.
- The upwards trend over the full year was partly fuelled by the release of the first fit for 55 tranche as part of the EU Green Deal that was agreed EU Wide in 2020. As a result a tighter availability is foreseen for future CO_2 Emission Allowances pushing prices upwards. In addition also speculators contribute to increasing as well as decreasing prices in order to benefit from its volatility.
- In addition, margins for coal-fired power have surpassed the margins for gas-fired power leading to so called gas-to-coal switching *(see Generator Margins NL and DE)*. As a consequence it has become more profitable to generate power with coal-fired power leading to a higher output of coal-fired generation. Since Coal is roughly twice as carbon intense as gas this also results in a higher demand for CO_2 Emission Allowances.

Source: energate

Generator Margins NL and DE

Both Gas and Coal margins were high at end of year despite higher fuel prices Gas-to-coal switching since February

Dutch Monthly Average Clean Dark Spread and Clean Spark Spread



Assumptions

***Coal**: efficiency Base 40%, New 45%, emission factor 91,7 tCO_2/TJth, heating value 25,1 MJ/kg; **Gas**: efficiency Base & Peak 55% emission factor 55,6 tCO_2/TJth,.*

- Around February the Clean Dark Spread Base and new (*for modern high efficient coal-fired power plants)* increased above the Clean Spark Spread Base suggesting Gas-to-coal switching. This indicates the point at which it is more profitable to produce electricity from coal than from natural gas.
- The effects of gas-to-coal switching in the actual monthly generation mix (*Generation in the Netherlands)* shows a significant increase in generation from coal-fired power plants and a decrease in the generation of gas-fired power plants in particular since July. Since November also gas-fired power had high positive margins resulting in higher generating outputs. This to a certain extent the result of a tight market in France, due to significant nuclear unavailability, that has lifted price in neighbouring countries above national marginal generation costs.

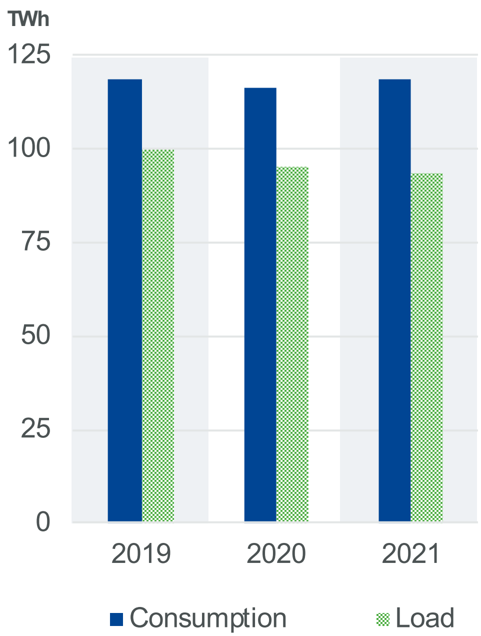
 Source: energate, ENTSO-E Transparency Platform

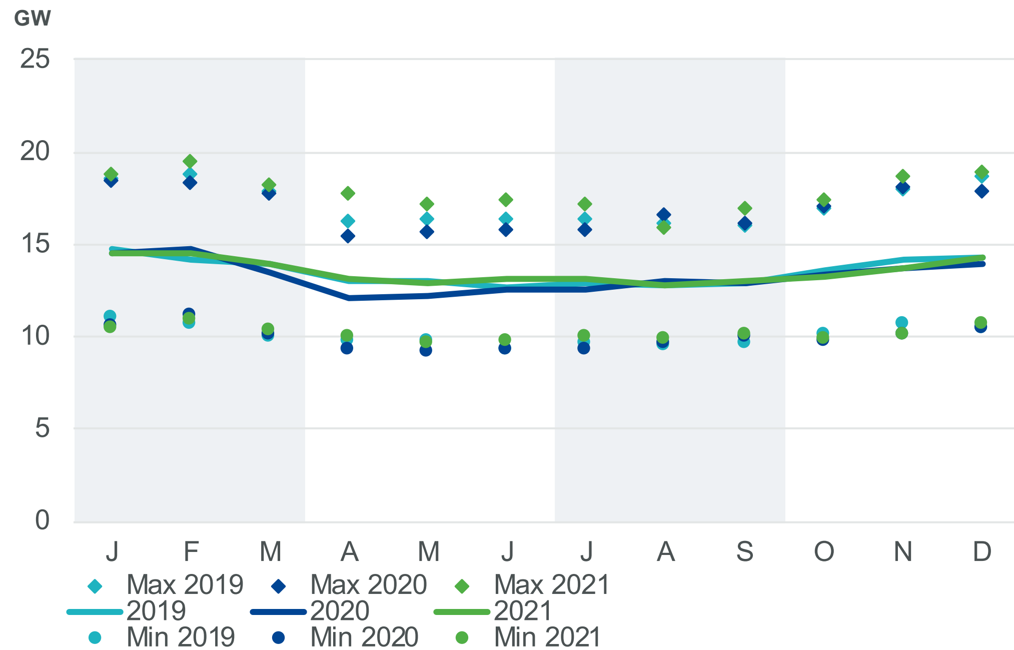
Capacity & generation

Consumption and Load in the Netherlands

Annual consumption level of 2021 comparable to 2019
Peak consumption slightly higher in 2021

Annual Consumption and measured Load + Monthly average, min and max of hourly average Consumption





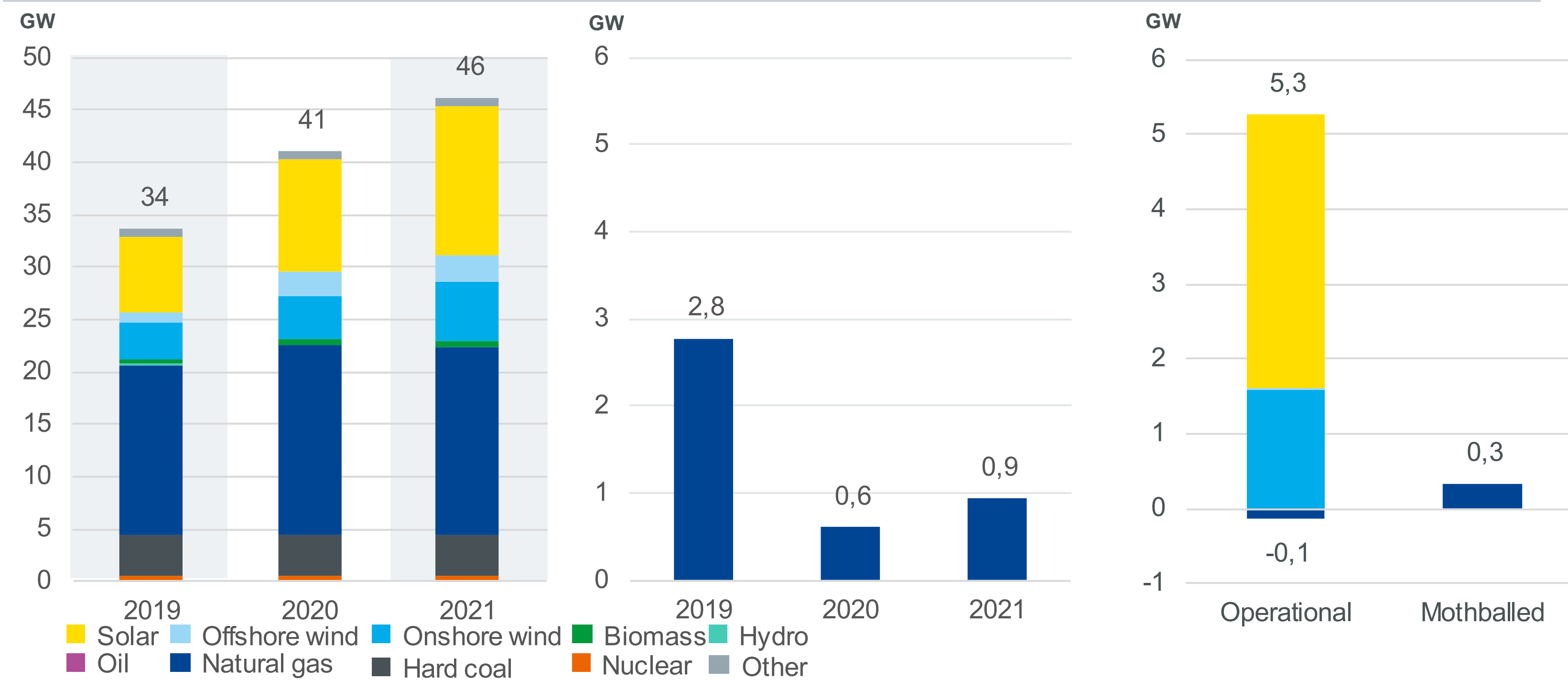
- The left figure shows that load and consumption are not the same. The load is the amount of electricity measured on TenneTs grid. Therefore, with similar consumption over the past few years, the decrease in load indicates an increase of decentral and behind the meter generation which is consumed at lower voltage levels.
- Annual consumption in 2021 was on average comparable to 2019 and 2 TWh higher than in 2020. The right figure shows that the monthly average, highest and lowest hourly consumption was lower in the first 3-4 “corona months” of 2020 (March-June).
- In 2021 the peak consumption seems to slightly have increased per month indicated by a higher level of maximum hourly consumption for every month except August.

Source: TenneT NL, energieopwek.nl

Capacity in the Netherlands

Main capacity increase by Solar PV, which increased by 3,6 GW
Onshore wind increased with 1,6 GW

Dutch Operational Capacity **Dutch Mothballed Capacity** **Changes (Δ2021-2020)**



The figures represent the end-of-year installed capacity as observed on December 31st of 2019, 2020 and 2021

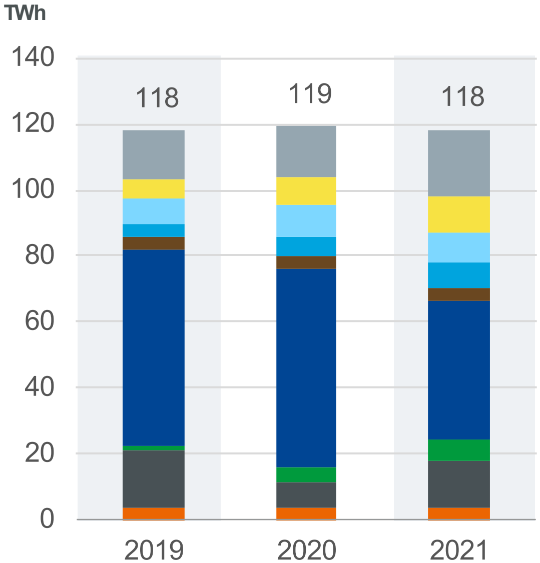
- Operational capacity increased by 5,3 GW, more than half is the result of solar PV which grew by 3,6 GW in 2021. Onshore wind accounted for the other 1,6 GW.
- 0,4 GW of gas-fired capacity left the market of which 0,3 GW was mothballed.

Source: TenneT NL, CBS, Solar Trendrapport 2022

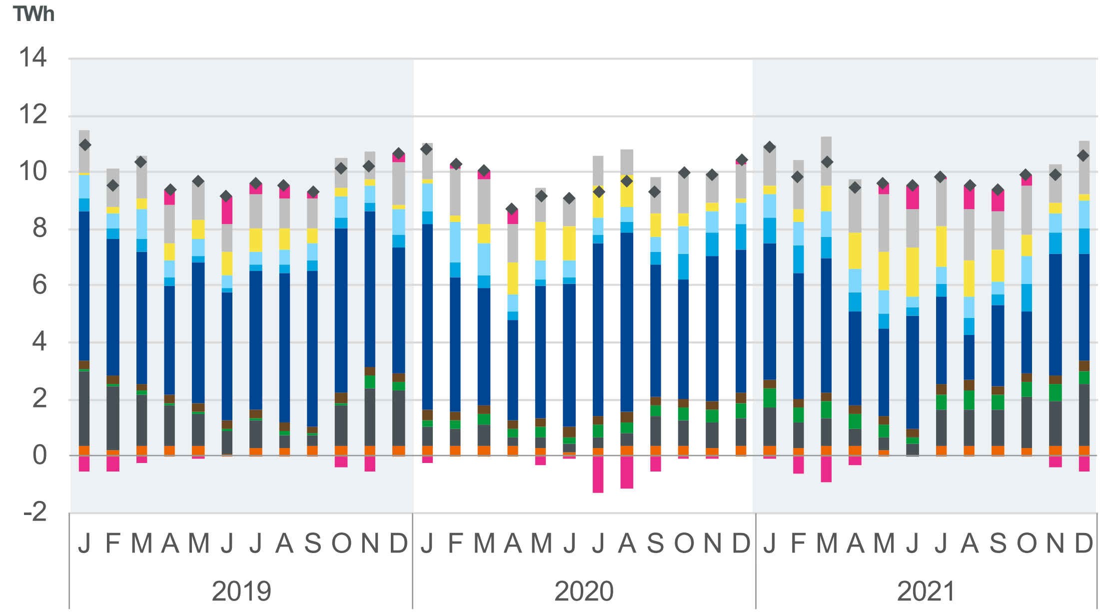
Generation in the Netherlands

Increase of import, solar, onshore and offshore wind
Reduced gas-fired and increased coal-fired and biomass co-fired generation

Dutch Yearly Gross Electricity Generation



Dutch Monthly Generation, net Imports and Exports



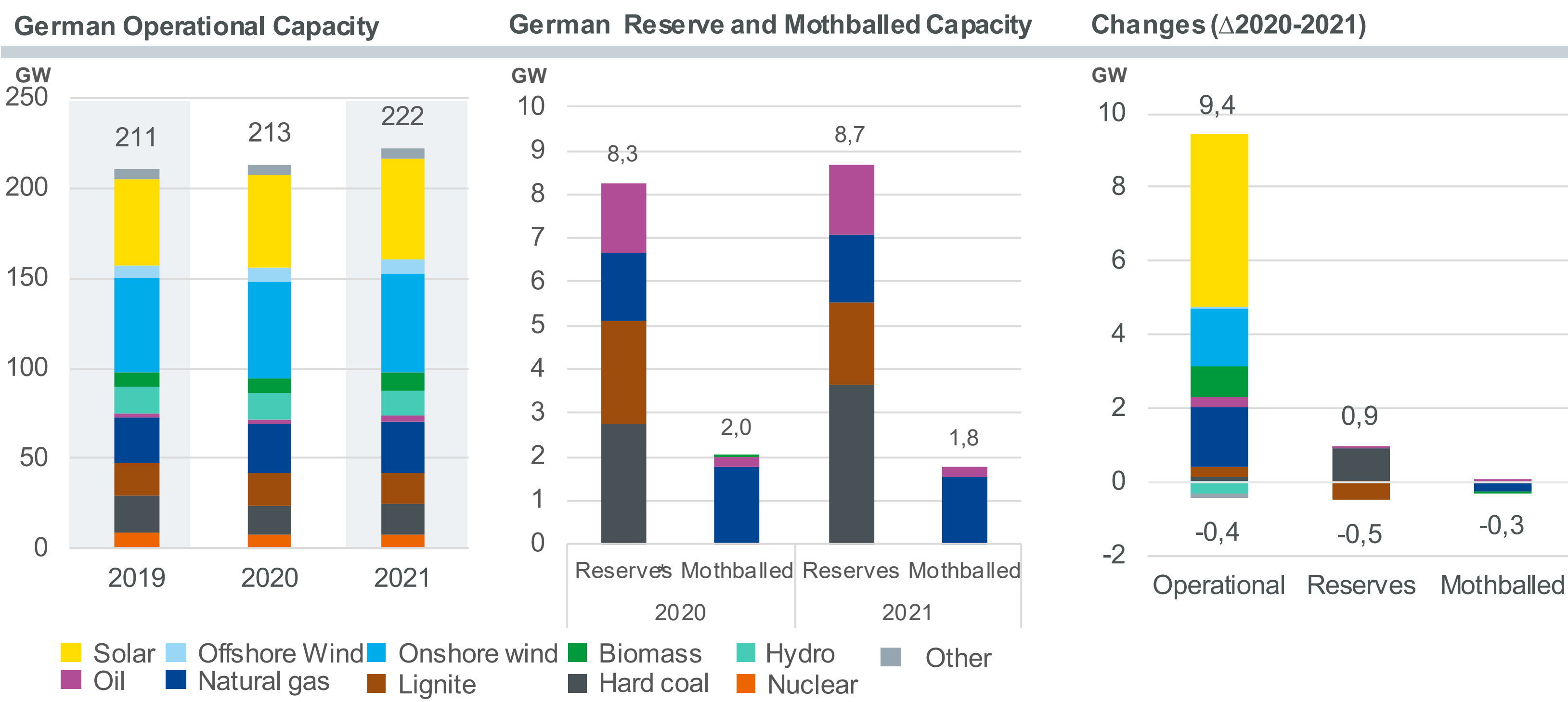
**Generation figures are based on a new methodology that combines measured generation by TenneT with decentralized and/or behind the meter generation. In the past editions this was only electricity infeed measured on public grids: ~79-85% of total NL generation.*

- The combined output from solar and wind increased 17% from 24 TWh in 2020 to 28 TWh in 2021.
- Biomass co-firing increased in 2021 up to 6,3 TWh which is almost meeting the expected 6,7 TWh annual generation from the SDE+ subsidies when co-firing of biomass will be fully reached (*NL: Cumulative development SDE+)*
- Generation from gas-fired power decreased with 20 TWh as a result of the gas-to-coal shift. This was partly compensated by 13TWh from increase of Coal-fired generation + Biomass co-firing, Solar, Wind and Imports.

Source: TenneT NL, CertiQ

Capacity in Germany

Solar capacity increased most with 4,7 GW



** Consist of 'Sicherheitsbereitschaft' outside market back-up capacity, and 'Netzreserve' used for congestion management*
***Strategic reserve scheme introduced in Oct. 2020. For first delivery period a total of ca. 1 GW gas-fired capacity contracted. This capacity is kept outside the market. The strategic reserves are plotted in the operational capacity category in this classification of the Kraftwerklisste from the Bundesnetzagentur.*
**** Figures are based on Kraftwerkliste from the Bundenetzagentur up to 21-11-2021*

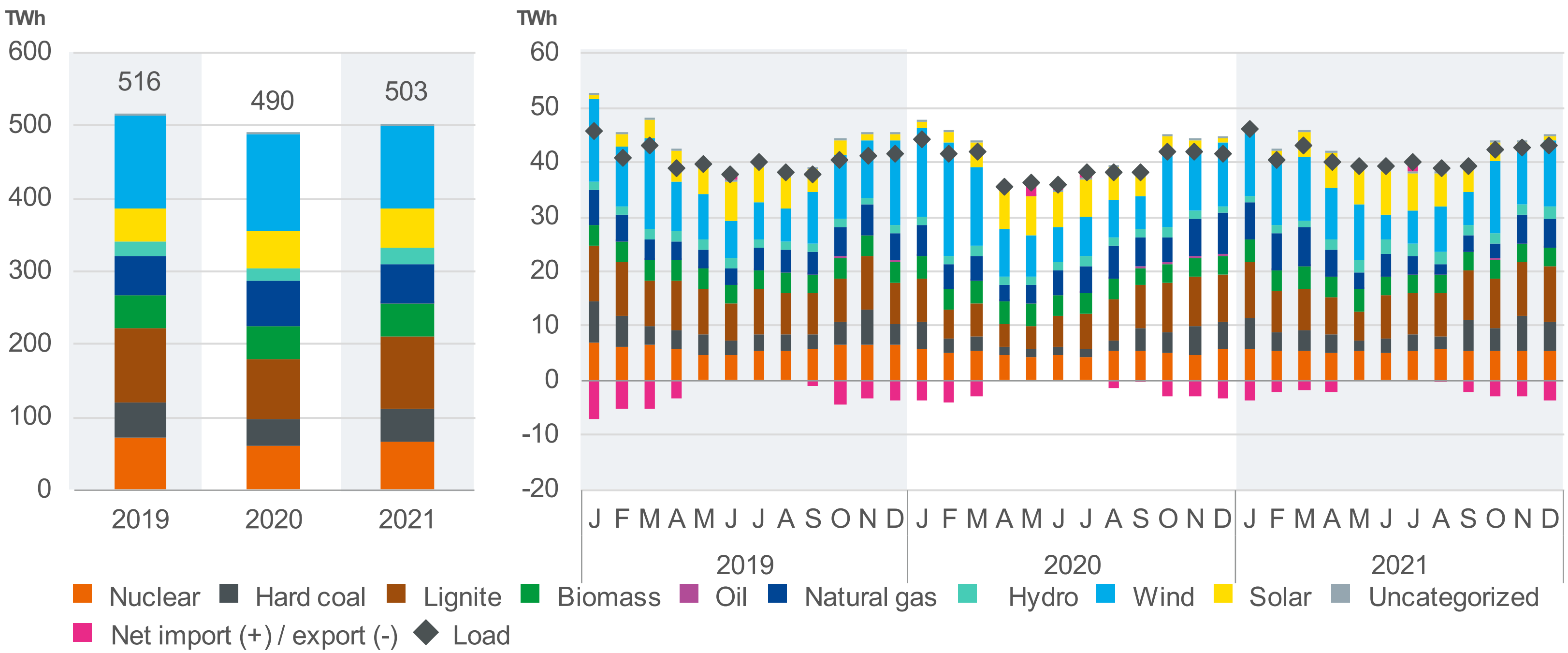
- Operational capacity increased with 9,4 GW, of which half is the result of solar PV which grew with 4,7GW. Wind onshore grew with 1,5 GW.
- In addition to the reported figures, at years end 2021 three nuclear power plants with a combined capacity of 4GW were decommissioned as part of the nuclear phase out. Also for coal and lignite another 1,5 GW and 1 GW are decommissioned respectively at years end 2021.

Source: Kraftwerkliste Bundesnetzagentur, Agora

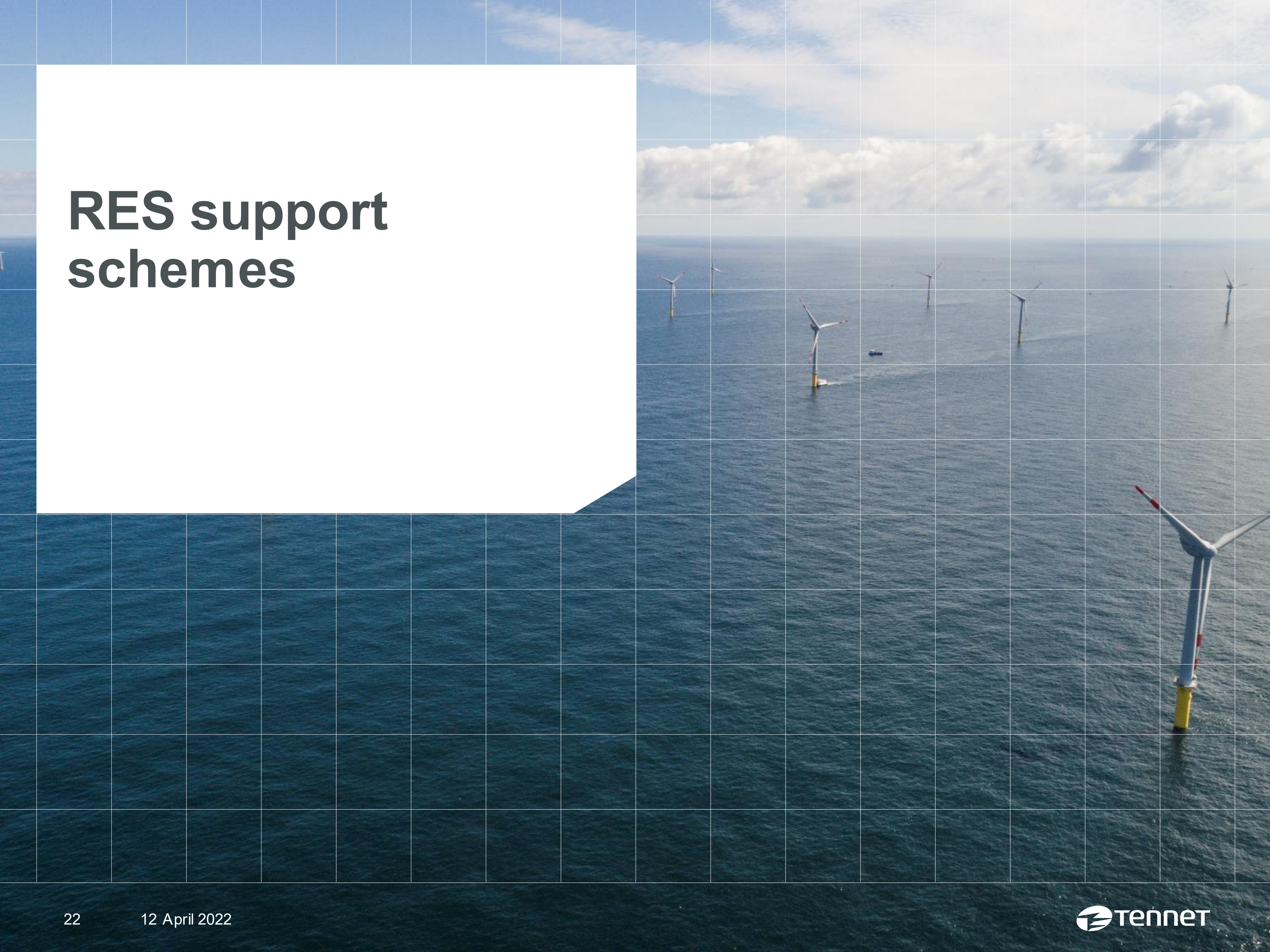
Generation in Germany

Overall generation in Germany increased in 2021 compared to 2020
Despite an increase in wind capacity overall wind generation decreased

German Yearly Gross Electricity Generation



- Total generation in Germany increased in 2021 compared to 2020 with 13 TWh (3%). Generation from hard coal increased with 11 TWh (30%) lignite with 17 TWh (20%) and nuclear with 4 TWh (7%).
- Solar generation increased with 2 TWh and hydro with 5 TWh. Despite the growth in capacity the output from Wind energy decreased with 17 TWh.
- Biomass generation remained a similar generation output over the past three years.

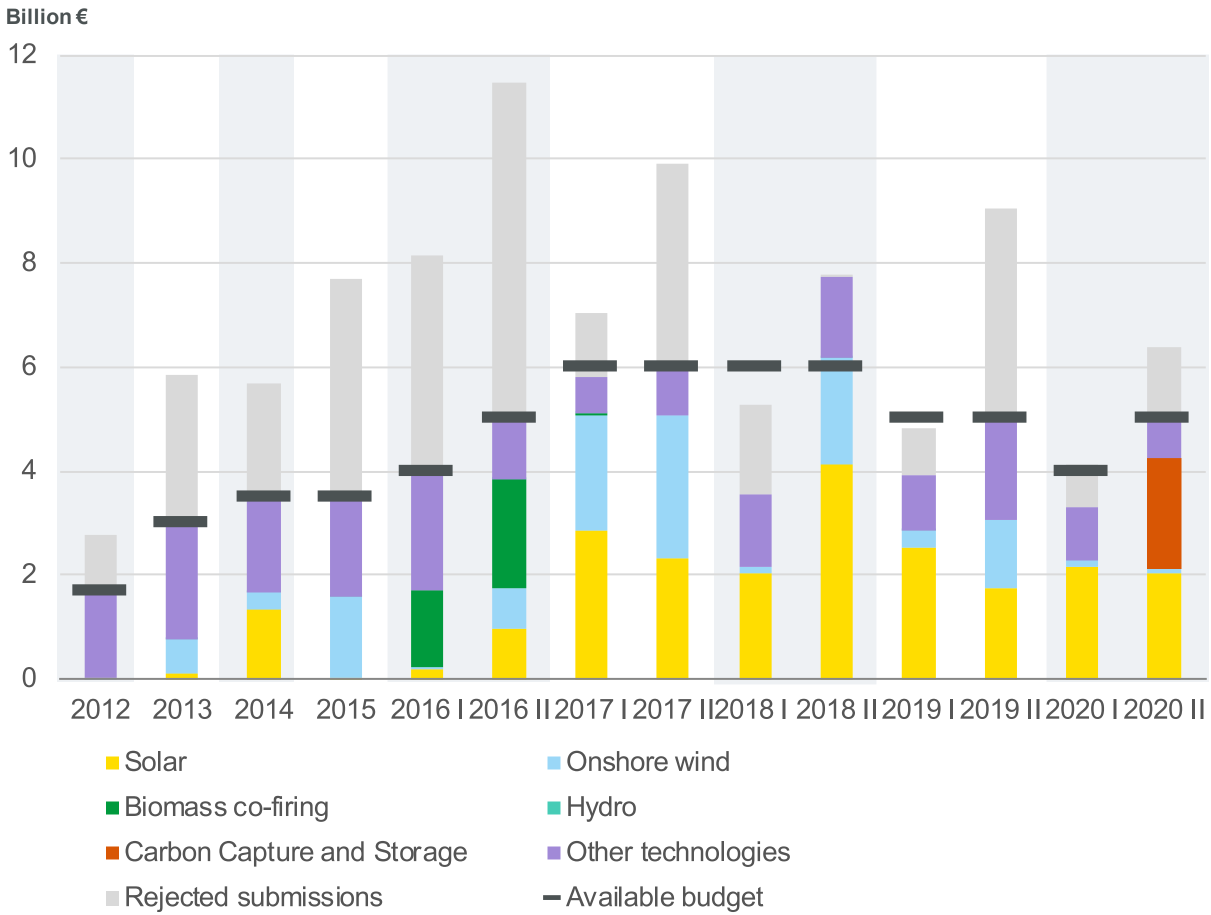


RES support schemes

NL: Budget Distribution SDE+(+)

Carbon Capture and Storage newcomer in SDE+ subsidy schemes 2020 round II
Solar the largest budget receiver from the electricity generation technologies

Budget Distribution per SDE+ Round



- The SDE+(+) is an operating (feed-in-premium) subsidy. Producers receive a guaranteed payment (subsidy) for the energy they generate from renewable sources.
- In round II 2020 the SDE+ was renewed with the SDE++. In the SDE++ technologies are awarded subsidies based on the highest abated CO2 per euro. Next to energy generation technologies also Carbon Capture and Storage and flexible consuming assets like e-boilers and electrolysers can participate.
- At the moment of publishing RVO had no update yet on the projects rewarded budgets in the only 2021 round.

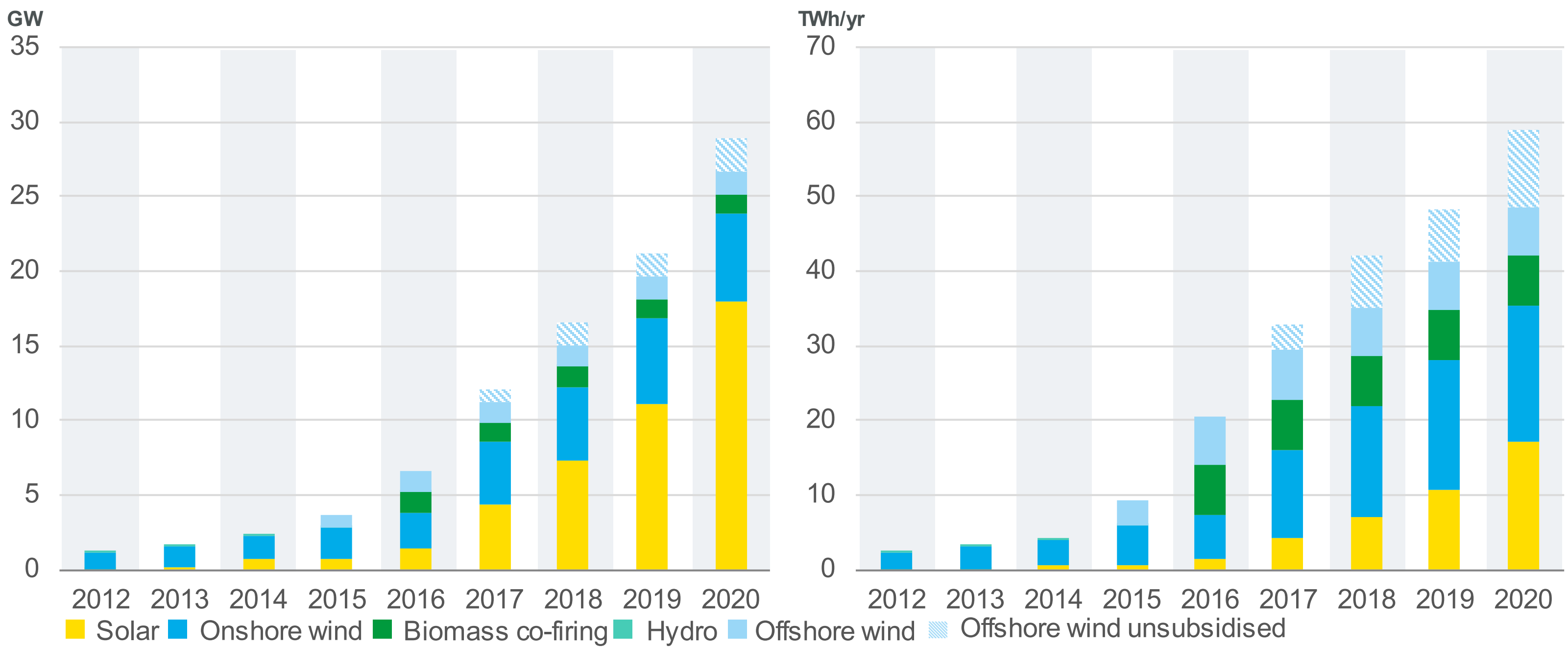
Source: RVO

NL: Cumulative development SDE+

Over 29 GW renewable electricity capacity is projected to be installed under the SDE+ subsidy scheme up to 2020

End of Year Cumulative Capacity to be installed under SDE+

End of Year Cumulative Electricity Generation to be generated annually under SDE+



**Note that 2021 SDE++ figures were not available at time of publishing*

- After 8,5 years of SDE+ subsidy schemes, more than 29 GW of awarded capacity of solar, on- and offshore wind, hydro, biomass co-firing is in operation or is planned to be installed. 2,3 GW of this capacity is unsubsidised offshore wind.
- This cumulative capacity will be good for 59 TWh annual generation of which 11 TWh from unsubsidised offshore wind. With an annual consumption of 118 TWh in 2021(*See: Consumption and Load in the Netherlands*), renewable generation resulting from SDE+ subsidies (excl. unsubsidised offshore wind) would correspond to 41% of total annual consumption.
- A clear discrepancy is seen between awarded capacity and the expected electricity generation of the awarded capacity. Even though the majority of capacity was awarded to solar in recent years, electricity generation from wind is higher. This can be attributed to the higher load factor of these technologies.

 Source: RVO

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Main findings

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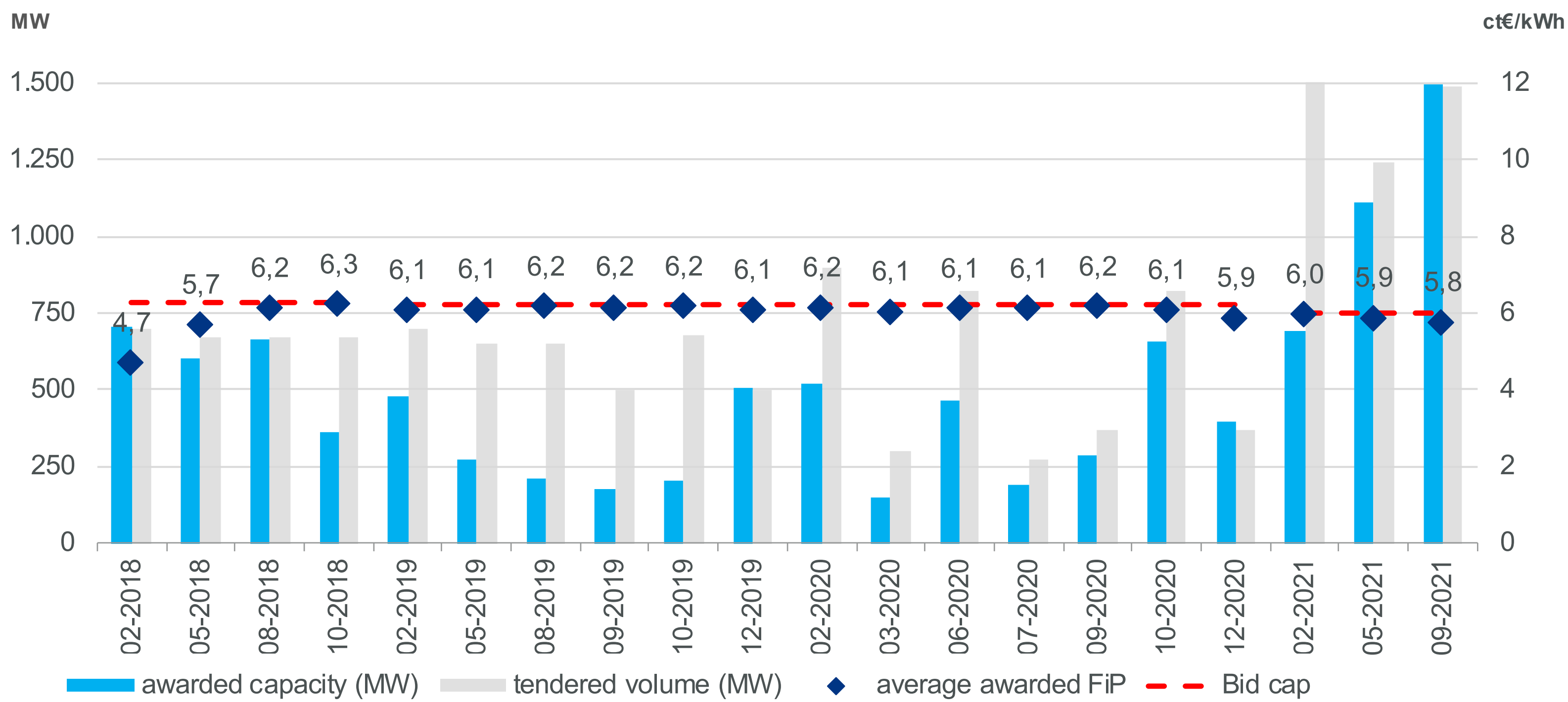
DE: Development of feed-in premiums

Level of feed-in premiums (FiP) for new onshore wind installations decreased slightly in 2021 with awarded FiP close to bid cap of 6,0 ct€/kWh

EEG Auction results for the onshore wind Feed-in Premiums (FIP)



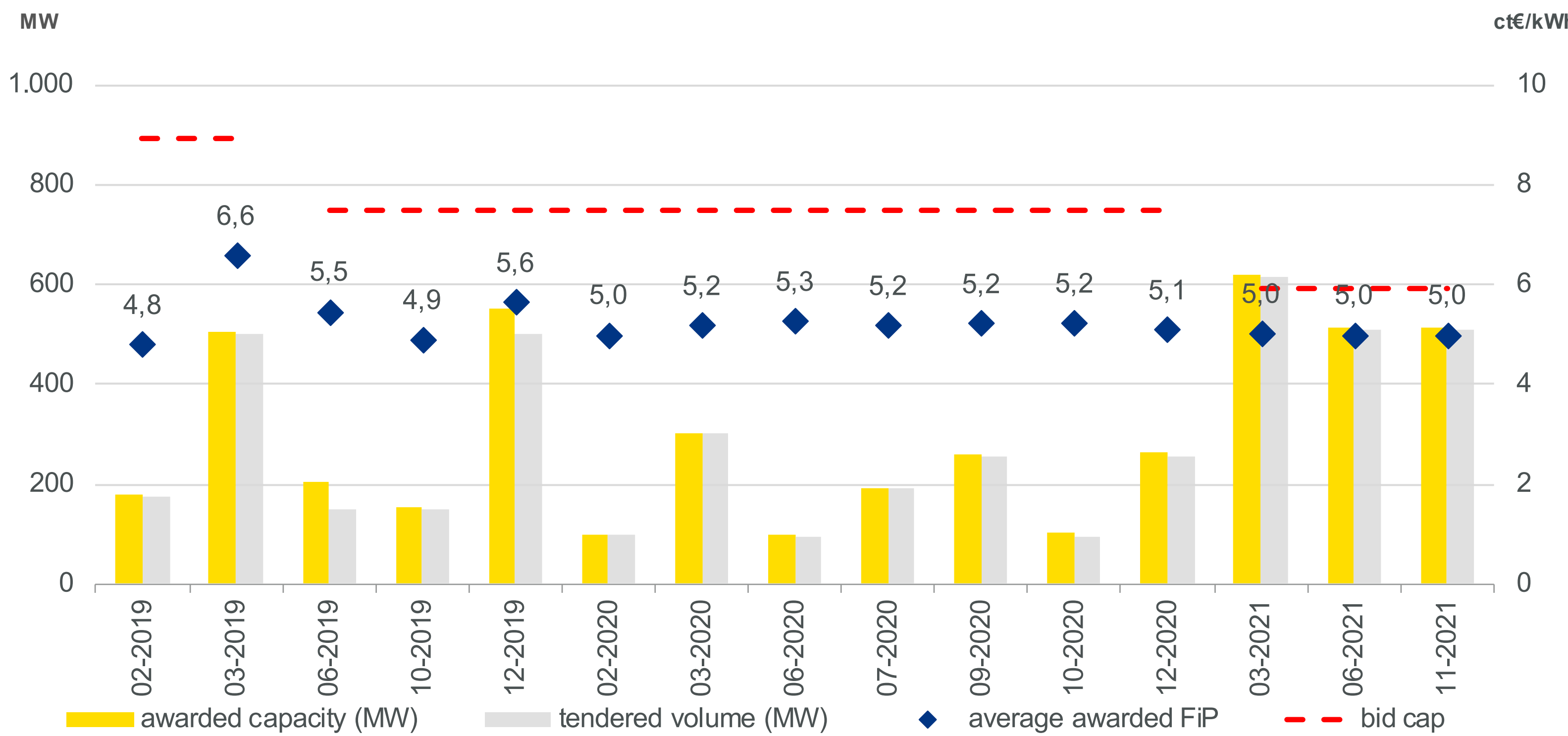
- As in 2019 and 2020 undersubscribed auctions in 2021 indicate a rather low degree of competition among bidders. As a result, awarded feed-in premiums on average close to bid cap of 6,0 ct€/kWh. This is partly attributed to reducing funding conditions such as public acceptance issues, long permitting times and finding sites. Additionally also Solar is at the moment more competitive and therefore getting more attention from developers.
- In total, only 3,3 GW of capacity was awarded in 2021 up to September (2019: 2,3 GW). This is an increase of awarded capacity for onshore wind after years with a decreasing trend. This awarded capacity is still significantly below the politically set target for new onshore wind capacity.

Source: Bundesnetzagentur

DE: Development of feed-in premiums

Average FiP for new PV installations (> 750 kW) in 2021 slightly decreased to 5,2 ct€/kWh

EEG Auction results for the PV solar Feed-in Premiums (FIP)



- In contrast to tenders for new wind capacity, auctions for new PV installations larger than 750 kW were all oversubscribed in 2021 leading to more competition among project developers as also reflected in the average awarded FiP being lower than the maximum bid cap of 5,9 ct€/kWh).

Source: Bundesnetzagentur

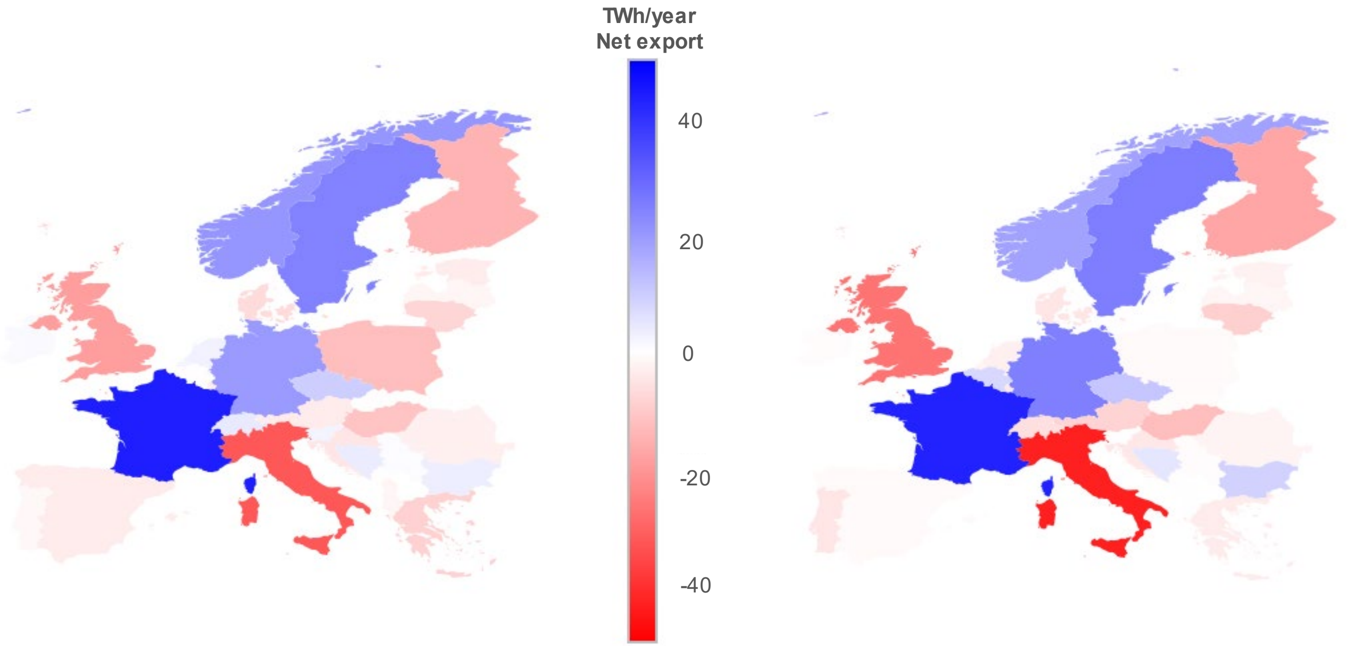
Wholesale market integration

Aggregated Exchange EU

Poland almost fully reduced its net import position
Higher imports in the UK and Italy

Yearly Aggregated Import and Export Volumes

2020 **2021**



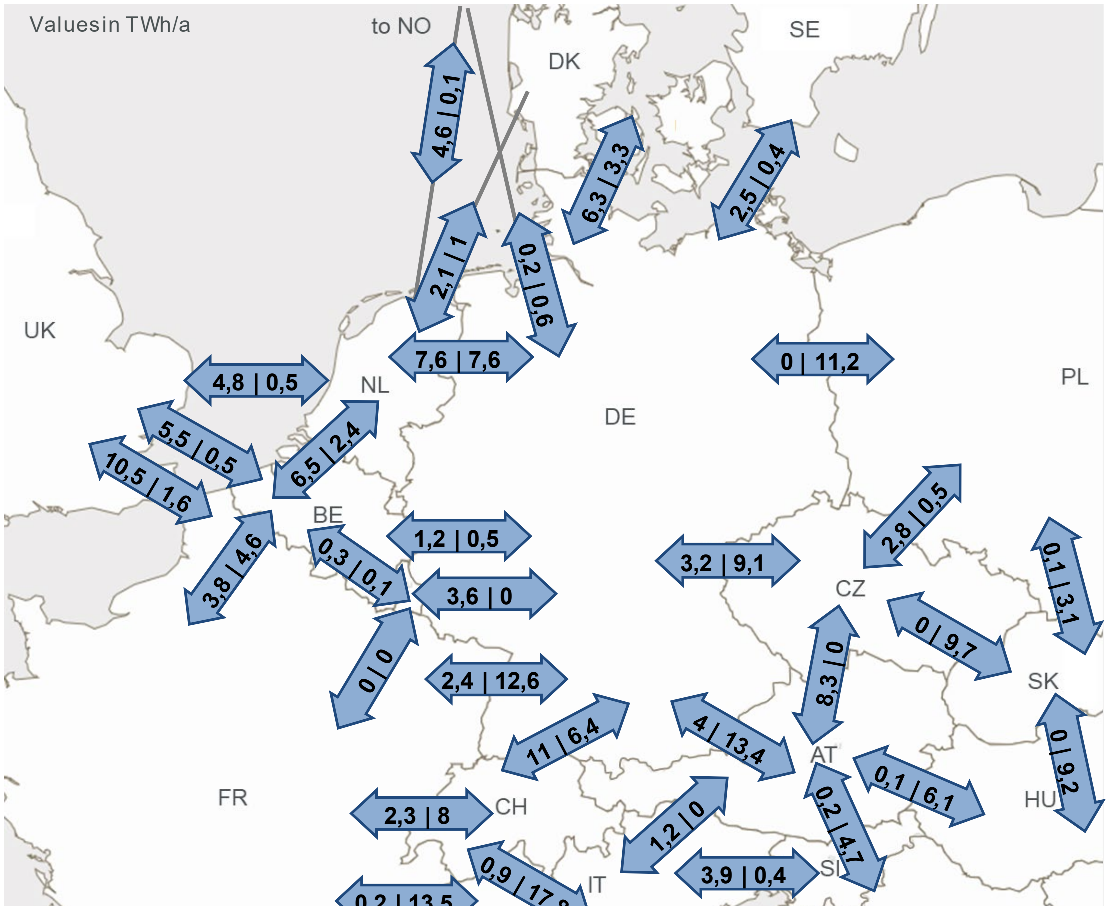
- Poland almost fully reduced its net import position in 2021 compared to 2020. The coal dominated power mix in Poland became a lot more competitive when gas prices started to increase much more than the coal prices since September 2021.
- On the contrary the import of the UK and Italy increased since they have a more gas dominated generation mix which was less competitive in 2021.
- The Netherlands returned in 2021 to a net importing position after being a net exporter in 2020.
- Germany remained a net exporter with more exports in 2021 compared to 2020.

Source: ENTSO-E Transparency Platform

Cross-border Flows 2020

Most NL imports came from DE and most exports went to BE
Most DE imports came from FR and most exports went to AT

Physical Cross Border Flows 2020



Note that this figure shows physical flows between countries, which are different from scheduled commercial exchanges between bidding zones.

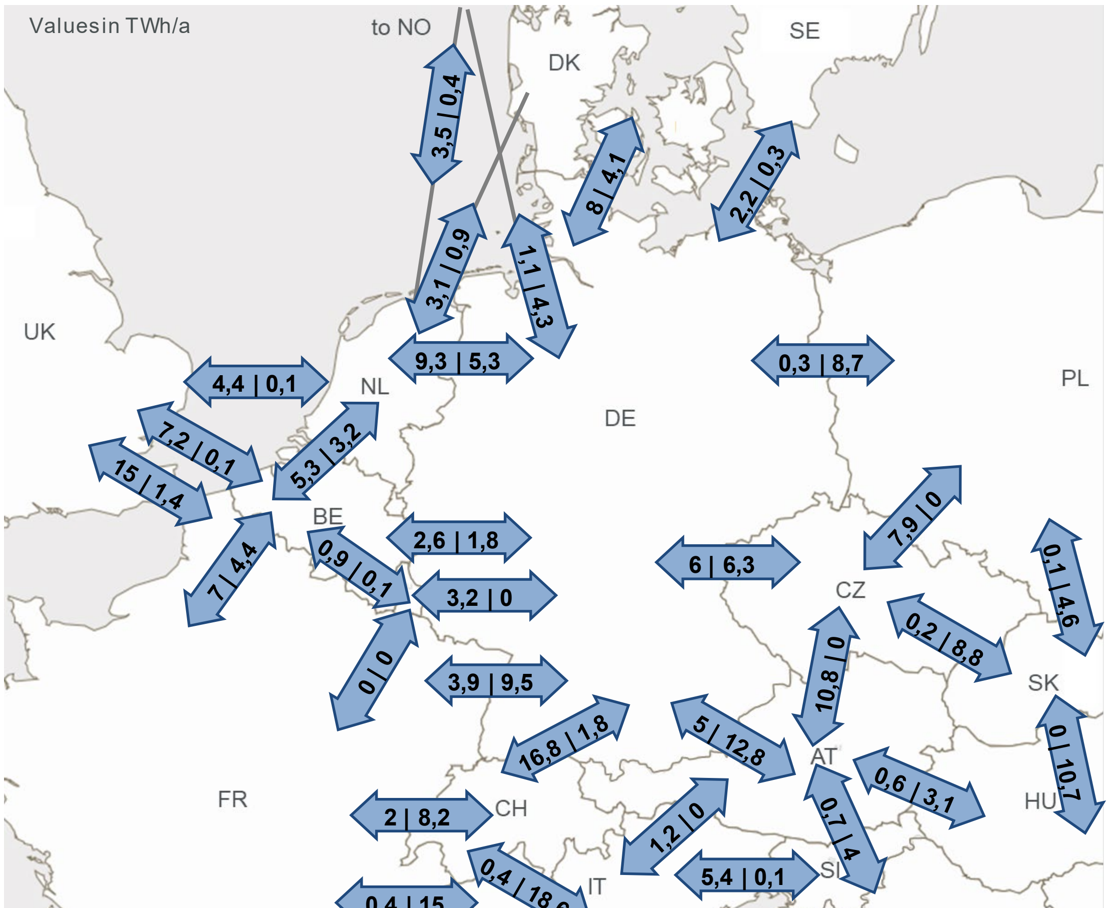
- The Netherlands received most of its imports from Germany (7,6 TWh). This is complemented by imports from Belgium (2,4 TWh) and Norway (4,6 TWh). The majority of exports were going to Belgium (6,5 TWh), followed by the UK (4,8 TWh).
- Total imports were much lower as Germany is a net exporting country, but were mostly received from France (12,6 TWh), the Netherlands (7,6 TWh), Denmark (6,3 TWh) and Switzerland (6,4 TWh). Germany's main exports went to Austria (13,4 TWh), Poland (11,2 TWh), Switzerland (11 TWh) and the Netherlands (7,6 TWh).
- Go-live of ALEGrO interconnector between BE and DE on November 9th 2020 and NordLink between DE and NO on December 8th 2020 resulted in the first BE-DE and DE-NO flows respectively.

Source: ENTSO-E Transparency Platform

Cross-border Flows 2021

Most NL imports came from DE and most exports went to the BE and DE
Most DE imports came from FR and most exports went to CH

Physical Cross Border Flows 2021



- Most imported flows from the Netherlands came from Germany with 9,3 TWh.
- In 2021 the Netherlands returned to net importing position after being a net exporter for the first time in 2020. The highest annual export flow form Germany went to Switzerland with 16,8 TWh.
- Germanies imports came mainly from the Nordic countries combined and France. Also substantial contributions from the Netherlands and the Check Republic.
- France is still a net exporter in Europe but increased its imports from and reduced its exports towards Belgium and Germany.

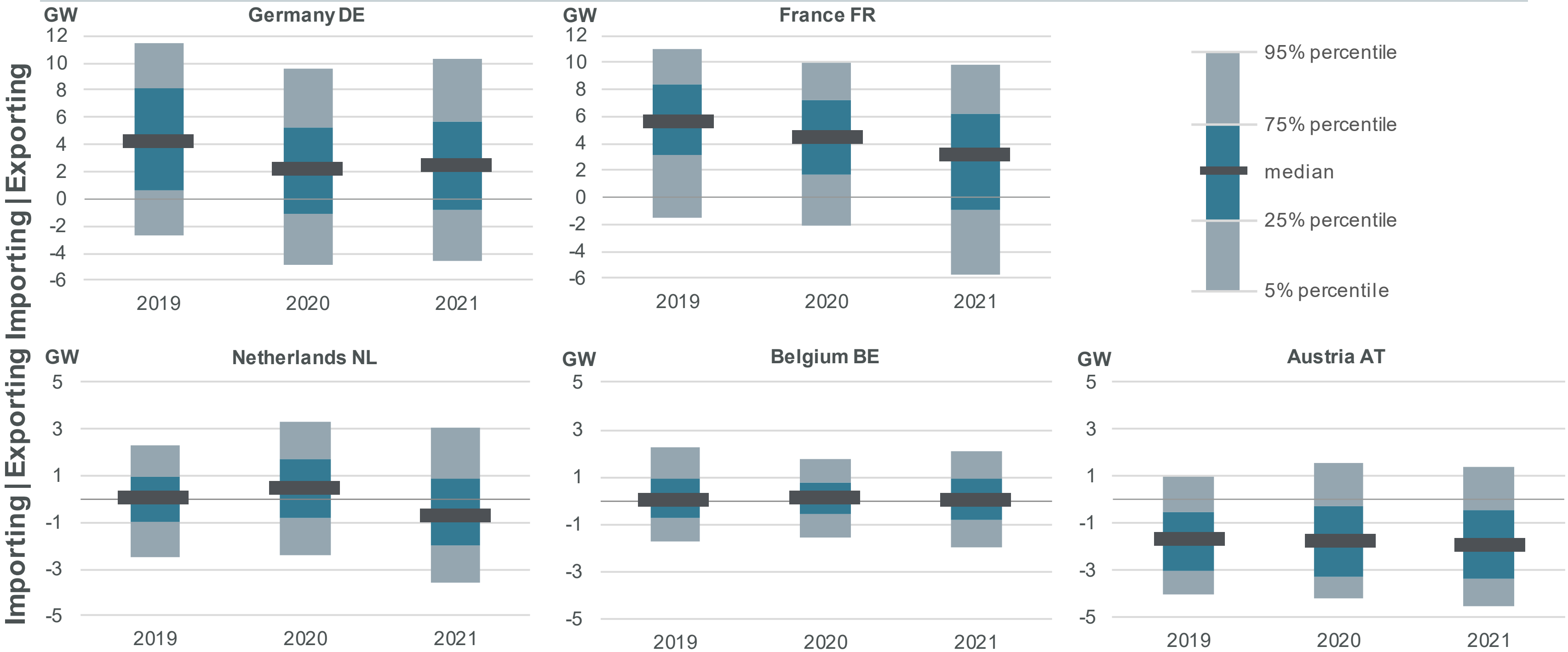
**Note that this figure shows physical flows between countries, which are different from scheduled commercial exchanges between bidding zones.*

Source: ENTSO-E Transparency Platform

Net Positions Central Western Europe

Decreased and exporting net position for France
Reduced and importing net position for the Netherlands

Spread of day-ahead net position in Central Western Europe (CWE)



'Net Position' means the netted sum of electricity exports and imports for each market time unit (hourly and Day-ahead in above graph) for a bidding zone

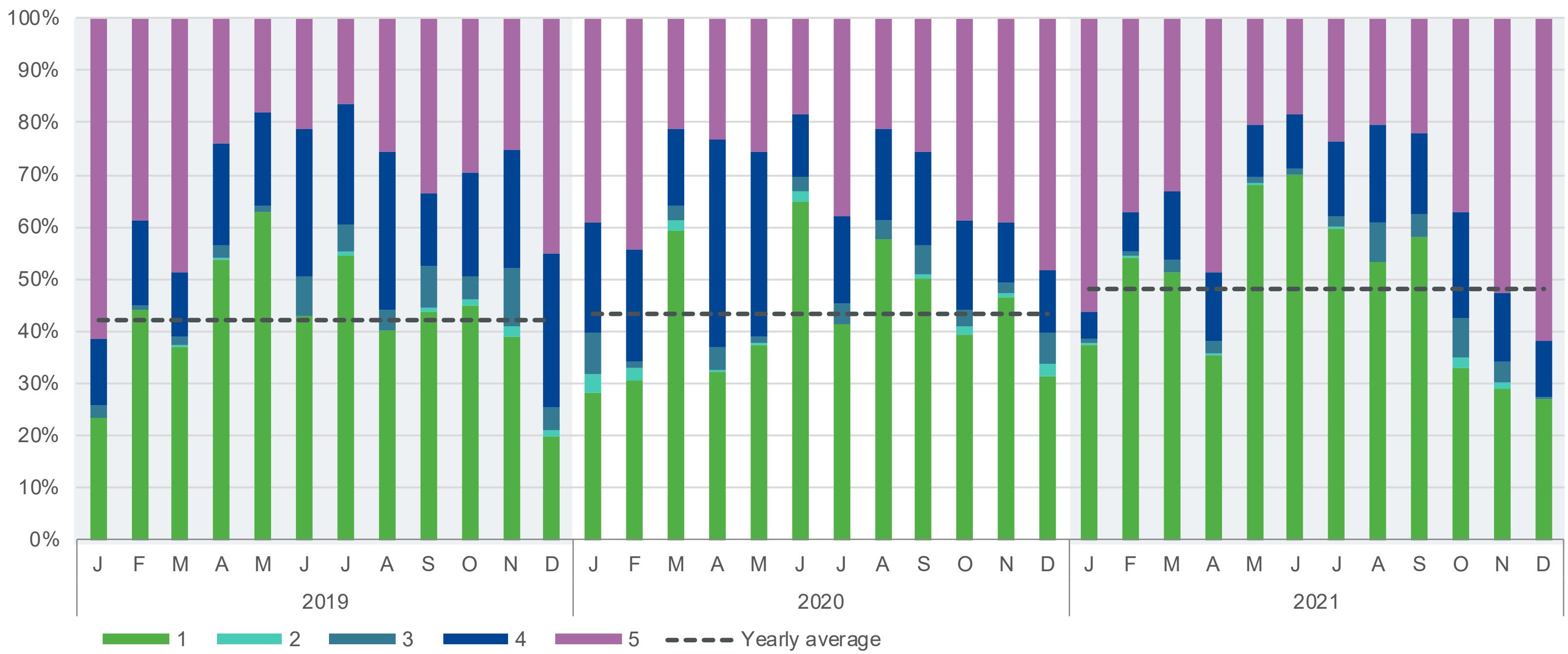
- The Netherlands decreased its annual net position in 2021 shifting towards a net import compared to previous years by an increased amount of hours with a negative net position (which reflects a net import of electricity).
- France had a decreased annual export position in 2021 compared to 2020 and 2019. Their export position is still dominantly exporting, but with an increase in the amount of hours with a negative net position which reflects a lot more imports. Nuclear unavailability in Q4 2021 have resulted in France having the highest average DA price and increased imports.
- Austria, Belgium and Germany have relatively a similar distribution of net positions over 2021 compared to 2020.

Source: ENTSO-E Transparency Platform

Price Areas in CWE

48% of hours with full price convergence in 2021 which is an increase compared to 2020 and 2019.

Monthly Distribution of Day-ahead Price Areas in the CWE Region



- The figure shows the time distribution of the number of day-ahead price areas in the CWE region bidding zones. When there is one price area, full price convergence occurs (all bidding zones have the same price).
- There was full price convergence (1 price area) for 48% of the time in 2021, which 6% percentage point higher than the full convergence of 42% in 2019 and 2020.

Source: ENTSO-E Transparency Platform

DA Price Convergence 2020

Higher convergence between CWE countries

Day-ahead Price Convergence for Selected Countries in 2020

- Relatively high convergence for CWE countries and DE-DK. Lower convergence between CWE and other countries.
- Centrally located countries that are included in the flow-based DA market coupling had higher price convergence with each other.
- For some bidding zone borders there is inherently zero or low price convergence as:
  - Grid losses are implicitly included in market coupling (e.g. NL-GB, NL-NO2)
  - For explicit coupled borders, the capacity auction price needs to be added to the DA prices (DE-PL, DE-CZ, AT-CZ, AT-HU, all CH borders).

Notes for figure:

- DA price convergence in white, black numbers show how often the DA price was higher in that country.
- Percentages do not always count up to 100% due to rounding

 12 April 2022

Source: ENTSO-E Transparency Platform

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DA Price Convergence 2021

Increased convergence within all CWE borders in 2021 compared to 2020

Day-ahead Price Convergence for Selected Countries in 2021

- 2021 DA price convergence increased for all CWE borders
- Full convergence for NL with DE in 53% of the time(+4%pp) which is higher than 2020. 27% of the time DE prices were higher than NL(-3%pp).
- NL convergence with DK1 in 2021 was 49% and increased compared to 2020 (+10%pp)
- Full convergence between DE and AT decreased (-7%pp).

Notes for figure:

- DA price convergence in white, black numbers show how often the DA price was higher in that country.
- Percentages do not always count up to 100% due to rounding

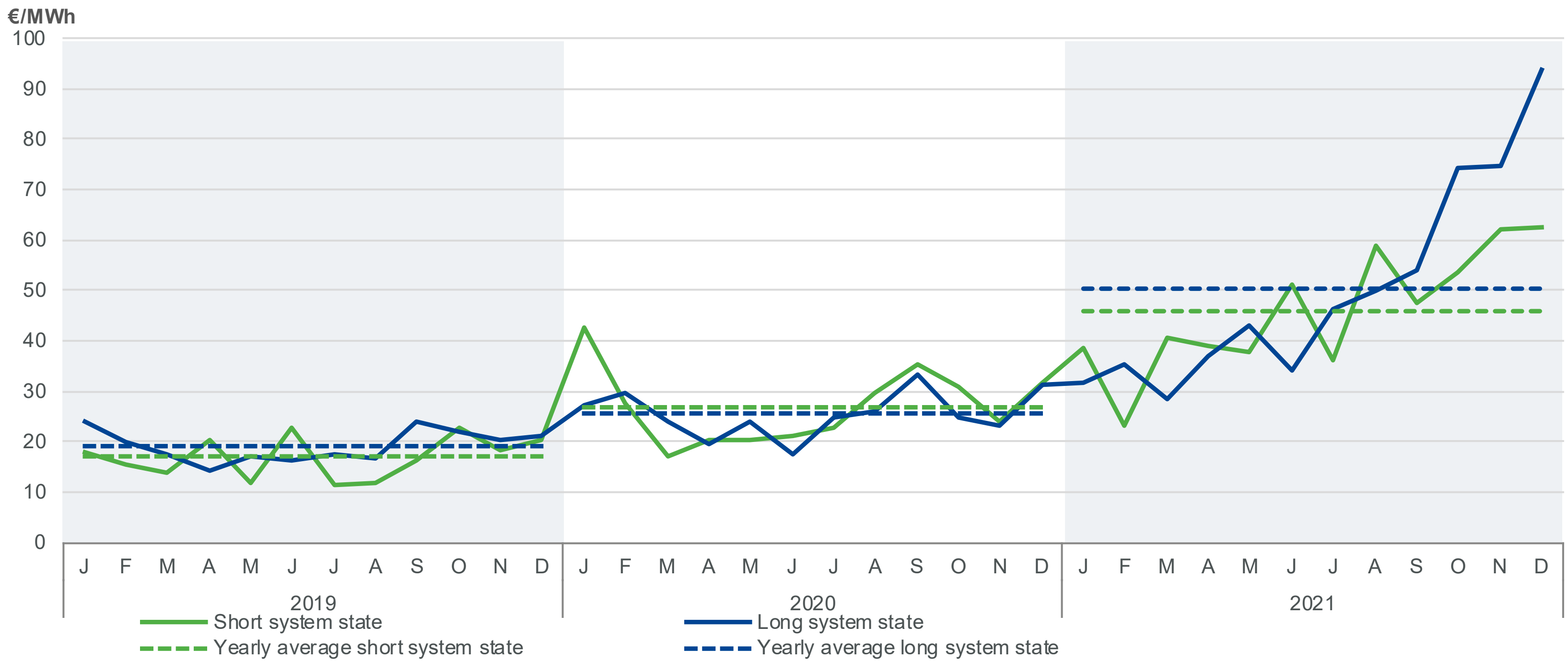
Source: ENTSO-E Transparency Platform

Balancing

Imbalance Price Delta NL

Average long and short system prices increased in 2021
Imbalance Price Delta is higher for long system than for short system

Average Imbalance Price Delta in the Netherlands



In the AMU 2018 ISPs with dual pricing were not included. Since the AMU 2019 these are included using the weighted average ISP price.

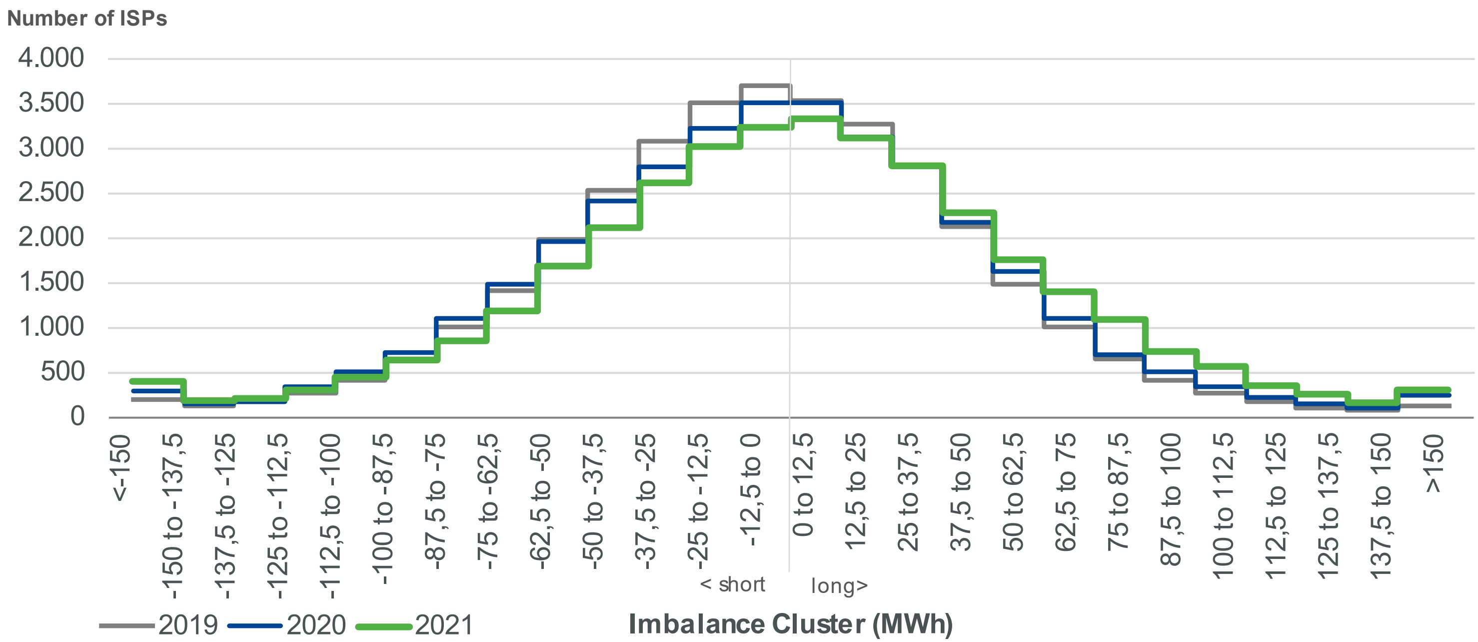
- The imbalance price delta is the difference between the imbalance price and the day-ahead price and can be considered as the penalty for being in imbalance.
- The average imbalance price delta of short system state (imbalance shortage) and of long system state (imbalance surplus) were higher in 2021 compared to 2019 and 2020.
- Long system had an average Imbalance Price higher than short system, most significant in the last quarter of 2021.

Source: TenneT NL, ENTSO-E Transparency Platform

Net Imbalance Volumes NL

Increased number of ISP's when system balance was long

Imbalance Volume Distribution in the Netherlands



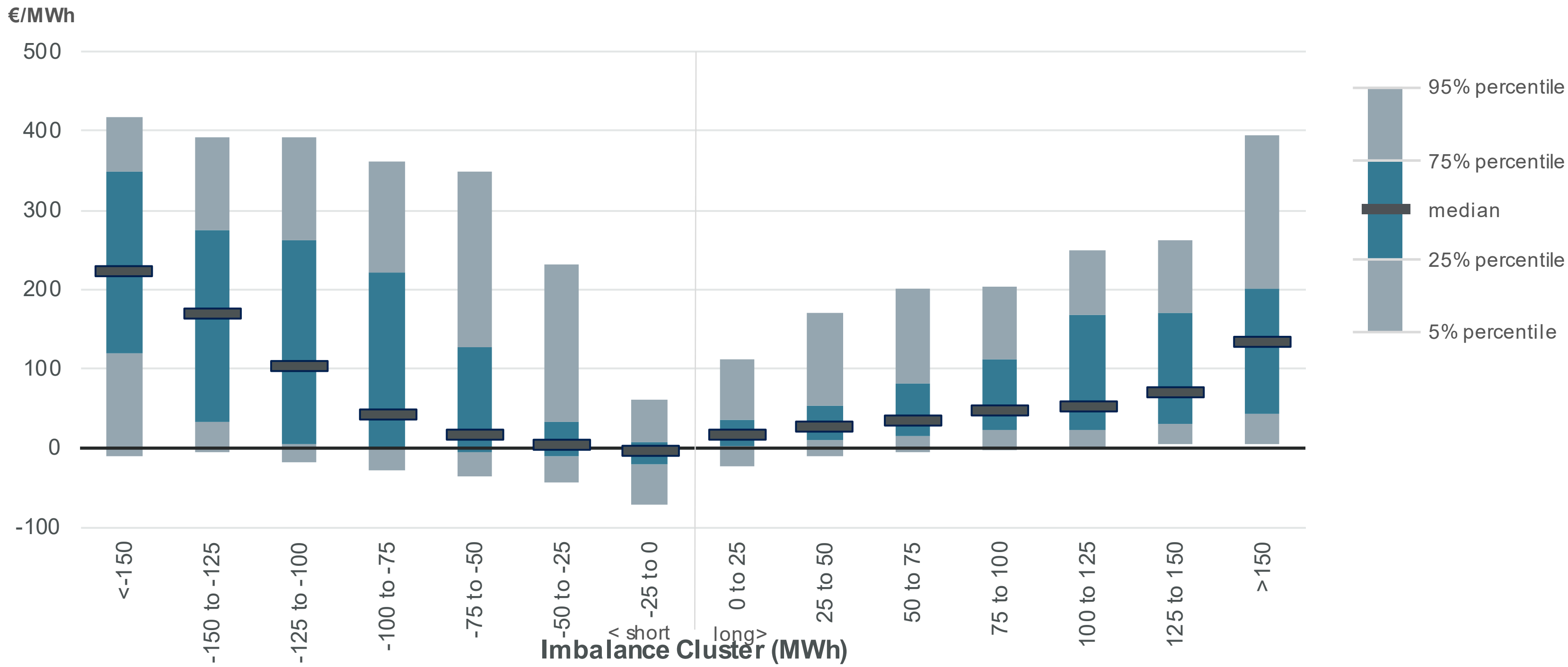
- This figure shows the total number of Imbalance Settlement Periods (ISPs) per year in which the net system imbalance volume fell within a certain cluster of net imbalance volumes.
- The imbalance Volume distribution in 2021 shows some more skewedness towards the right side indicating an increase of the number of ISP's when system imbalance was long.

Source: TenneT NL

Imbalance price delta spreads NL

Higher prices at higher imbalance volume clusters

Spread of Dutch Imbalance Price Delta 2021



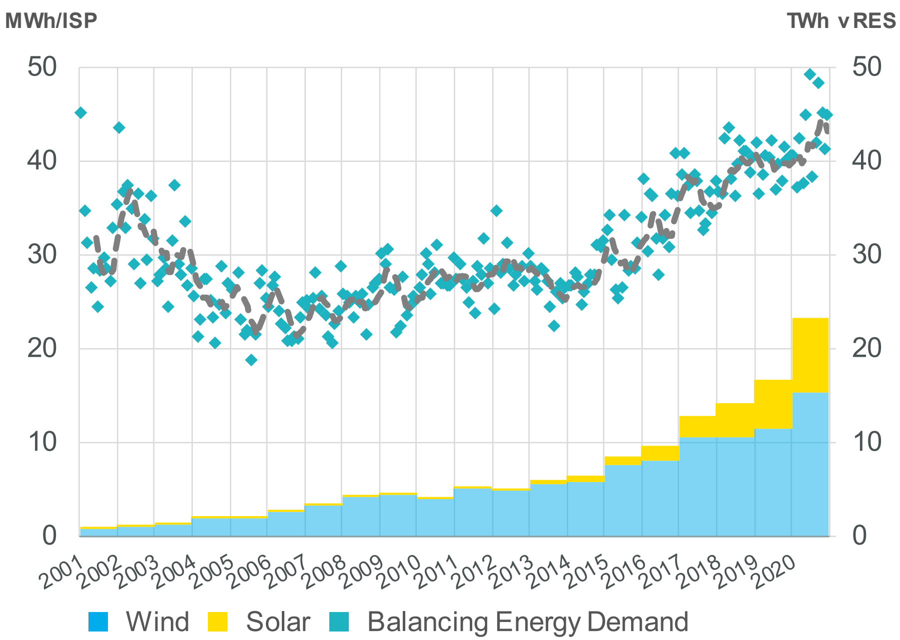
- The figure shows the spread or variability in imbalance price delta, the difference between the day-ahead price and the imbalance price, for certain imbalance clusters.
- The spread is higher at larger imbalance volume clusters, which corresponds to the principle that the incentive to stay balanced or to help restore the system is larger with larger system imbalance volumes.
- As was the case last years as well (*see AMU 2019 and 2020)*, the imbalance price spread includes negative values in most imbalance clusters. This can be attributed to the depressing price effect of IGCC (cooperation between TSOs to exchange imbalance volumes in opposite directions).

Source: TenneT NL, ENTSO-E Transparency Platform

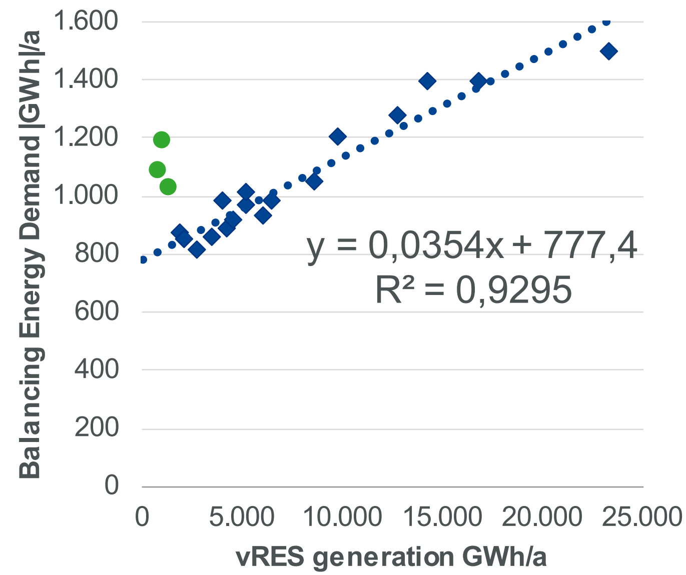
Balancing Energy Demand NL 2001-2020

Increasing balancing energy demand due to increase in renewables
Correlation of 3,5% of annual RES infeed increase in balancing energy demand

Balancing energy demand graph 2001 - 2020



Correlation vRES vs Balancing energy demand



** Note that this correlation in the Netherlands is in contrast with the observations in Germany where an increase in vRES has not led to increased balancing energy demand what is considered as the 'German Paradox' see: The "German Paradox" in the balancing power Markets*

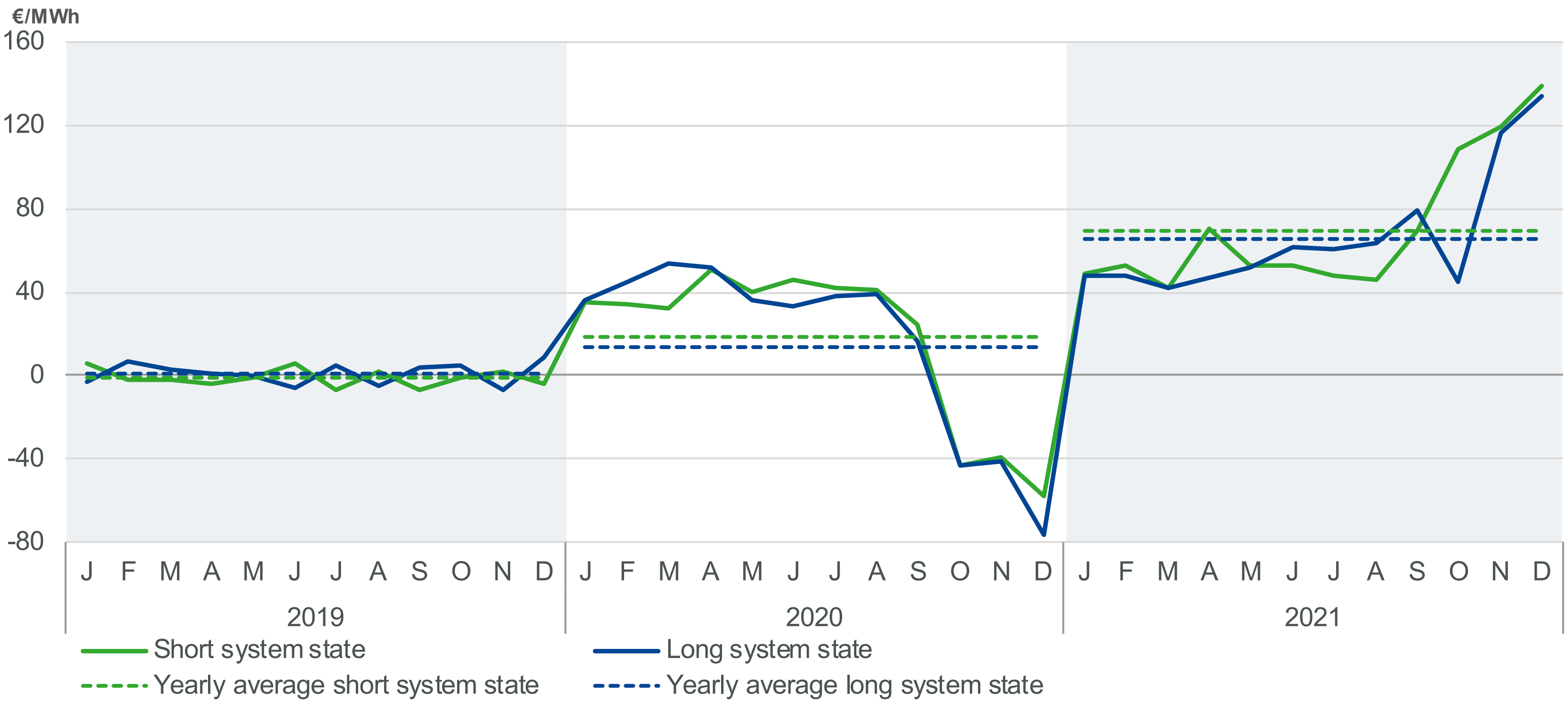
- The left graph shows the absolute Balancing Energy Demand per month since 2001 and the generation of solar and wind combined (vRES) during the same period. The first years of the balancing market design are characterised with a decrease of balancing energy needs during the first years of the imbalance market design. Since 2004 a strong correlation is observed: an increase of balancing energy demand coincides with the increase of vRES.
- The graph on the right shows the correlation between vRES and the Balancing Energy Demand taking 2004 as a starting year. The correlation indicates a Balancing Energy Demand increase of 3,5% of annual RES infeed. Note that this is a correlation, not necessarily causality.

Source: TenneT NL, CBS

Imbalance Price Delta DE

Average long and short system imbalance price delta's increased in 2021

Average Imbalance Price Delta in Germany



- The imbalance price delta is the difference between the imbalance price and the day-ahead price and can be considered as the penalty for being in imbalance.
- The average imbalance price delta of short system state (imbalance shortage) and of long system state (imbalance surplus) were higher in 2021 than in 2020, although they became significantly negative since October 2020.

Source: ENTSO-E Transparency Platform, ENTSO-E Transparency Platform

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Introduction

Main findings

Wholesale market prices

Fuel prices & generators

Capacity & generation

RES support schemes

Wholesale market integration

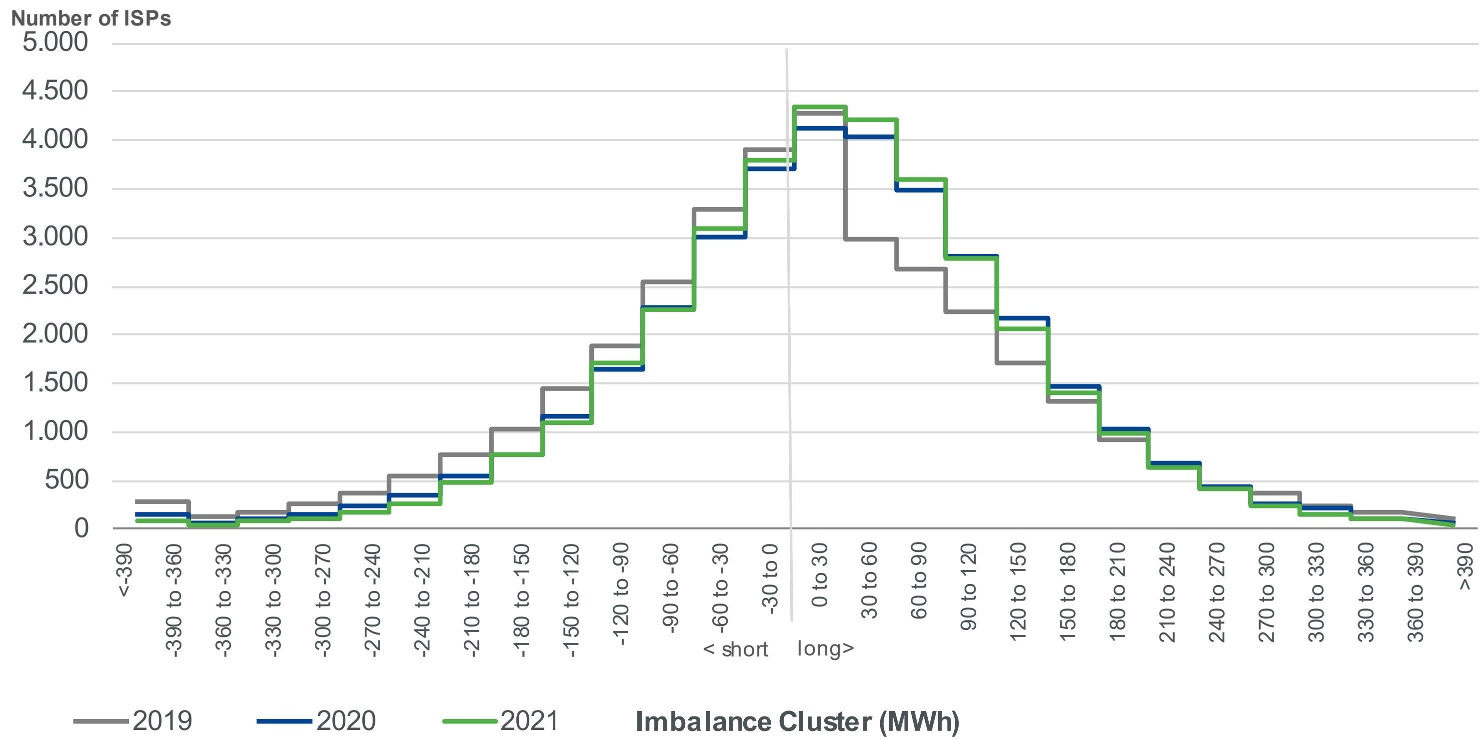
Balancing

Congestion management

Net Imbalance Volumes DE

Increased number of ISP's in long system Imbalance Cluster

Imbalance Volume Distribution in Germany



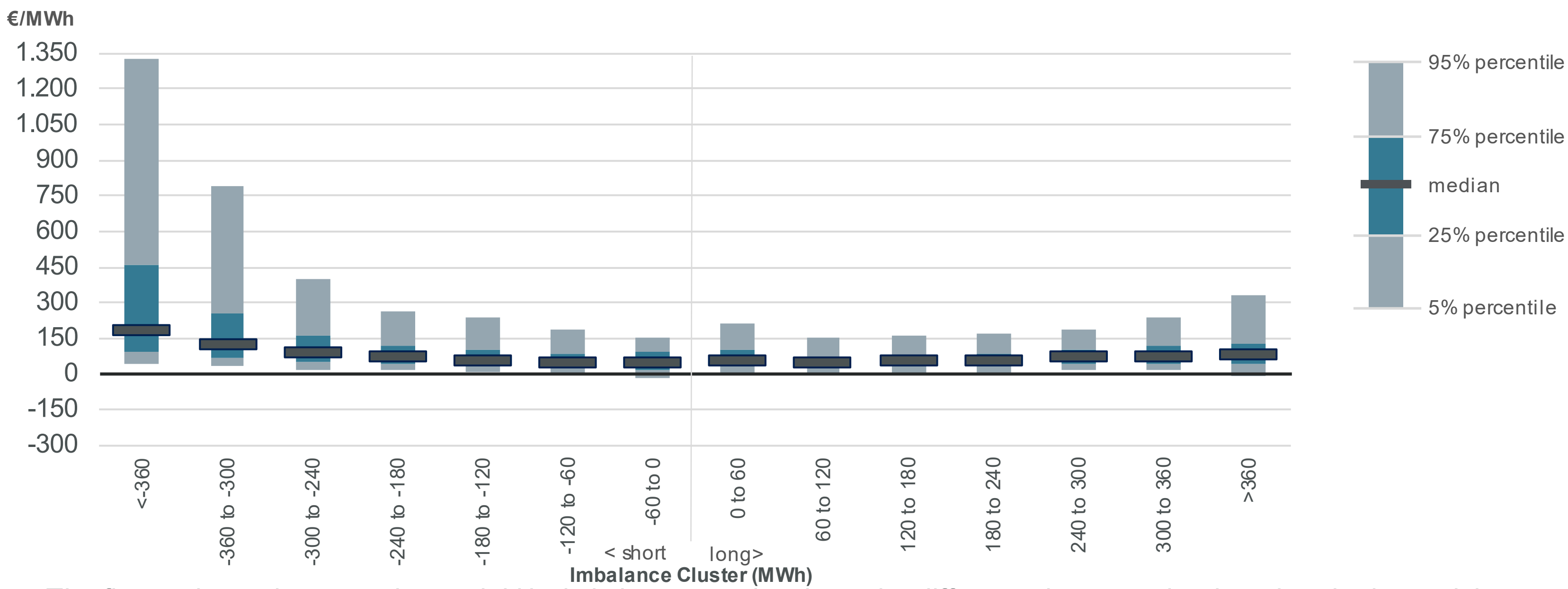
- This figure shows the total number of Imbalance Settlement Periods (ISPs) per year in which the net system imbalance volume fell within a certain cluster of net imbalance volumes.
- The imbalance Volume distribution in 2021 and 2020 shows some more skewedness towards the right side indicating an increase of the number of ISP's in a long system Imbalance Cluster compared to 2019.

Source: ENTSO-E Transparency Platform

Imbalance price delta spreads DE

Higher prices at higher imbalance volume clusters

Spread of German Imbalance Price Delta 2021



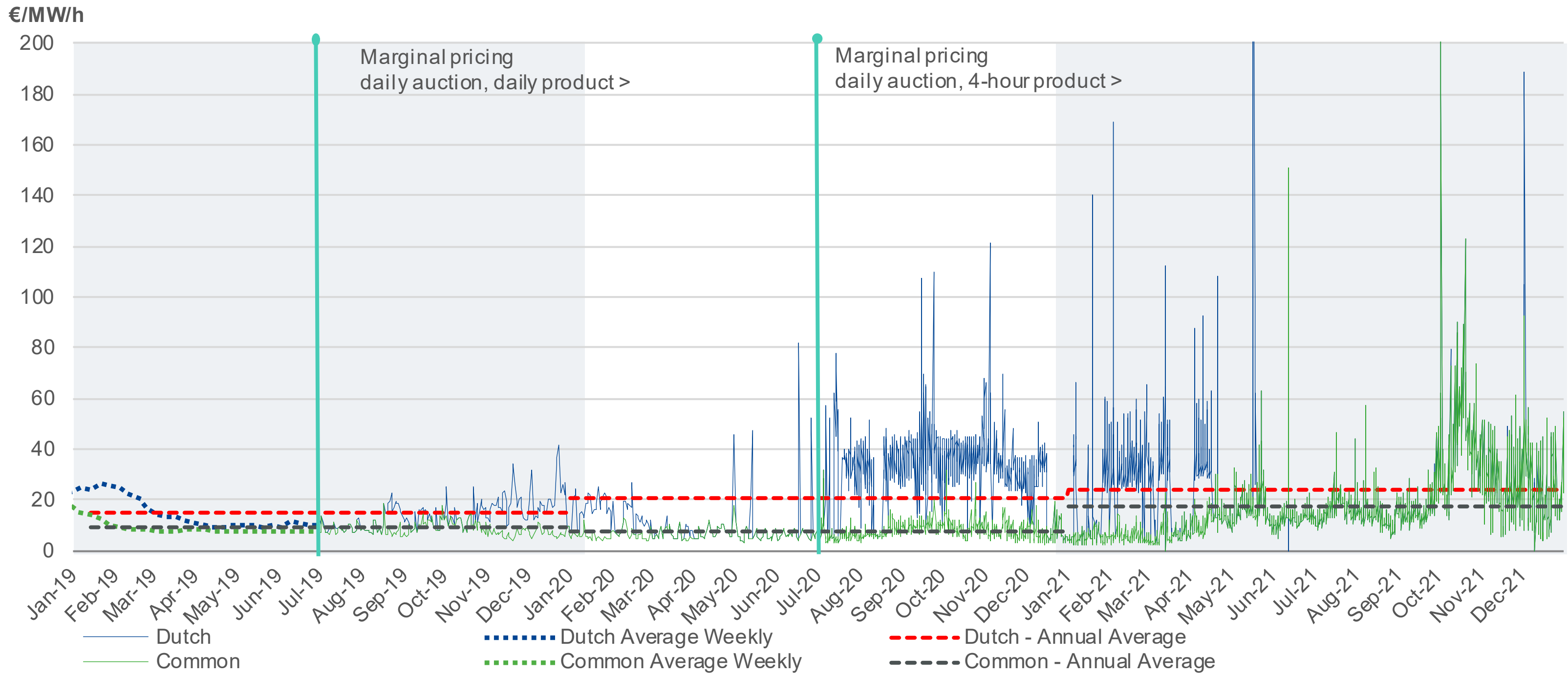
- The figure shows the spread or variability in imbalance price delta, the difference between the day-ahead price and the imbalance price, for certain imbalance clusters.
- A defining aspect of the current average pricing model is the local price peak around zero imbalance which is reflected in the graph in the -60 to 0 and 0 to 60 cluster. This is a difference with the imbalance price delta of approximately zero for small imbalance volumes in the Dutch system.
- The spread is higher at larger imbalance volume clusters, which corresponds to the principle that the incentive to stay balanced or to help restore the system is larger with larger system imbalance volumes.
- Short system has higher and more volatile price delta's, particularly at the larger imbalance clusters. This indicates higher cost for short system which contributes to the imbalance volume distribution being skewed to a more long system state (*see: Net Imbalance Volumes DE*)

Source: ENTSO-E Transparency Platform, ENTSO-E Transparency Platform

FCR common & Dutch auction

Increased convergence of the Common and Dutch prices since May 2021
Increased prices for the Common and Dutch prices in 2021 compared to 2020

Frequency Containment Reserve (FCR) Capacity Prices in the Common and Dutch Auctions



Note that since 01-07-2019 there is no separate auction for NL, the minimum capacity that needs to be active in the NL control area (34MW) is a boundary condition in the common auction algorithm.

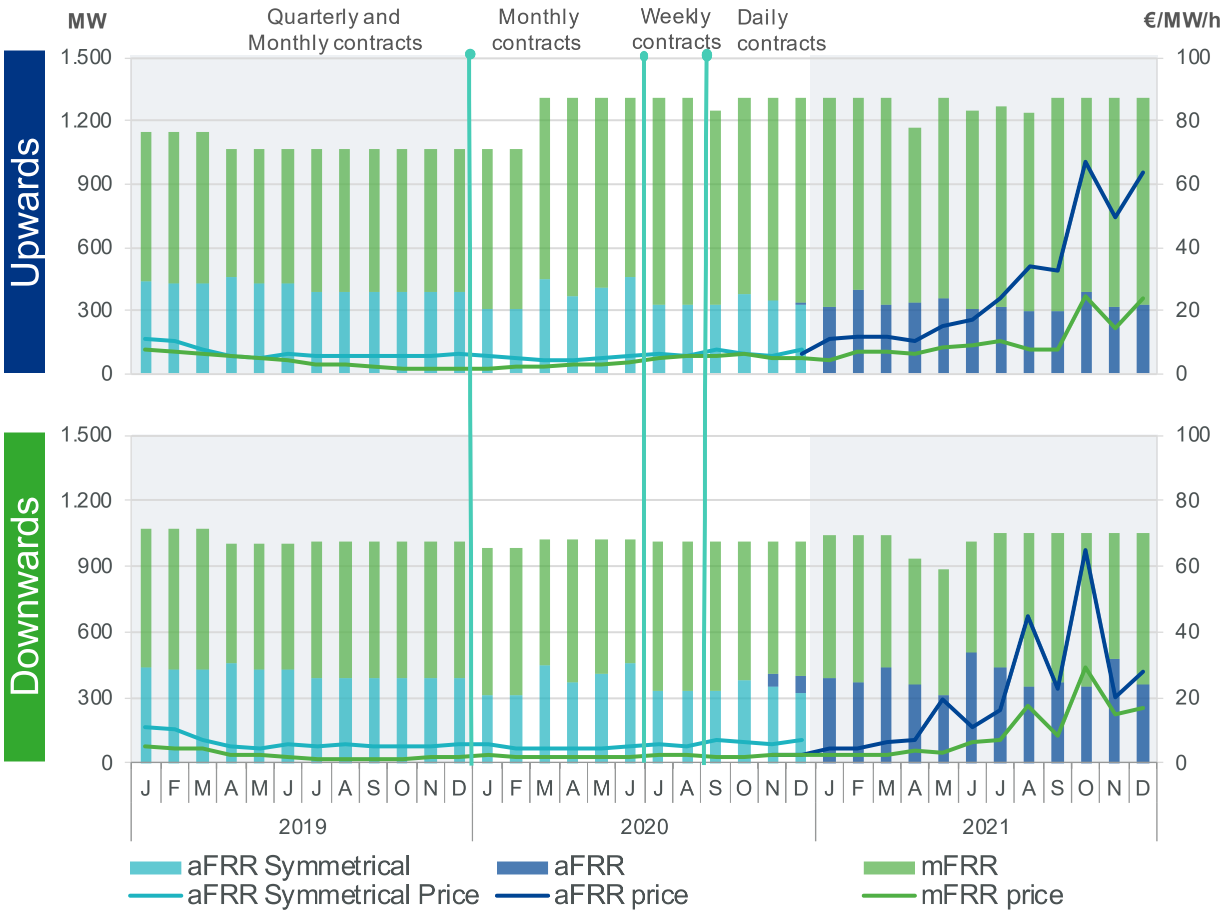
- The prices in the common auction (is also German price) converged with the Dutch prices for most 4-hour blocks since May 2021.
- Overall FCR prices in 2021 have increased compared to 2020 this is partly the result of increased prices for energy.
- From July 2020 the auction systematics changed for both the Common and Dutch Auction. The D-1 daily auctions for a daily product were replaced with daily auctions for six 4-hour products.

Source: regelleistung.net

aFRR and mFRRda in the Netherlands

Increased capacity costs for all contracted aFRR and mFRR

Contracted automatic Frequency Restoration Reserve (aFRR) and manual Frequency Restoration Reserve directly activated (mFRRda) Capacity Volumes and Prices in the Netherlands



**aFRR symmetrical prices are a represented as costs divided by the volume and divided by 2 to represent only the costs for the visualized direction (upwards or downwards)*

Source: TenneT NL

- aFRR and mFRR capacity costs have increased during 2021.
- Prices in the Netherlands have increased compared to Germany. In the relatively small NL market higher prices can easily be triggered/boosted by specific market structure details, like the 24h contract period in NL (4h in DE) or small differences in bidding methods/regulations.

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aFRR and mFRRda in Germany

Capacity prices peaked in May and October 2021 due unavailability, especially pumped hydro storage

Contracted automatic Frequency Restoration Reserve (aFRR) and manual Frequency Restoration Reserve (mFRR) Capacity Volumes and Prices in Germany

- Capacity costs for aFRR and mFRR have increased in 2021 but much less as in the Netherlands.
- The unavailability that caused the peaks in March and October is e.g. due to droughts, leading to less hydro, and revisions of pumped storage.

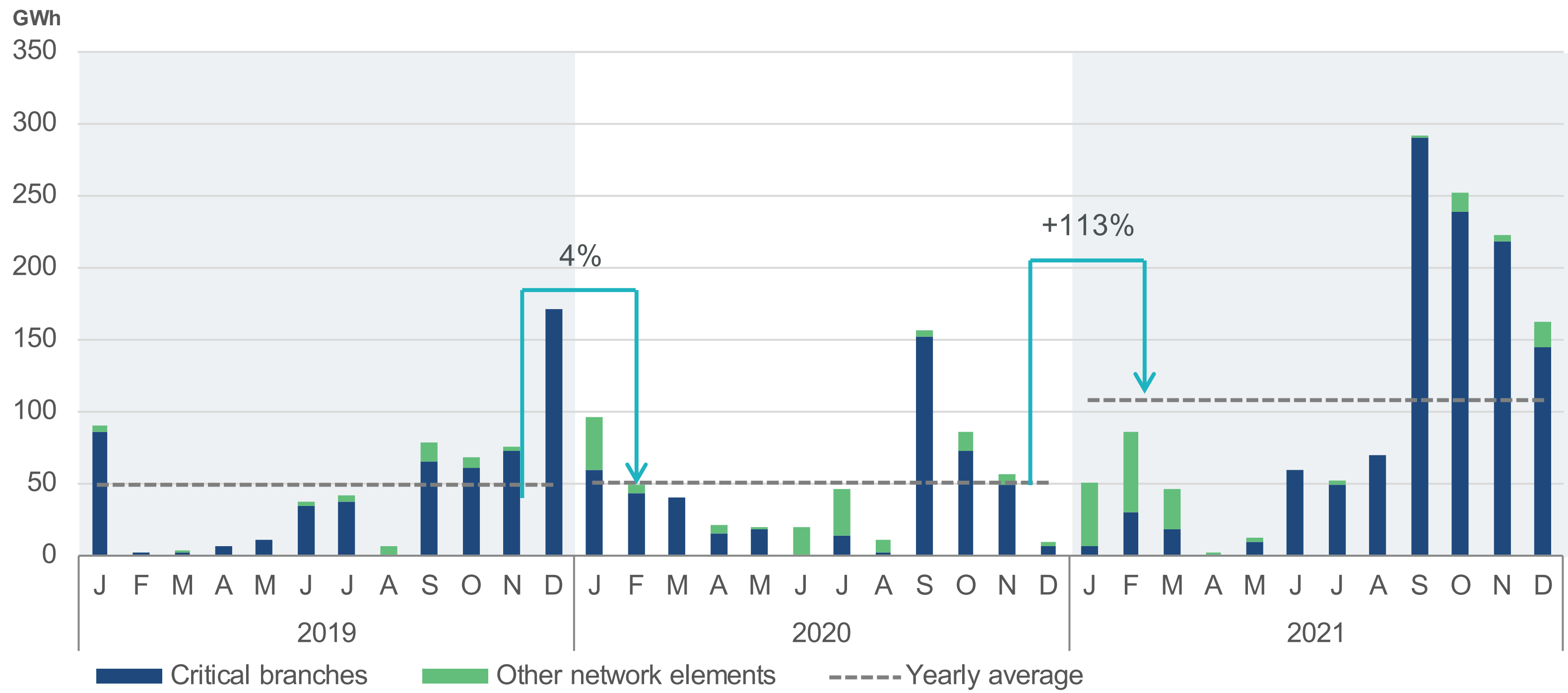
Source: TenneT DE

Congestion management

Redispatch Volumes NL

Redispatch volumes increased with 113% compared to 2020
Most redispatch required on critical branches

Redispatch upwards and downwards volumes in the Netherlands



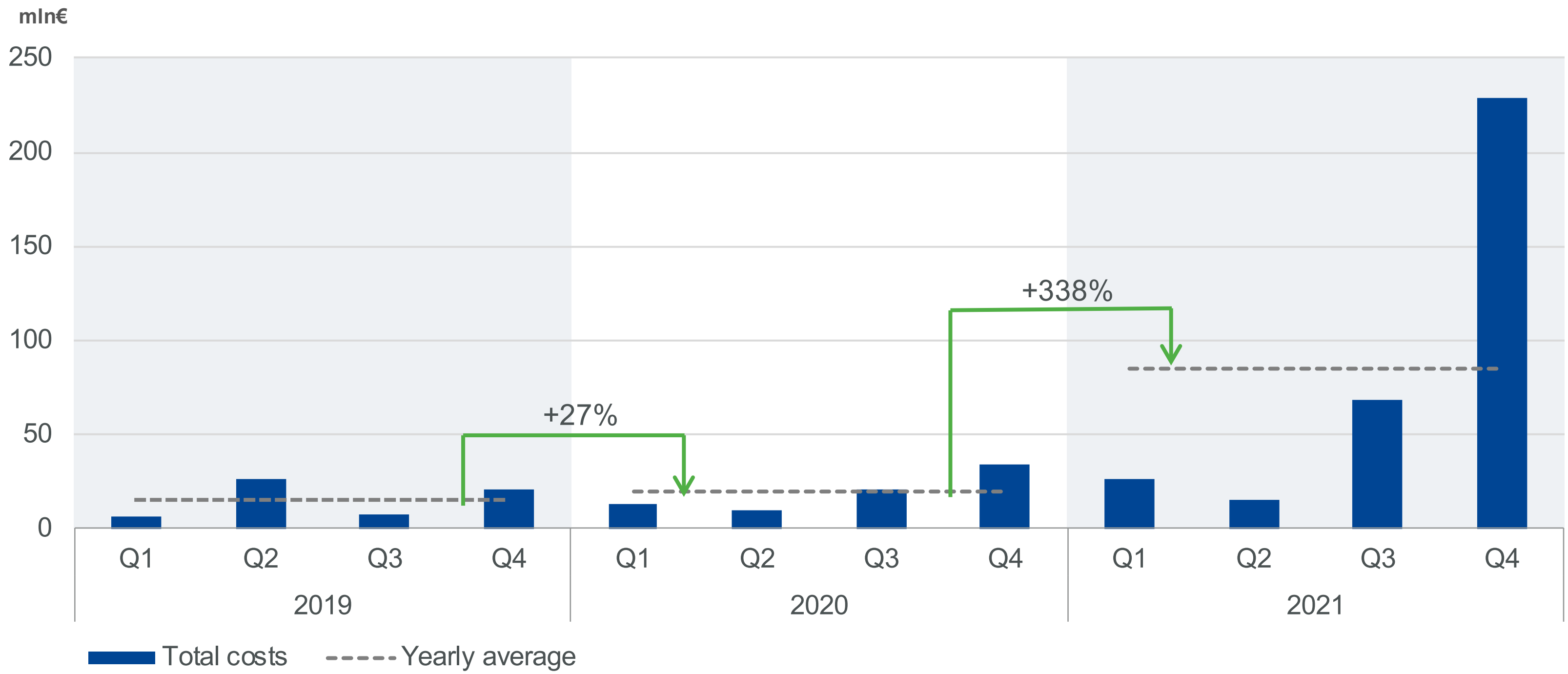
- Critical branches are lines that are included in CWE flow-based market coupling, as they significantly impact and are impacted by CWE cross-border exchanges. Redispatch takes place to ensure that grid operation remains within operational security limits.
- Redispatch volumes increased from an average of 51GWh/month in 2020 towards 108 GWh/month in 2021. The total redispatch volume in 2021 was 1.302 GWh.

Source: TenneT NL

Congestion Management Costs NL

Costs for Congestion Management increased by 338% in 2021

Redispatch and Restriction Costs in the Netherlands



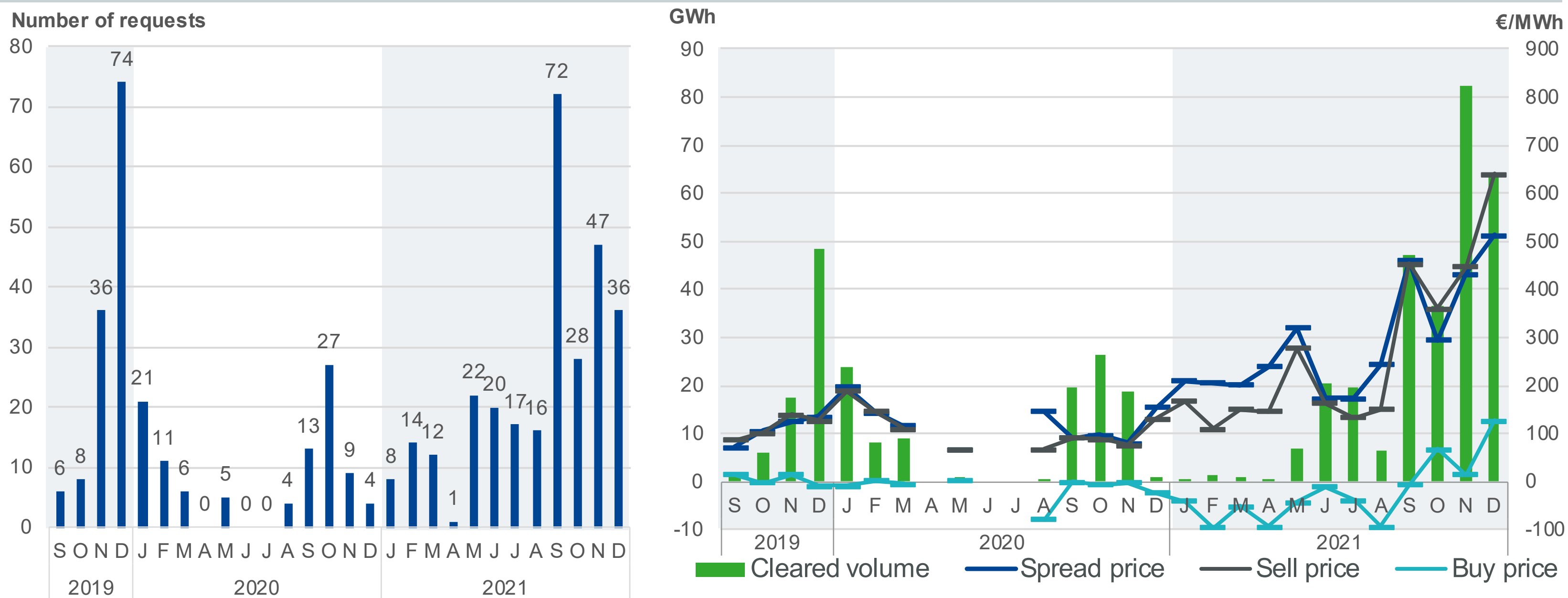
- This figure shows redispatch and restriction agreements in the Netherlands. Restriction agreements concerns contracts with market parties to withhold a share of production for a certain period.
- Total costs increased from €77,6 million in 2020 to € 339,7 million in 2021 with a more than doubling of redispatch volume activated. The cost increase is a combination of higher energy prices, more redispatch volumes and increased restriction agreements.
- A majority of the costs in Q3 and Q4 in 2021 are related to the upgrading project of the connection 380kV Lelystad-Diemen which will increase from a 2.500 ampere towards a 4.000 ampere connection.

Source: TenneT NL

GOPACS

286 GWh of redispatch volume contracted through GOPACS Highest average IDCONS prices in December 2021 of 513 €/MWh

Number of congestion management request, cleared volume of IDCONS, and weighted average prices of cleared IDCONS



** Note that volumes are expressed as volume upwards + volume downwards for consistency with the redispatch volume figures. Previous AMU's reported only single IDCONS volumes.*

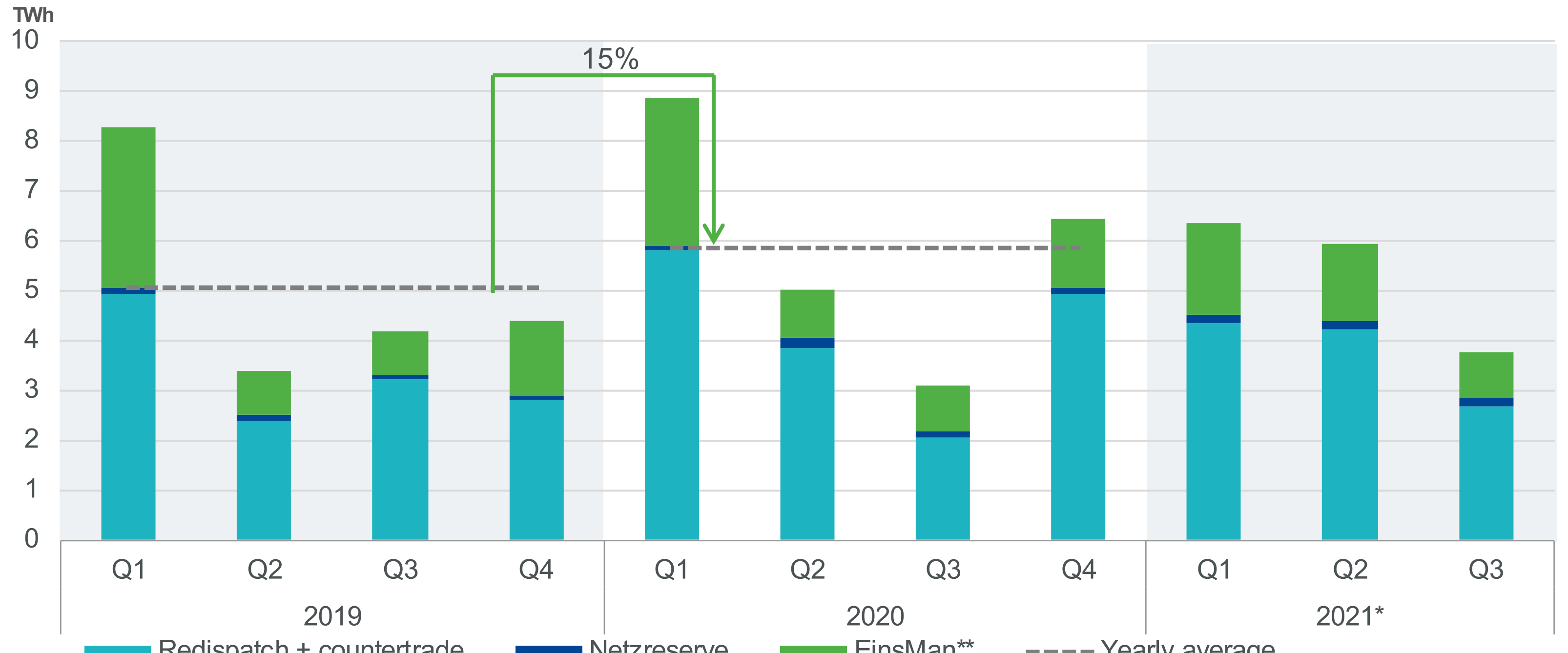
- In September 2019 the first Intraday Congestion Spreads (IDCONS) were activated via the Grid Operators Platform for Congestion Solutions (GOPACS). GOPACS is a Dutch TSO-DSO coordinated market-based congestion management platform that enables intraday bids with a geo-tag to be used for congestion management as well. An IDCONS is the spread the Grid Operator pays in order for a buy and sell bid to be cleared. For a more detailed explanation visit: www.GOPACS.eu.
- In total 286 GWh of redispatch volume was procured via the GOPACS platform in 2021. This is 22% of the total redispatch volume of 1.302 GWh.
- Spreads were highest in December 2021 with 513 €/MWh. The average buy prices are typically around zero or negative.

Source: TenneT NL

Redispatch Volumes DE

Lower Redispatch Volumes in Q1 and higher volumes in Q2 and Q3

Redispatch Volumes in Germany



** For 2021 only volumes for the first three quarters were available. ** EinsMan volumes exist only of downward adjustments.*

- Conventional redispatch (conventional power plants > 10 MW) in combination with countertrade remained the most common process used for solving congestion in the German grid. RES curtailment (EinsMan) related redispatch slightly decreased in the first three quarters of 2021, especially in Q1.
- The contracted Netzreserve plants are called upon when redispatch availability is insufficient. For the first three quarters of the 2021, the use of Netzreserve increased slightly, mostly in Q1.

Source: Bundesnetzagentur

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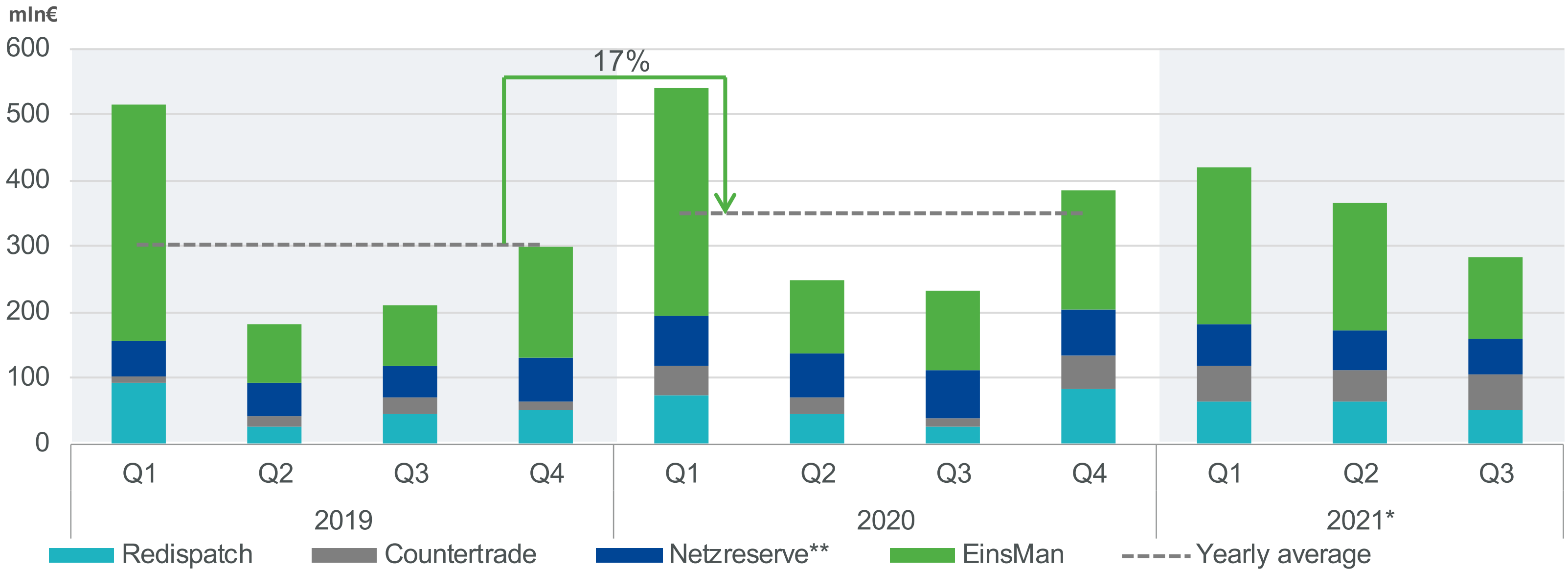
Congestion Management Costs DE

Increased redispatch costs, mainly in Q2

Redispatch Costs in Germany



** For 2021 only costs for the first three quarters were available. ** Netzreserve costs for all years were given as yearly aggregated values. Therefore, costs were equally divided over the four quarters.*

- Costs for congestion management are almost similar for the first three quarters of 2021 compared to 2020. Nevertheless Q2 and Q3 are much higher than the same quarters in 2019 and 2020. For Q2 this is mostly related to a higher volume requested for congestion management, for Q3 the higher energy prices partly contribute to this higher costs.
- Biggest contribution to increasing costs due to EinsMan (high wind energy production). Redispatch and countertrade costs also increased, Netzreserve costs decreased.
- Congestion management costs are generally higher in winter months, due to more stressed grid conditions. Due to higher energy prices in Q4 2021 it is expected that Q4 costs are higher than previous years.
- When compared to the previous slide, redispatch measures show the lowest costs per GWh, and EinsMan the highest.

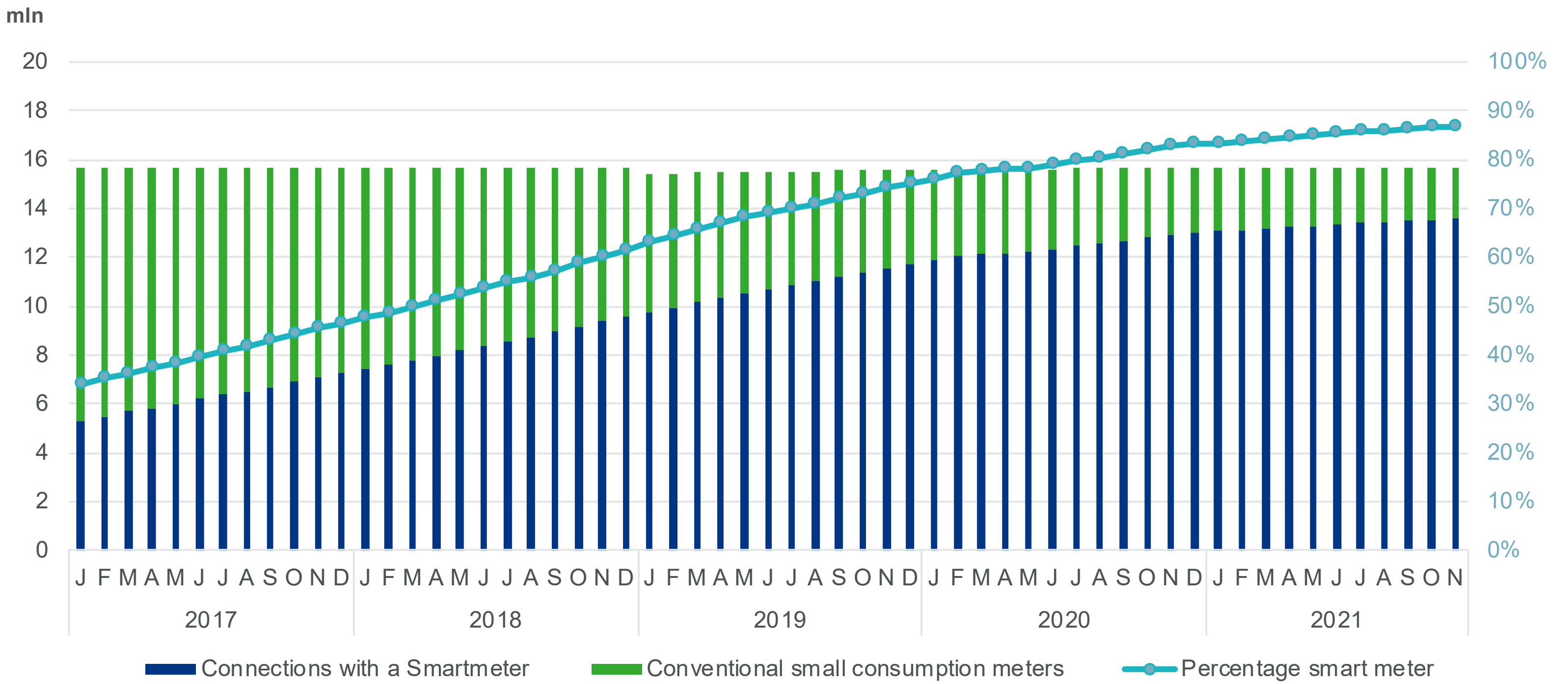
Source: Bundesnetzagentur

Market facilitation

Smart meter Adoption in the Netherlands

Smart meter adoption reaching 87% in November 2021

Smart meter and conventional meters from 2017 – 2021



- Smart meter adoption for small consumption meters reached 87% of all small consumption connections until November 2021.
- The adoption of the smart meter is an important precondition for allocation 2.0 (*see: Allocatie 2.0 NEDU*). Allocation 2.0 will replace the static consumer profiles used in the current allocation process with actual consumer smart meter measurements. This will improve transparency, fairness and efficiency in the market.

Source: NEDU

Annex

Annex (1/2)

	Day-ahead avg. price 2020	Day-ahead avg. price 2021	Physical import 2020	Physical import 2021	Physical export 2020	Physical export 2021	Net export position 2020	Net export position 2021
	€/MWh	€/MWh	TWh/year	TWh/year	TWh/year	TWh/year	TWh/year	TWh/year
AT	33,1	106,9	23,1	25,3	19,6	16,8	-3,6	-8,5
BE	31,9	104,1	12,8	12,5	12,4	20,0	-0,4	7,6
CH	33,9	114,9	23,4	28,8	27,6	22,7	4,2	-6,0
CZ	33,6	100,7	12,1	14,4	21,8	25,6	9,7	11,2
DE	30,5	96,8	43,7	44,2	63,4	69,2	19,8	24,9
DK1	25,0	88,1	18,2	19,7	11,4	14,8	-6,9	-4,9
DK2	28,4	87,9						
EE	33,7	86,7	7,0	7,2	3,4	4,5	-3,6	-2,6
ES	33,9	111,9	15,6	14,8	11,9	14,0	-3,6	-0,8
FI	28,0	72,3	21,4	24,5	6,8	6,9	-14,7	-17,5
FR	32,2	109,2	16,1	20,6	60,0	63,6	44,0	43,0
GB	39,6	117,8	22,3	29,8	3,3	2,7	-19,0	-27,0
HR	38,0	114,7	8,0	9,0	3,0	4,6	-5,0	-4,3
HU	39,0	113,9	17,9	18,8	6,5	6,0	-11,5	-12,8
IE	35,8	136,1	0,7	1,0	1,6	0,5	0,9	-0,5
IT-CNOR	38,7	125,2	38,3	45,5	5,5	2,1	-32,8	-43,4
IT-CSUD	39,7	125,1						
IT-NOR	37,8	125,0						
IT-SARD	39,1	123,4						
IT-SICI	46,1	128,9						
IT-SUD	38,9	123,4						
LT	34,0	88,8	10,8	11,6	2,8	2,4	-8,1	-9,2
LV	34,4	90,5	3,2	4,0	1,6	2,2	-1,6	-1,8
NL	32,2	103,0	17,3	19,2	20,0	16,2	2,6	-3,0
NO1	9,3	74,7	4,3	7,6	24,7	25,9	20,4	18,3
NO2	9,3	75,1						
NO3	9,5	41,1						
NO4	8,9	35,0						
NO5	11,5	74,6						
PL	45,4	87,0	19,2	14,8	6,4	13,8	-12,8	-1,0
PT	34,6	112,0	6,2	8,1	4,7	3,3	-1,5	-4,8
SE1	14,4	42,5	13,8	10,2	38,2	35,4	24,4	25,2
SE2	14,7	42,6						
SE3	21,6	66,0						
SE4	26,7	80,5						
SI	36,7	114,8	5,7	7,2	7,7	7,5	2,0	0,3
SK	34,0	102,8	13,0	13,7	12,7	13,0	-0,3	-0,7

Annex (1/2)

	Unit	2019		2020		2021		Source
		NL	DE	NL	DE	NL	DE	
Yearly average hard coal price (API#2 OTC)	€/MWh.th	8,0		6,3		13,8		[1]
Yearly average natural gas price (TTF OTC monthly)	€/MWh.th	14,1		9,1		40,3		[1]
Yearly average carbon price (EEX futures)	€/tCO2	24,9		24,7		53,3		[1]
Yearly average Clean Dark Spread base	€/MWh	0,6	-2,8	-3,9	-5,7	24,5	18,4	[1,2]
Yeary average Clean Dark Spread new	€/MWh	5,1	1,7	0,1	-1,7	33,2	27,1	[1,2]
Yearly average Clean Spark Spread base	€/MWh	3,6	0,3	4,8	3,0	2,1	-4,0	[1,2]
Yearly average Clean Spark Spread peak	€/MWh	9,1	6,8	10	9,6	16,7	14,0	[1,2]
Average imbalance price delta long system	€/MWh	16,4	1,1	25,4	13,8	25,4	65,7	[2,3]
Average imbalance price delta short system	€/MWh	16,4	-0,8	27,0	18,7	27,0	69,2	[2,3]
Yearly average FCR price Dutch auction (symmetrical)	€/MW/h	15,5		20,4		24,0		[3,4]
Yearly average FCR price common auction (symmetrical)	€/MW/h	9,4		7,3		17,8		[5]
Yearly average aFRR upward price	€/MW/h	6,5	3,8	5,7	2,5	29,0	11,0	[3,4]
Yearly average aFRR downward price	€/MW/h		3,6		2,2	21,0	9,8	[3,4]
Yearly average mFRRda upward price	€/MW/h	4,1	6,1	4,0	2,7	11,0	7,4	[3,4]
Yearly avergae mFRRda downward price	€/MW/h	2,5	2,3	2,1	1,3	9,8	2,6	[3,4]
Redispatch volumes	GWh/year	589,5	20.235,0	610,2	23.360,0	1.301,9		[3,4,6]
Redispatch costs	mln.€/year	61,0	1.206,6	77,5	759,7	339,7		[3,4,6]

Sources
1) 1) energate 2) ENTSO-E Transparency Platform 3) TenneT NL 4) TenneT DE 5) regelleistung.net 6) Bundesnetzagentur

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