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ENERGY RESEARCH

The energy crunch: why have UK and European energy prices spiked?

September 2021

Aurora provides data-driven intelligence for the global energy transformation

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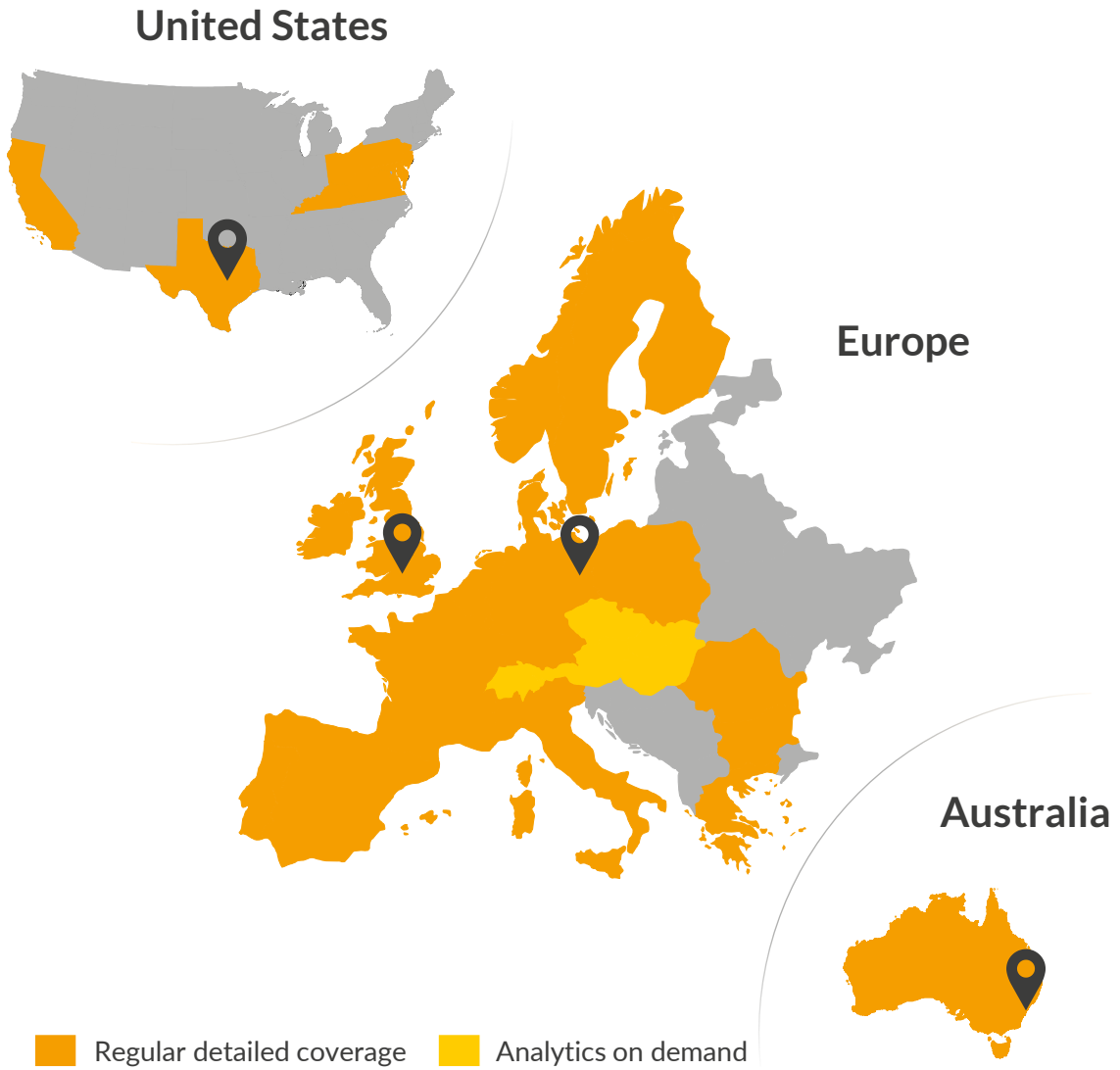
- Power markets
- Renewables
- Storage
- Electric vehicles
- Hydrogen H_2
- Carbon CO_2
- Natural gas



4 Offices
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180+
market experts

350+
subscribing companies

100+
transactions supported in 2020

Source: Aurora Energy Research

Agenda

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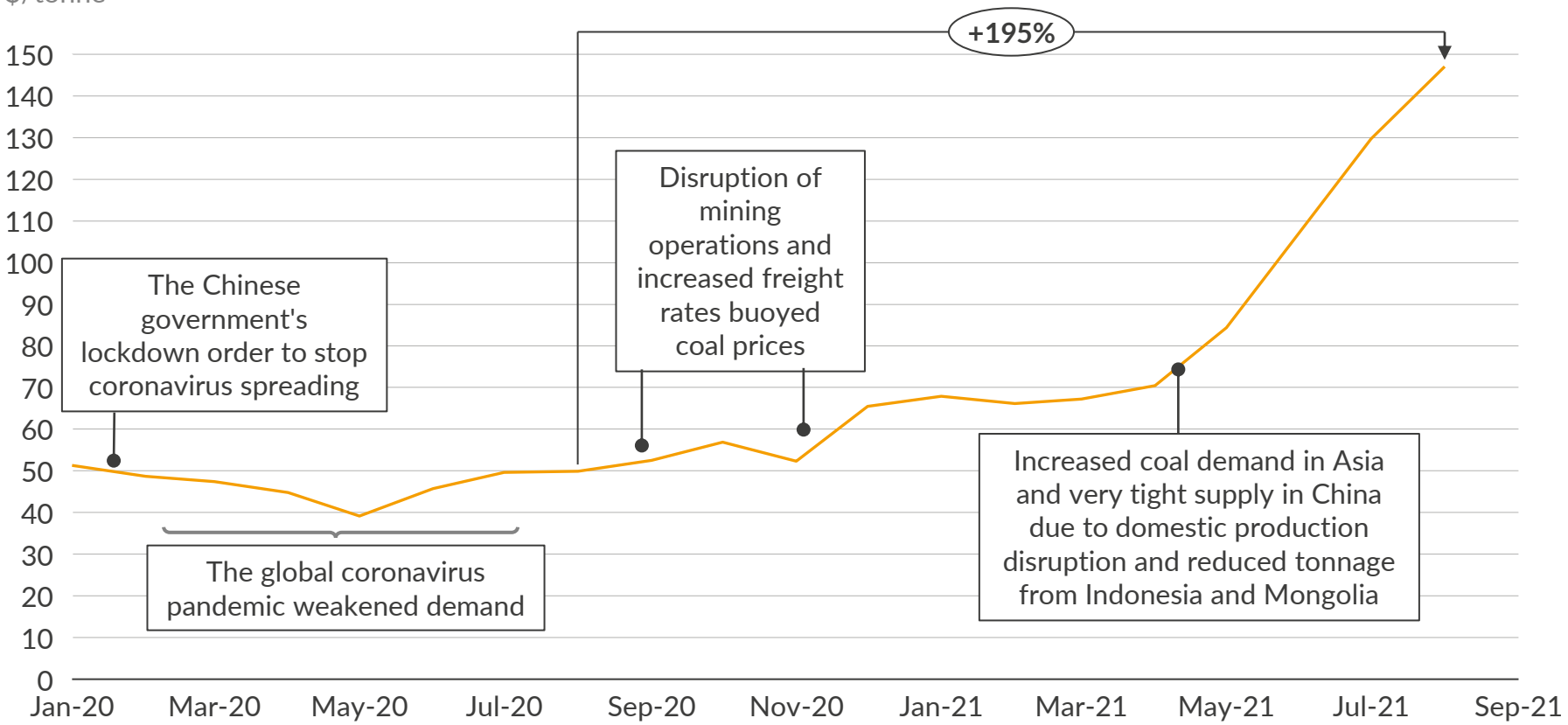
I. Why have commodity prices spiked and how long will this last?

1. Coal
2. Gas
3. EU ETS Carbon market

II. What are the implications for GB power markets?

ARA coal prices rose to $147/tonne in Aug-21, up 195% y-o-y and growing on average 20.3% m-o-m since Apr-21

Traded average monthly price of steam coal at ARA
$/tonne



- ARA coal has reached $147/tonne in Aug-21, growing on average 20.3% m-o-m since Apr-21, and reached a daily price of $169/tonne in Sep-21[1]
- China and India are driving global coal demand as industry and economy recover. Chinese demand outstripped domestic supply between Feb and Apr-21. More than half of India's coal fired power fleet had less than 7 days' supply of coal left at the beginning of Sept-21, according to the Indian Central Electricity Authority
- Supply has been weakened by reduced tonnage from Indonesia and Mongolia due to COVID restriction in June. Moreover, several key Chinese mines' production was disrupted by safety inspections
- Low supply in Asia pushed European coal prices upwards due to the big opportunity for arbitrage

1) On 16/09/2021, the coal (API2) daily price reached $169/tonne at ARA hub.

Sources: Aurora Energy Research EOS, EIKON

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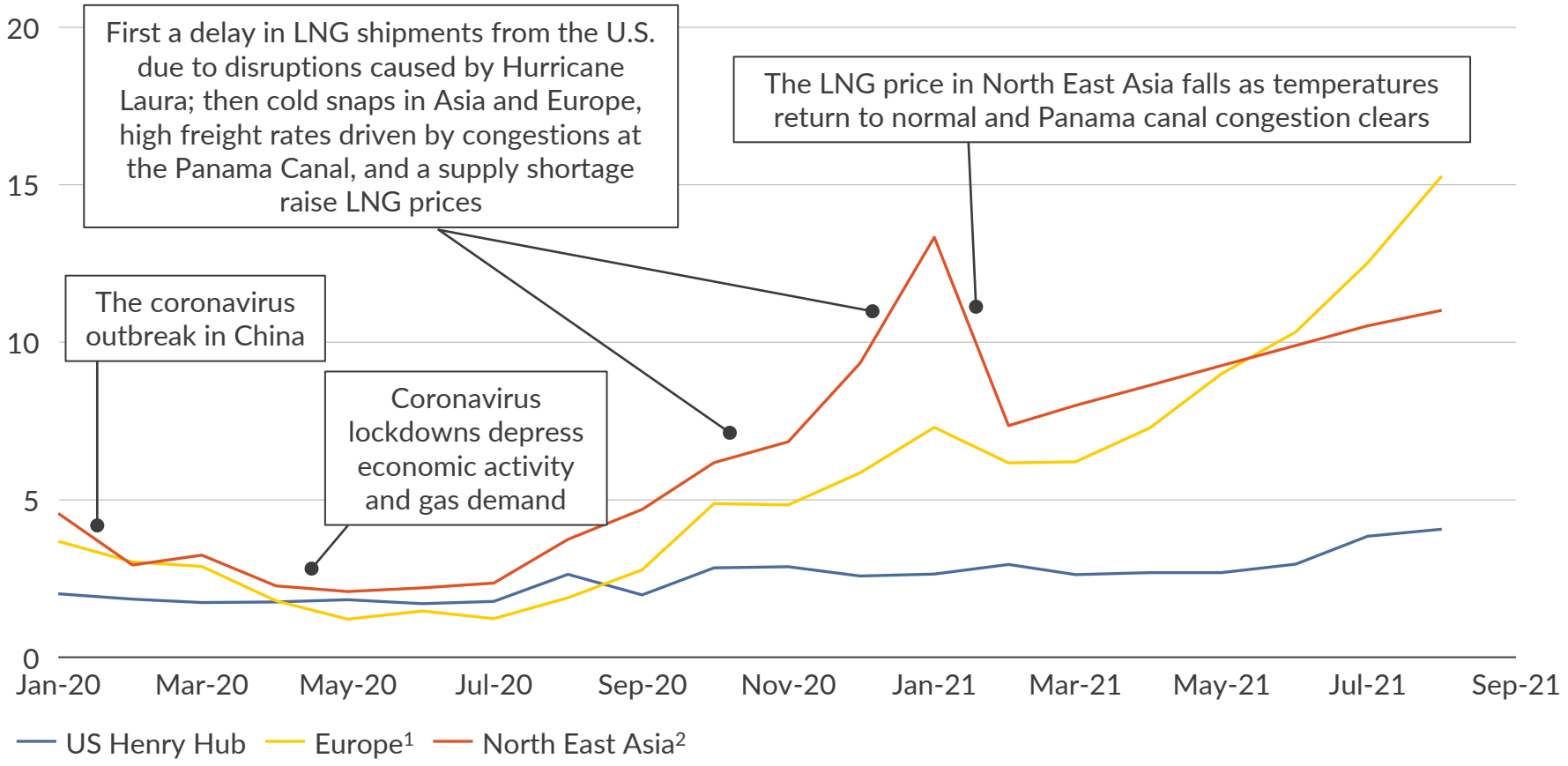
Gas prices in Europe and Asia have increased significantly since Feb-21 due to economic recovery amid tight pipeline and LNG supply

Traded average monthly gas prices
$/MMBtu



- European and Asia gas prices have been on the rise since Feb-21. North East Asia gas price reached $11/MMBtu in Aug-21, growing by 49.8% in six months. TTF averaged $15.3/MMBtu (€44/MWh) in Aug-21, increasing 19.8% m-o-m on average since Mar-21, surpassing Asian price levels in May-21
- The surge in European gas prices was driven by a combination of
  1. High demand as Europe emerges from lockdown
  2. Asian demand driving a tight LNG market
  3. Fall in indigenous production
  4. Flat Russian pipeline supply
  5. Low inventories following colder-than-normal weather

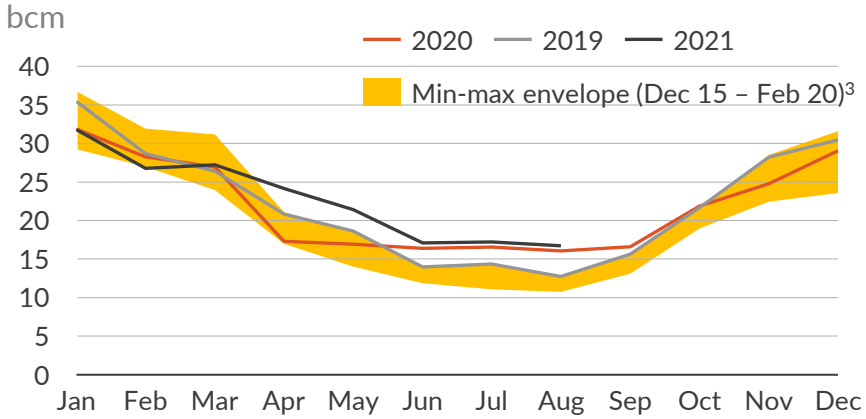
1) The reference hub is TTF in the Netherlands. 2) The reference country is Japan.

Sources: Aurora Energy Research EOS, EIKON

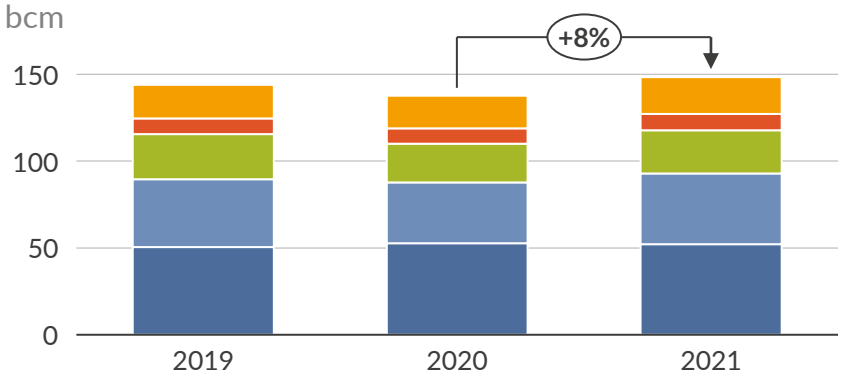
Monthly gas demand remains above pre-pandemic levels during summer in NW Europe, averaging 17bcm between Jun and Aug-21

North West Europe[1]

Monthly gas demand

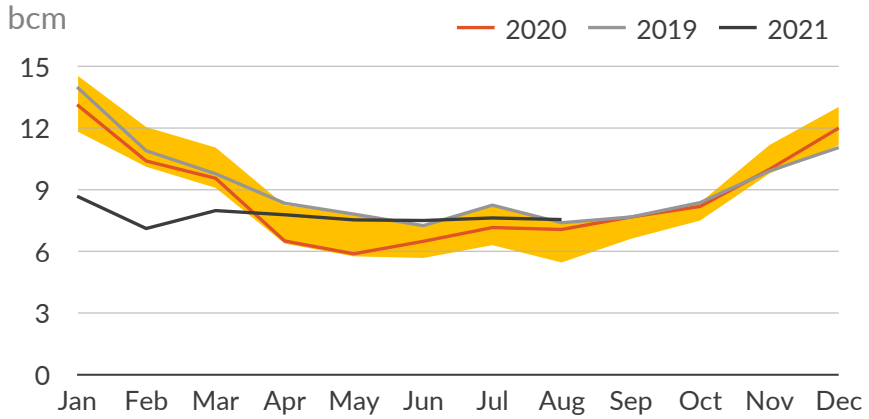


Total H1 gas demand

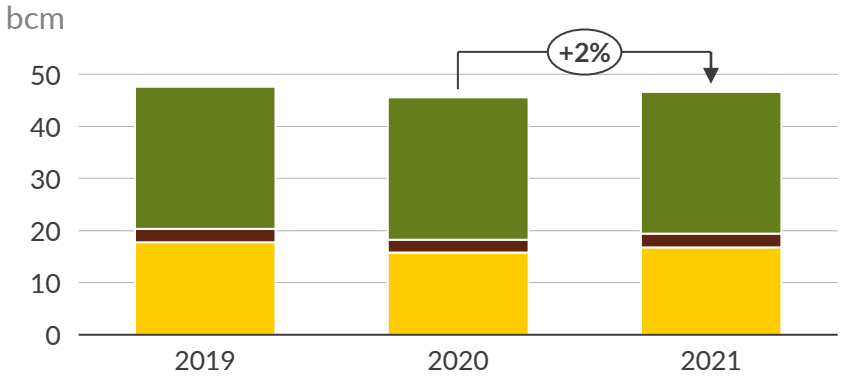


Southern Europe[2]

Monthly gas demand



Total H1 gas demand



- Between June and August 2021, monthly gas demand in North West Europe remained above pre-pandemic levels, averaging 17bcm, versus the 16.3bcm and 13.7bcm of 2020 and 2019, respectively
- In Southern Europe monthly gas demand was largely flat, averaging 7.6bcm between June and August 2021, only 0.4bcm lower than the peak observed in March
- Total H1 2021 gas demand recovered from the troughs of 2020, increasing by 8% and 2% y-o-y, in North West and Southern Europe respectively

1) Belgium, France, Germany, the Netherlands and UK. 2) Spain and Italy. 3) Envelopes are calculated by taking the maximum and minimum monthly values from Dec-15 to Feb-20 (up until the start of the global pandemic).

Sources: Aurora Energy Research EOS, EIKON, JODI-GAS, OIES

Driven by Chinese gas demand, North East Asia LNG imports increased by 8% and 13% y-o-y in Jul-21 and Aug-21, respectively

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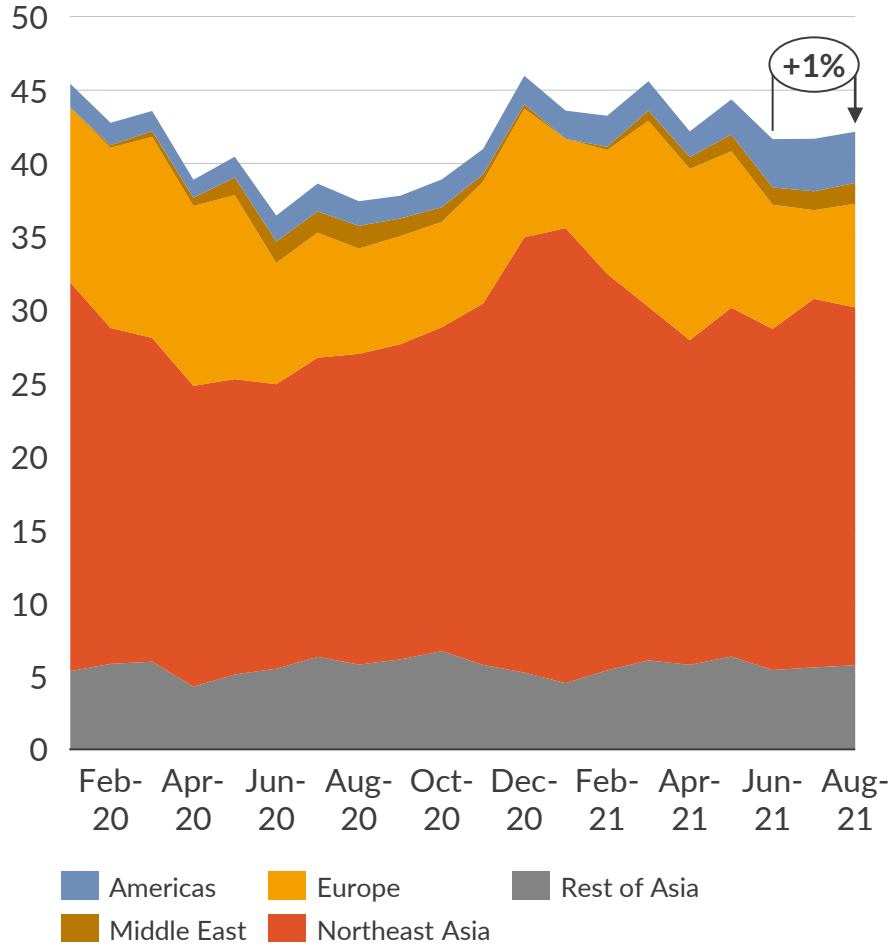
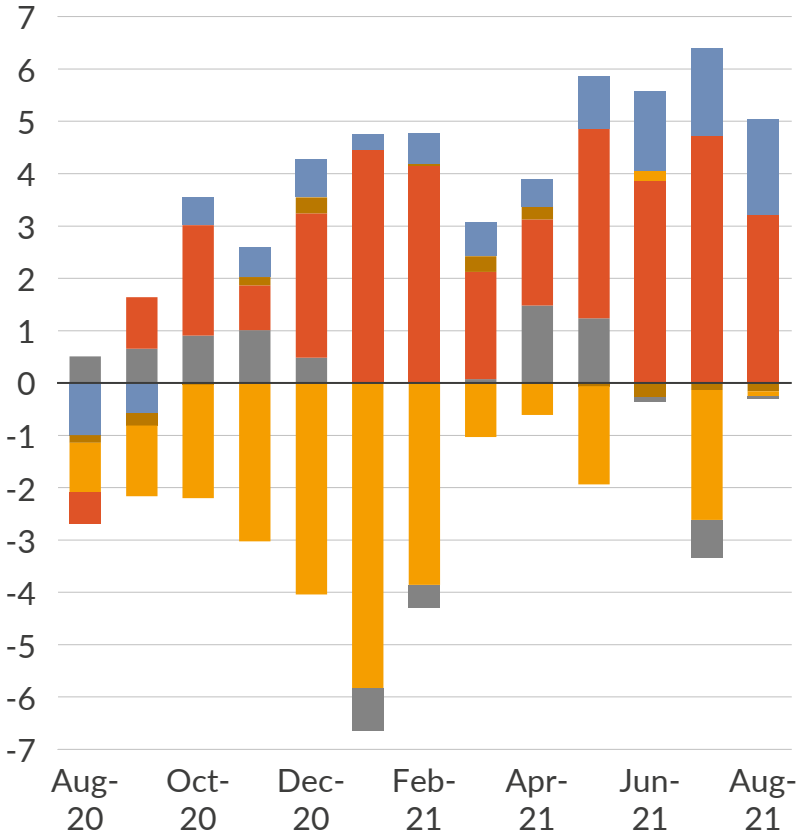
Global LNG imports by region
bcm



Year-on-Year change in LNG imports
bcm



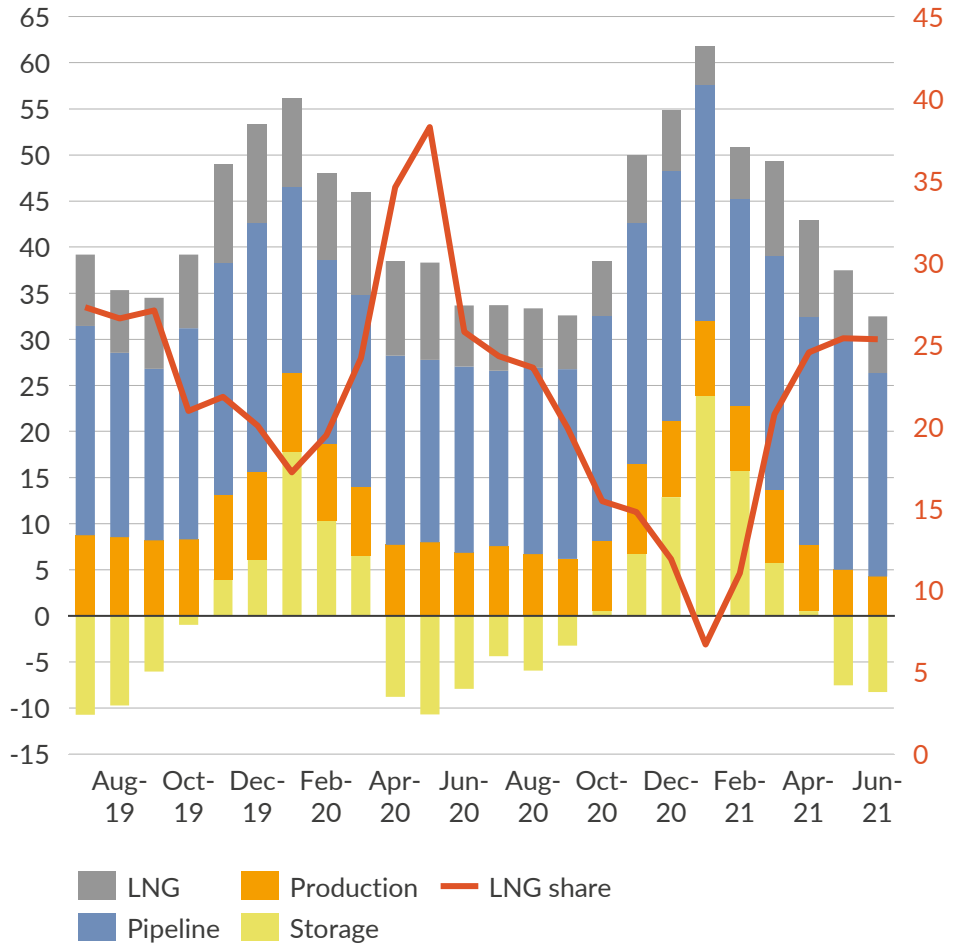
- Driven by North East Asia and the Americas, global LNG imports increased by 8% and 13% in Jul-21 and Aug-21 y-o-y, respectively. Global LNG imports also increased by 1% from June to August 2021 (+0.5bcm).
- In particular, North East Asia LNG imports increased by 2bcm m-o-m in Jul-21 at the expense of Europe, which saw its LNG deliveries fall by 2.4bcm (-29%) in the same period
- Imports to North East Asia are driven by China, which has seen its gas demand for industry and power generation rise. This pickup has more than offset a drop in LNG demand from India, which was dampened by new lockdown restrictions in May-21

Sources: Aurora Energy Research, JODI-GAS

Both LNG supply and indigenous production fell in May-21, down 3bcm and 2.2bcm m-o-m, respectively

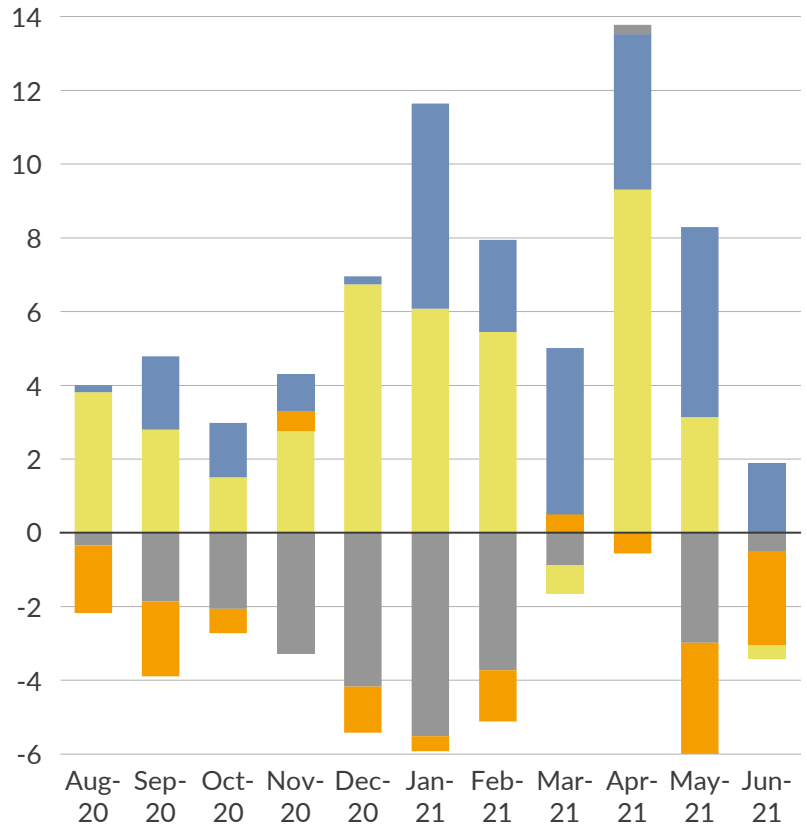
European supply balance[1] **LNG share in supply mix**

bcm bcm



Y-o-y change in European supply balance

bcm



- Following the reduction in demand, total gas supply in Europe fell by 44% from Apr-21 levels, averaging 27bcm in May and June
- As demand decreased, gas storage facilities saw a switch from net withdrawals in Apr-21 to net injections in May and Jun-21, 7.5bcm and 8.3bcm, respectively. Tight supply however meant injections were down vs 2019 and 2020
- Pipeline supply was largely steady between Mar and May-21, but shrank in Jun, down 11.3% m-o-m. However, y-o-y, pipeline supply in the first six months of 2021 was larger, as supply recovered somewhat from the consequences of the pandemic
- A substantial drop in indigenous production was observed in May-21 and Jun-21, due to several disruptions in the facilities in the North Sea

1) Europe includes EU-27 and the UK.

Sources: Aurora Energy Research EOS, JODI-GAS

By Aug-21, TTF hub gas prices were almost triple the Russian export price but pipeline imports from Russia remained largely steady

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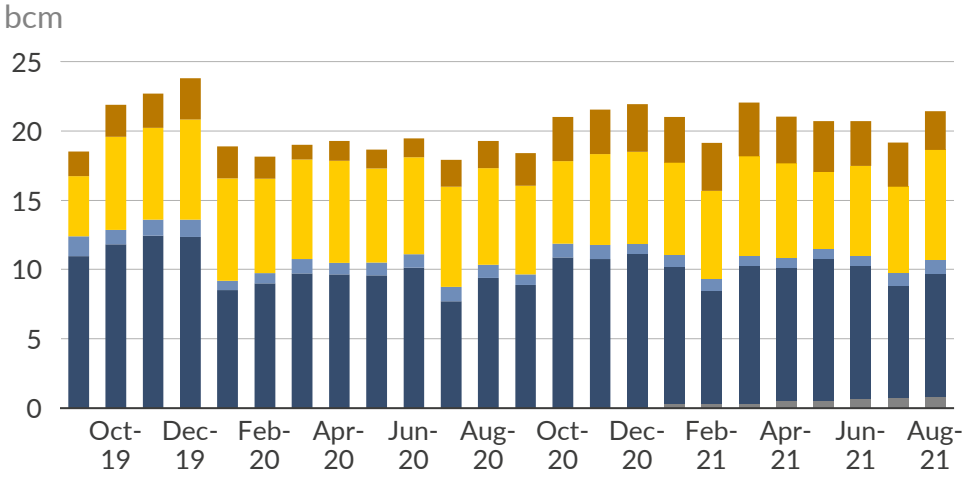
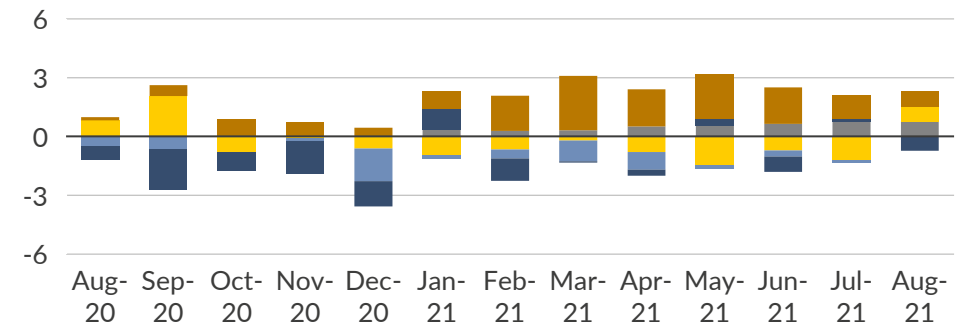
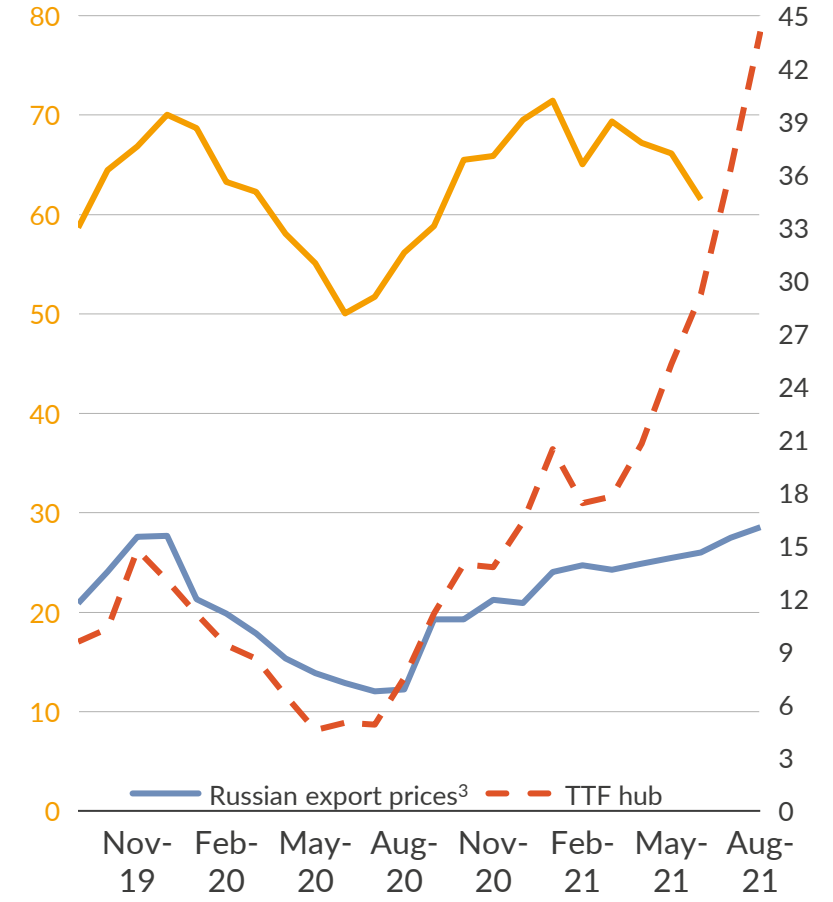
Gross pipeline imports from outside Europe



Y-o-y change in pipeline imports



Russian gas production / Gas prices



North Africa | Norway[1] | Russia to Poland and Hungary | Russia through three main routes[2] | Azerbaijan via TAP to Italy

- TTF Hub gas prices (€ 44.1/MWh) have climbed up to reach almost three times the estimated Russian export price (€16.1/MWh in Aug-21). Both prices have been growing since Apr-21, with TTF gas prices growing 20% m-o-m on average, and Russian export prices 3.3% m-o-m
- Despite extremely favourable market prices, Russia first adopted a price-over-volume strategy, and then prioritised the refilling of domestic storage facilities
- Supply from Norway suffered in the May to July 2021 period, due to several planned and unplanned maintenance activities which disrupted production and pipeline deliveries

1) Norway's pipeline exports to continental Europe (excluding the UK). 2) Russian three main routes include Ukraine corridor, Yamal and Nord Stream. 3) Include Russian pipeline export prices only

Sources: Aurora Energy Research EOS, EIKON, Gazprom

Gas inventories in Jul and Aug-21 were below pre-pandemic minimum levels registered both in North West and Southern Europe

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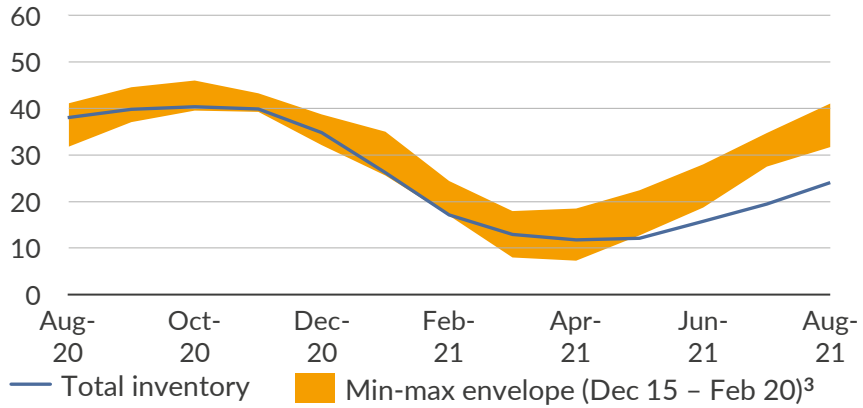
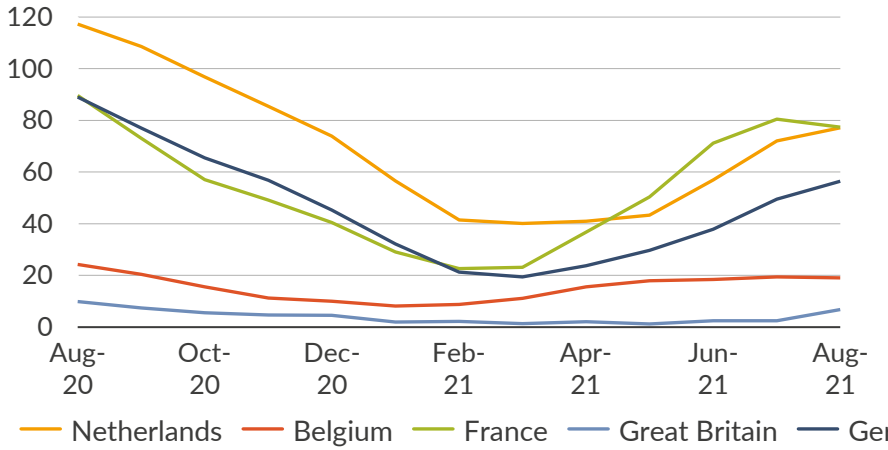
North West Europe[1]

Storage inventory bcm



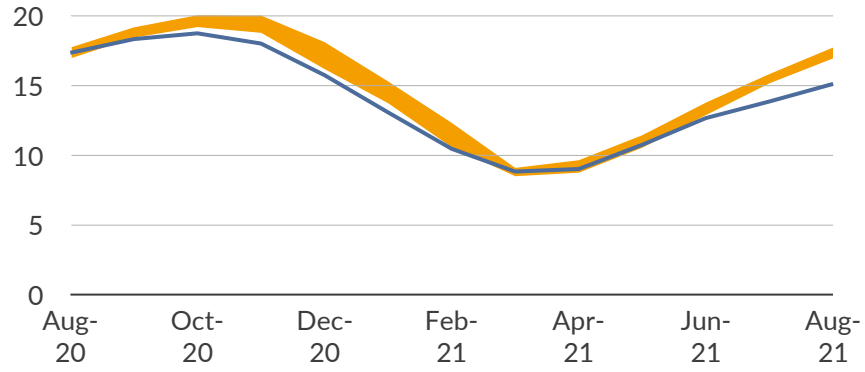
Storage margin (days of demand in store[4])

days



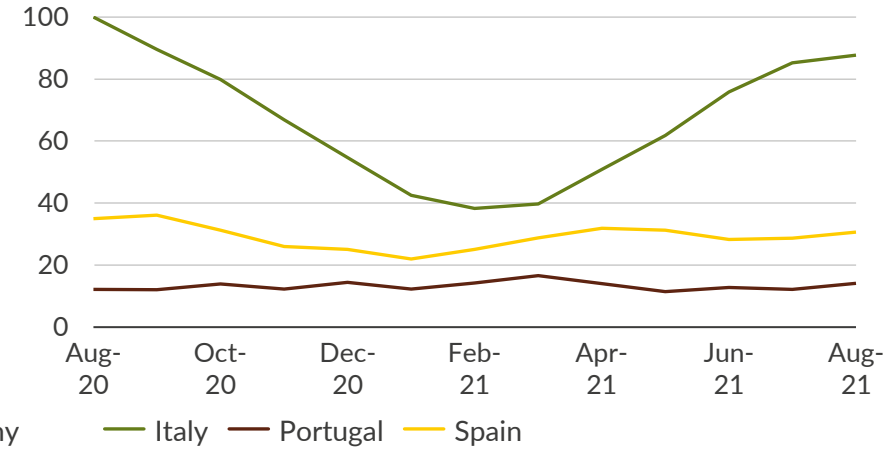
Southern Europe[2]

Storage inventory bcm



Storage margin (days of demand in store)

days



- Gas inventories in North West Europe totalled 24.1bcm in Aug-21, 37% down y-o-y. Following sustained demand through summer and weak pipeline supply from Russia and Norway, gas stocks have struggled to recover to levels within the min-max envelope range considered (Dec-15 to Feb-20)
- In Southern Europe, gas inventories reached 15.1bcm in Aug-21, 13.2% down y-o-y. Since Jun-21, gas stocks have further diverged from the min-max envelope for the region
- The storage margin in Aug-21 was down y-o-y for all countries in North West and Southern Europe but Portugal

1) Belgium, France, Germany, the Netherlands and UK. 2) Spain and Italy. 3) Envelopes are calculated by taking the maximum and minimum monthly values from Dec-15 to Feb-20 (up until the start of the global pandemic). 4) Days of demand in store is defined as the number of days that the storage inventory could potentially solely satisfy, all contractual constraints left aside.

Sources: Aurora Energy Research EOS, EIKON, Gazprom

Current gas market tightness eases by the mid 2020s, but continued demand growth in Asia sustains prices in the long term

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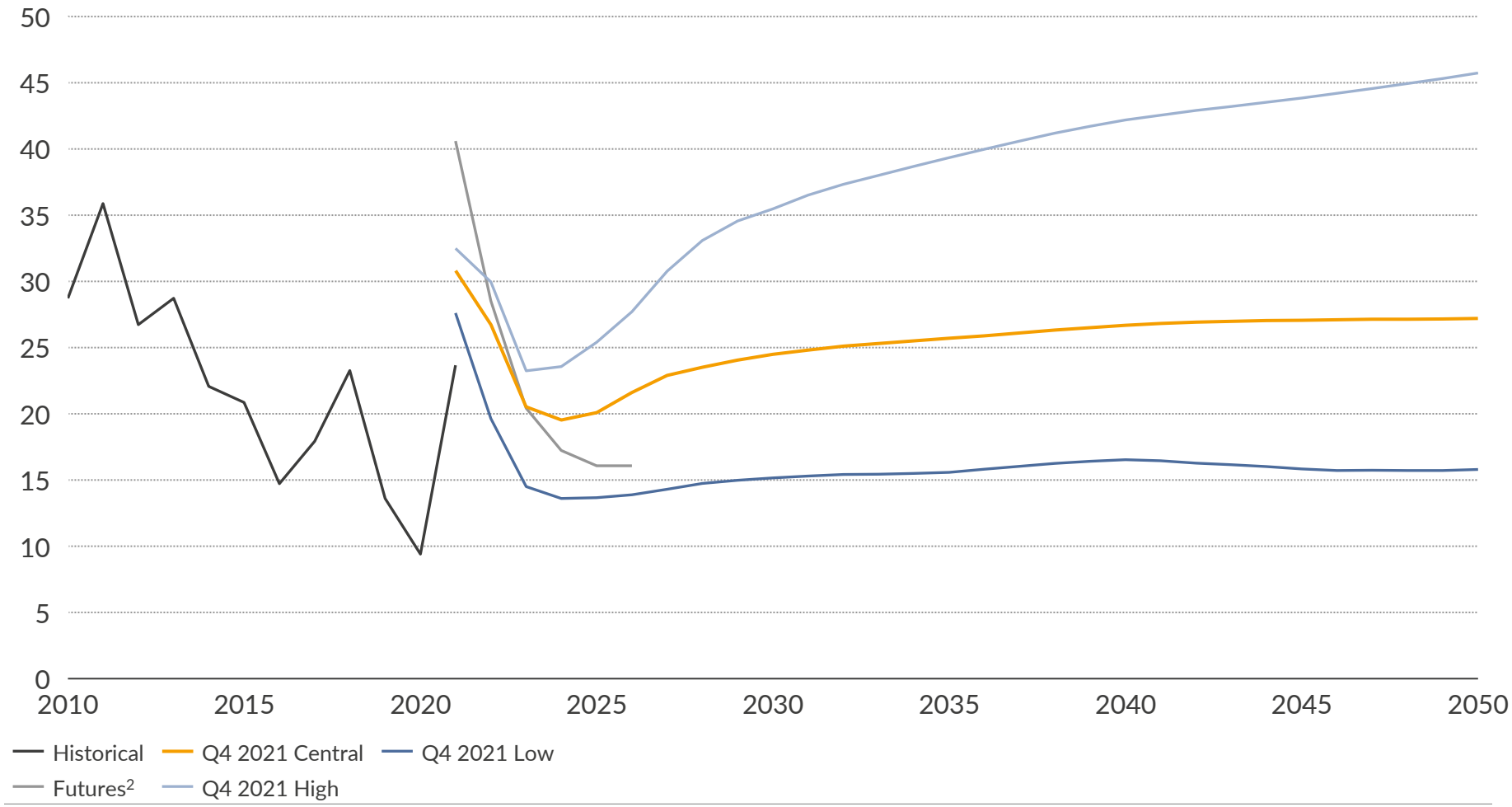
TTF gas prices[1]
€/MWh (real 2020)



1) For years 2021-2026, the prices shown take into account current futures prices for the years in question, with declining weights. 2) A rolling 30-day average as of 23/08/2021.

Source: Aurora Energy Research

2021-2026

- The gas price in the period to 2026 averages £21.2/MWh, 14% higher than previously forecast
- For 2021 and 2022 the gas market is tight due to low gas inventories, strong Asian gas demand, flat Russian supply via pipeline and a tight LNG market amidst strong domestic demand
- From 2024 to 2026 the market is expected to rebalance on increased supply from Russia and LNG, and normalised storage stocks and gas demand

2027-2050

- The gas price rises to €25.5/MWh in the 2030s as Asian gas demand continues to rise, tightening the global LNG market
- From 2040 onwards, the gas price broadly flattens out at €27/MWh as rising renewables generation slows down Europe's LNG imports

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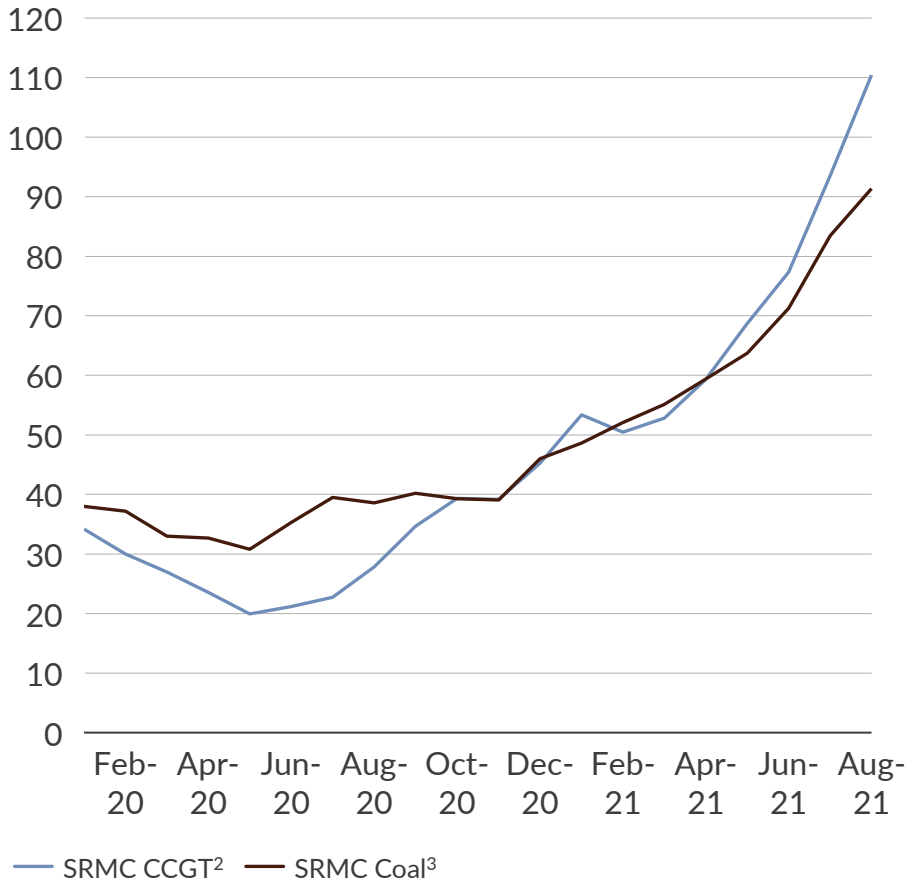
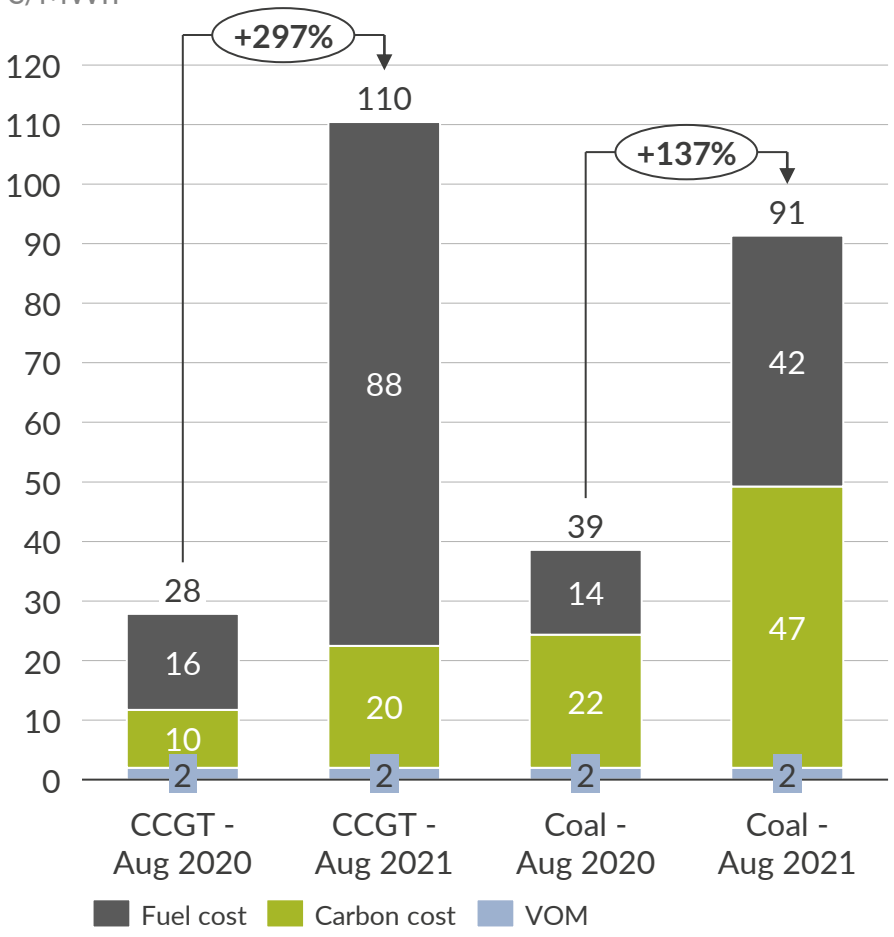
II. What are the implications for GB power markets?

Record high gas prices have pushed coal power into merit in Europe, with a SRMC 17.2% below that of CCGTs in Aug-21

Short-run marginal cost[1]
€/MWh



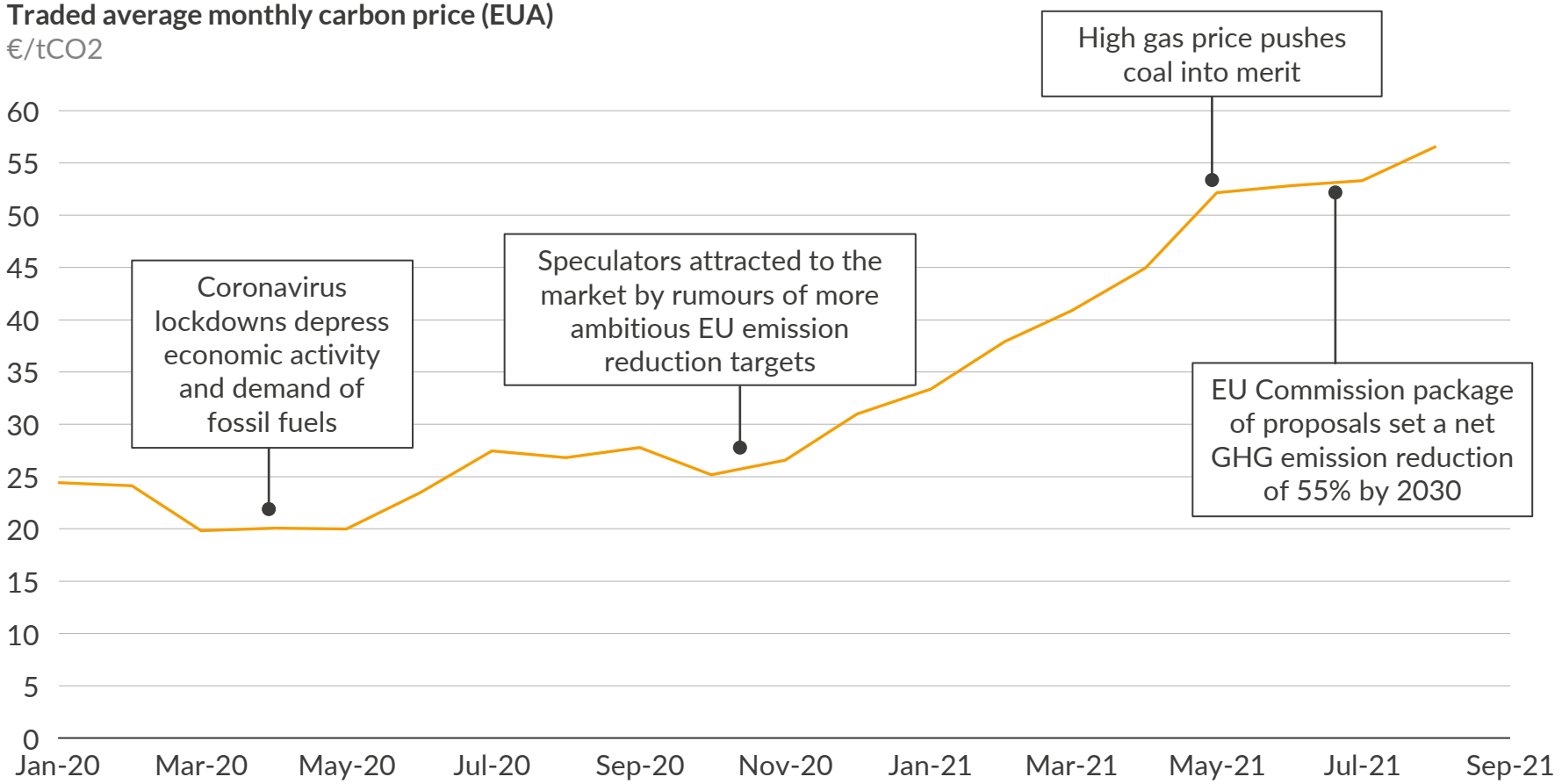
Short-run marginal cost components
€/MWh



- We compare the short-run marginal cost (SRMC) of production for an example CCGT plant and coal-fired power plant in Germany. The SRMC includes fuel costs, carbon costs, variable operation and maintenance costs and plant efficiency
- SRMCs have been increasing for both the CCGT and coal power plant since May-20, as fuel and carbon prices kept rising. Since May-20, CCGTs saw an average m-o-m increase of 16.8%, while coal power stations saw an increase of 11.4%
- Despite EUA prices and coal prices trading at €56.6/tCO_2 and €124.9/tonne in Aug-21, respectively, coal generation remains more favourable as new record gas prices pushed the SRMC of CCGTs up to €110.4/MWh

1) Short-run marginal costs take into account the costs of fuel, carbon emissions (clean fuel cost) and variable O&M. 2) Combined cycle gas turbine. We assume a thermal efficiency of 50% and a CO_2 emission factor of 0.18tCO_2/MWhth. 3) Coal fired steam cycle. We assume a thermal efficiency of 41% and a CO_2 emission factor of 0.34tCO_2/MWhth.
Source: Aurora Energy Research

EUA prices climbed to €56.6/tCO$_2$ in Aug-21 supported by speculator activity and new ambitious emission reduction targets



- EUA prices averaged €56.6/tCO$_2$ in Aug-21. Prices have increased by 8.6% m-o-m on average since Oct-20. In September daily prices rose above €60/tCO$_2$
- Expectations of ambitious carbon reduction targets attracted speculators to the market at the end of 2020. Such expectations were met in Jul-21 with the publication of the new European Commission package of proposals for net GHG emissions reduction targets[1]
- The new package sets emission reduction targets at 55% by 2030 compared to 1990 levels
- The sustained increase in European gas prices has pushed coal generators into merit since May 2021, further boosting demand for EUA permits due to their higher emissivity

1) The new package of proposals (14/07/2021) include EU's climate, energy, land use, transportation and taxation policies aimed at reducing net greenhouse gas (GHG) emissions by 55% by 2030. These proposals set emission reduction targets more ambitious than those previously discussed in 2020 and early 2021, at 40-50%.

Sources: Aurora Energy Research EOS, EIKON

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GB power prices have climbed with commodity prices since February, whilst a tight system has driven price spikes in September...

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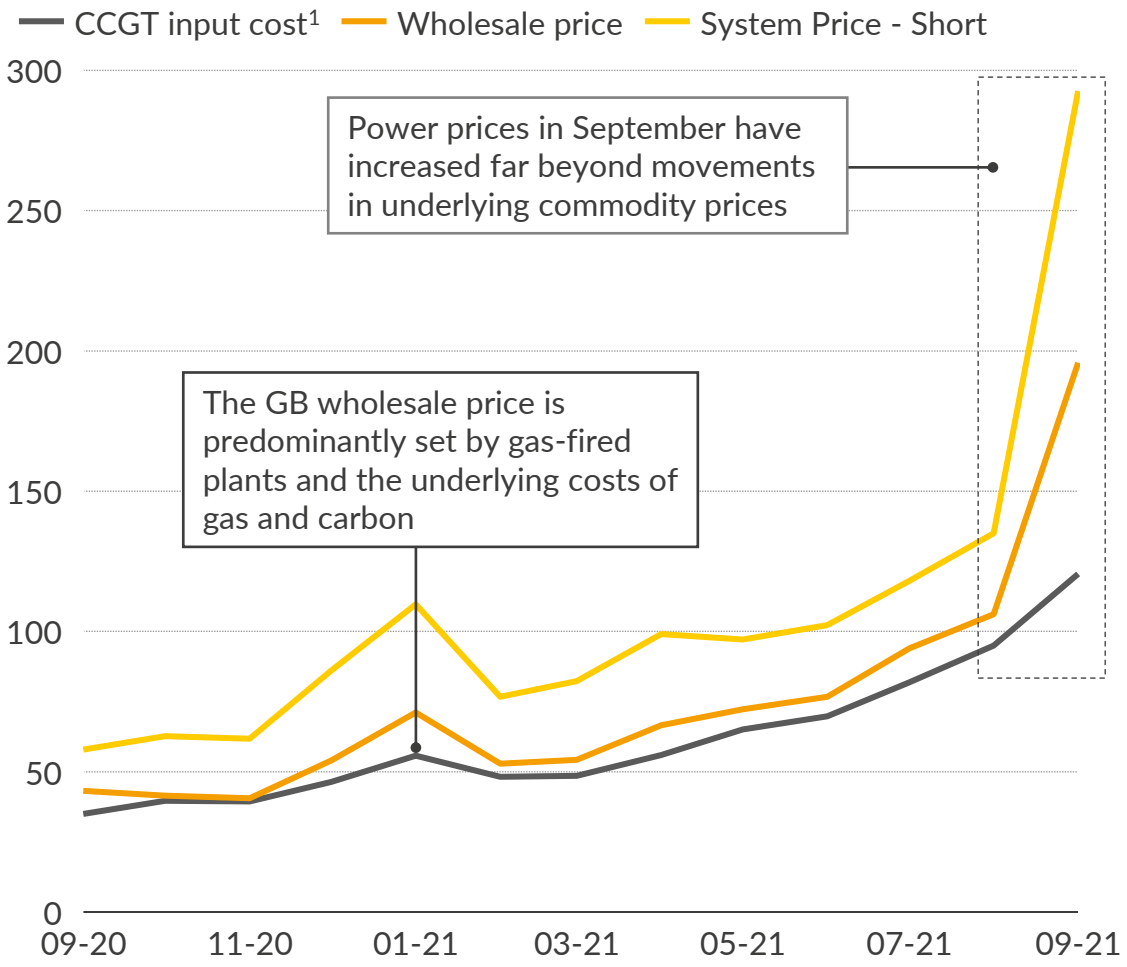
GB Monthly average price metrics

£/MWh – nominal

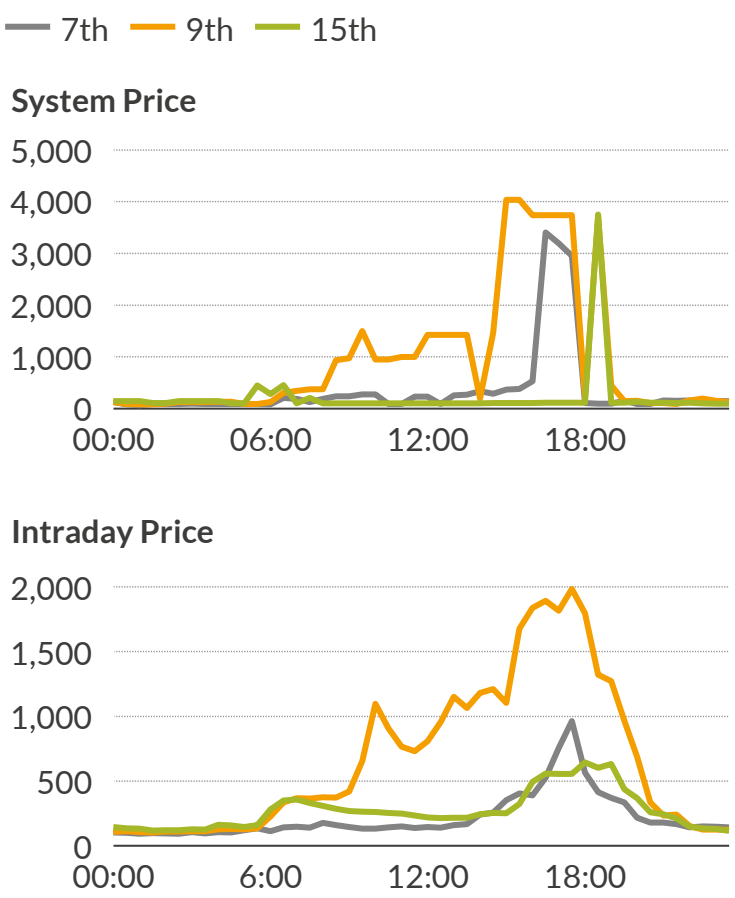


September Price Spikes

- Increased average is the result of extreme price events on a few days, which pull average prices up for the whole month
- The 7th , 9th and 15th all saw extreme prices movements and system prices in excess of £4,000/MWh during evening peak power demand periods (16:00-20:00)
- The GB power system was exceptionally tight on all three days, driven by low wind speeds and a number of plant outages, creating market scarcity...

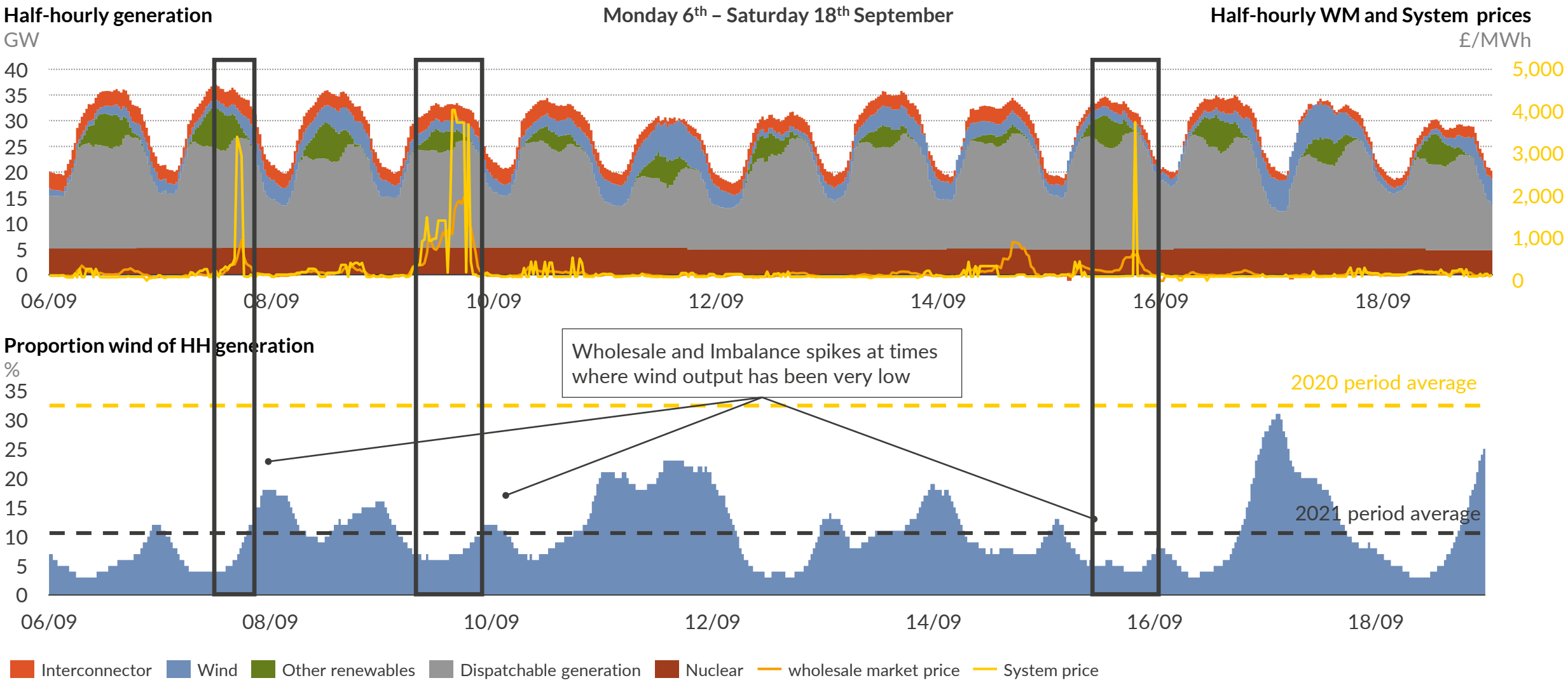
GB Power prices on peak days

£/MWh – nominal



1) Total cost of gas plus carbon for a 52% efficiency CCGT per MWh of electricity produced

Price spikes coincided with periods of low wind; with low supply exacerbated by CCGT, nuclear and interconnector outages

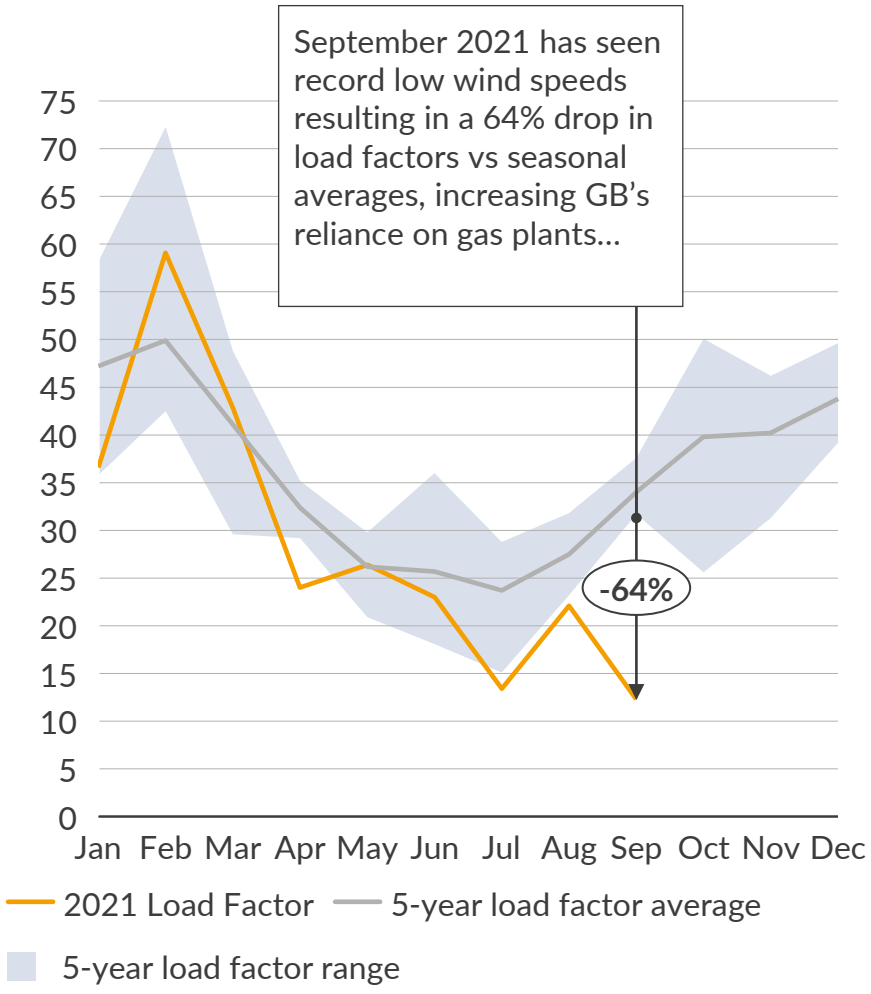


1)

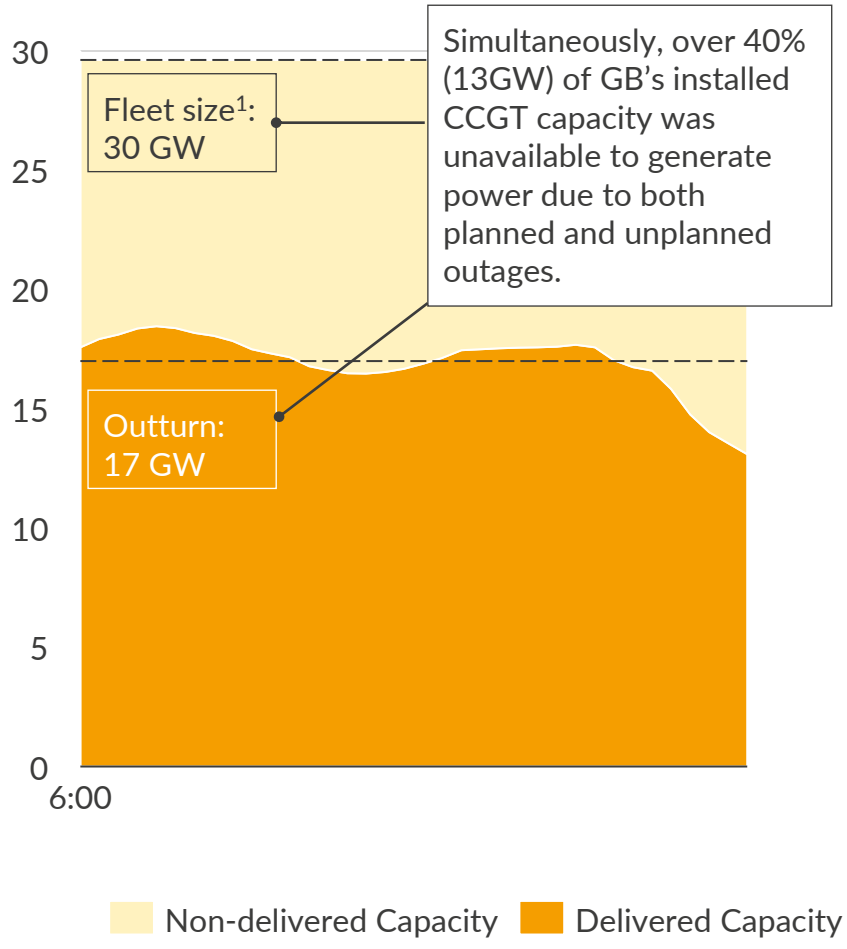
Sources: Aurora Energy Research

Abnormally low wind speeds in September saw a 64% drop in wind generation, whilst over 40% of CCGT capacity was unable to deliver

2021 wind load factors compared to 5-year range and average
%



Delivery of GB gas plants – 9th September,
GW



- 2021 has seen the lowest recorded load factors for wind plants for the month of September, with less than 15% load factors on average
- This has created a shortfall, increasing reliance on the required generation from dispatchable plants
- At the same time, a number of gas plants have not delivered capacity, likely due to maintenance delayed by COVID-19, while nuclear plants delivered less than 60% of capacity, and the 1 GW IFA 1 interconnector went offline due to a fire on the 15th
- As we are still officially in the "summer" of the power market, plants are strongly incentivised to complete any maintenance before we enter the winter months (October-March)

1) Excludes Calon assets

The combination of low wind and plant outages resulted in razor-thin system margins, driving scarcity in GB power markets

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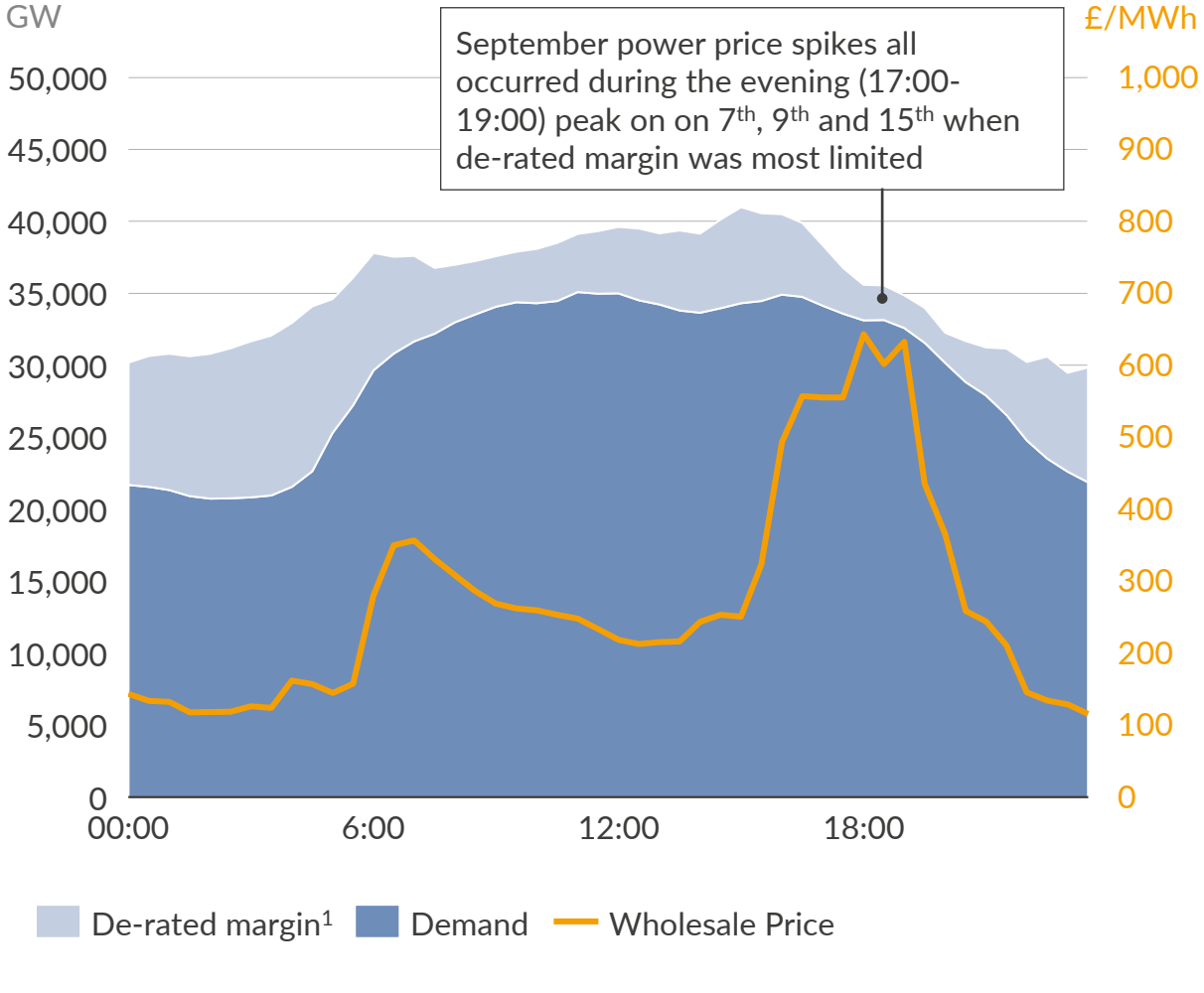
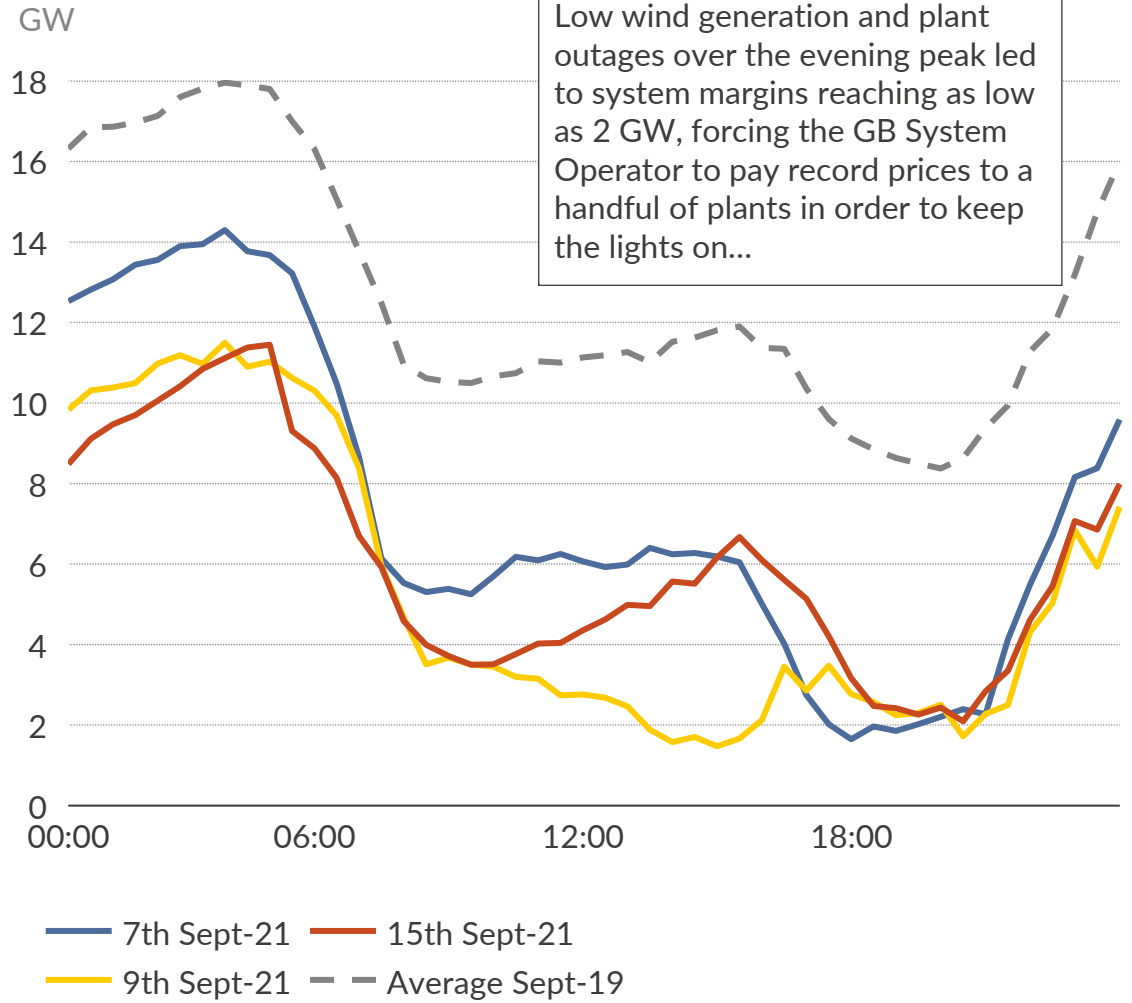
GB Demand and de-rated margin - 15th September, Wholesale market spot price



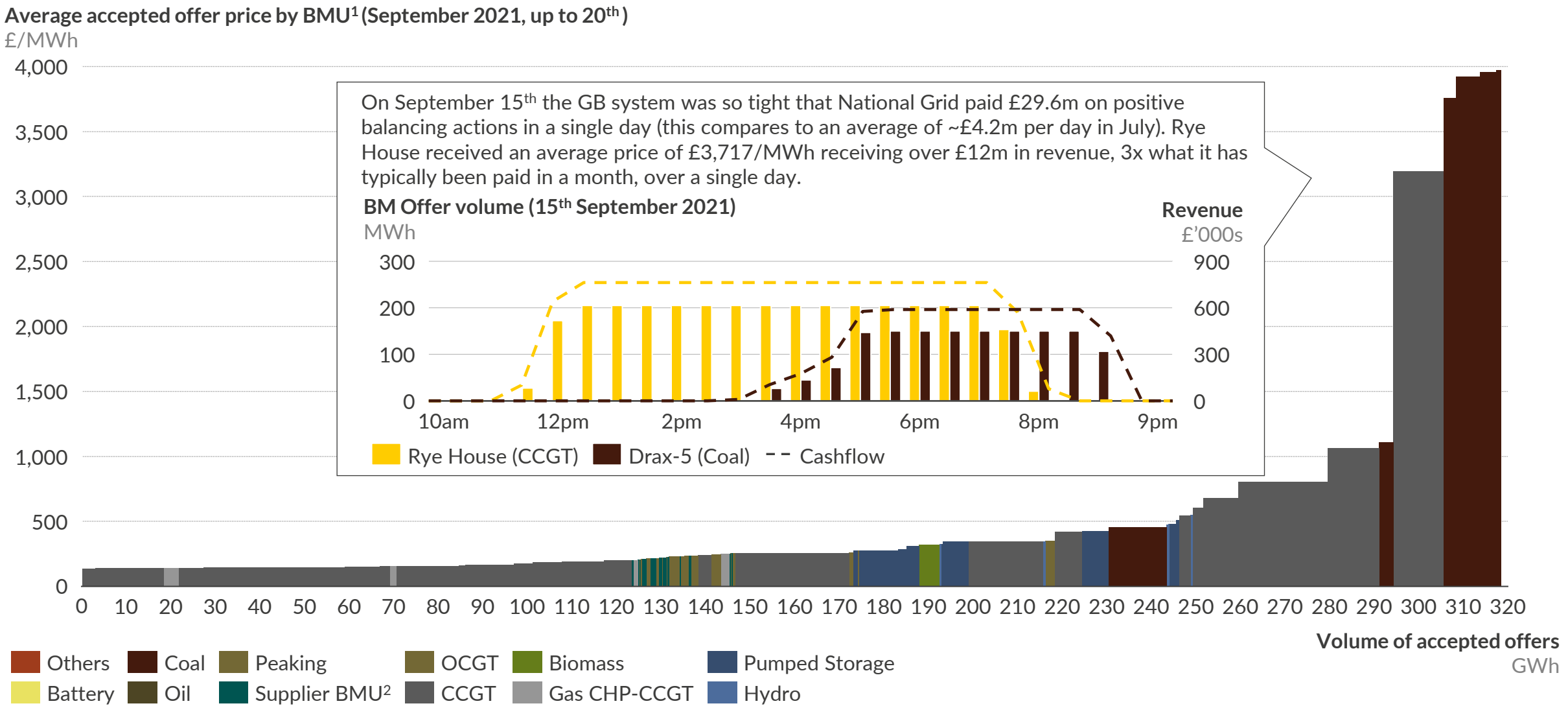
GB De-rated system margin[1]



1) De-rated margin is a forecast published by Elexon of the capacity available to turn up, de-rated by a factor describing the likelihood of it's delivery.

The GB System Operator, National Grid, was forced to pay millions out to a handful of gas and coal plants, leading to windfall revenues…

AURORA



1) Balancing Mechanism Unit. Units with less than 100 MWh of accepted offer volume in the month omitted. 2) Includes aggregators, suppliers and small embedded generators

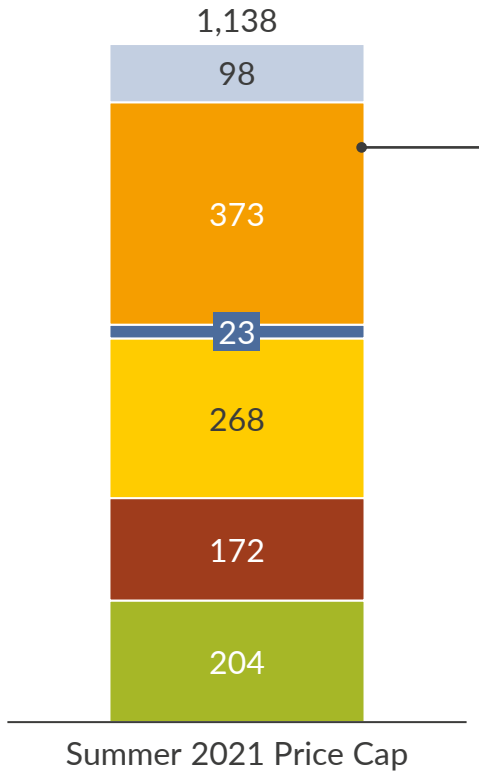
Source: Aurora Energy Research, National Grid ESO

The retail price cap for consumers was last set by Ofgem during a period of lower prices...

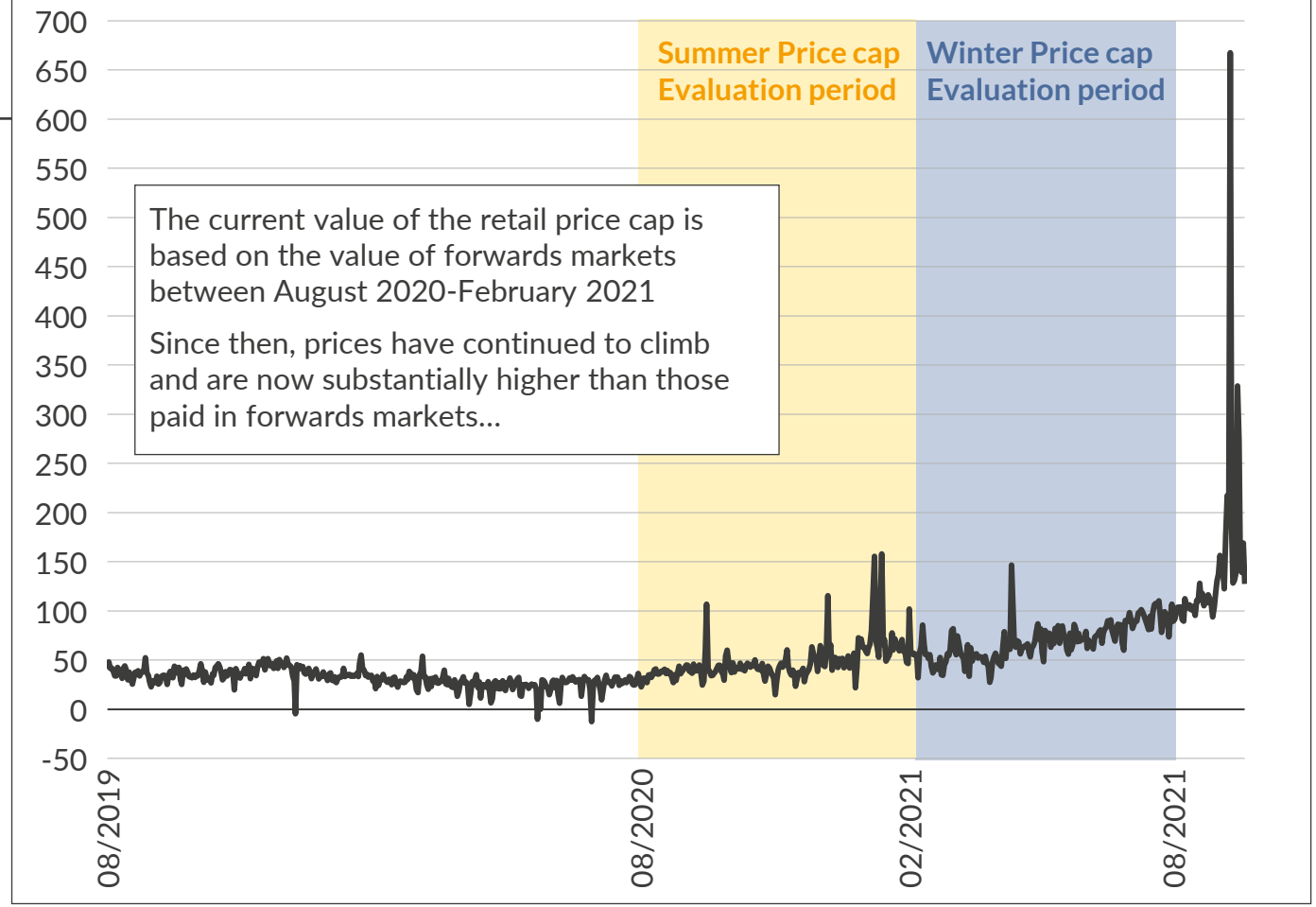
AURORA

Ofgem Retail Price Cap by component
£/customer/year

- Ofgem maintains a price cap on the prices that retailers can charge consumers
- This is indexed to the expected consumption of a typical consumer in a year and the prices that manifest in forwards markets in the period preceding a price period



Wholesale Electrcity Spot Prices
£/MWh, daily average

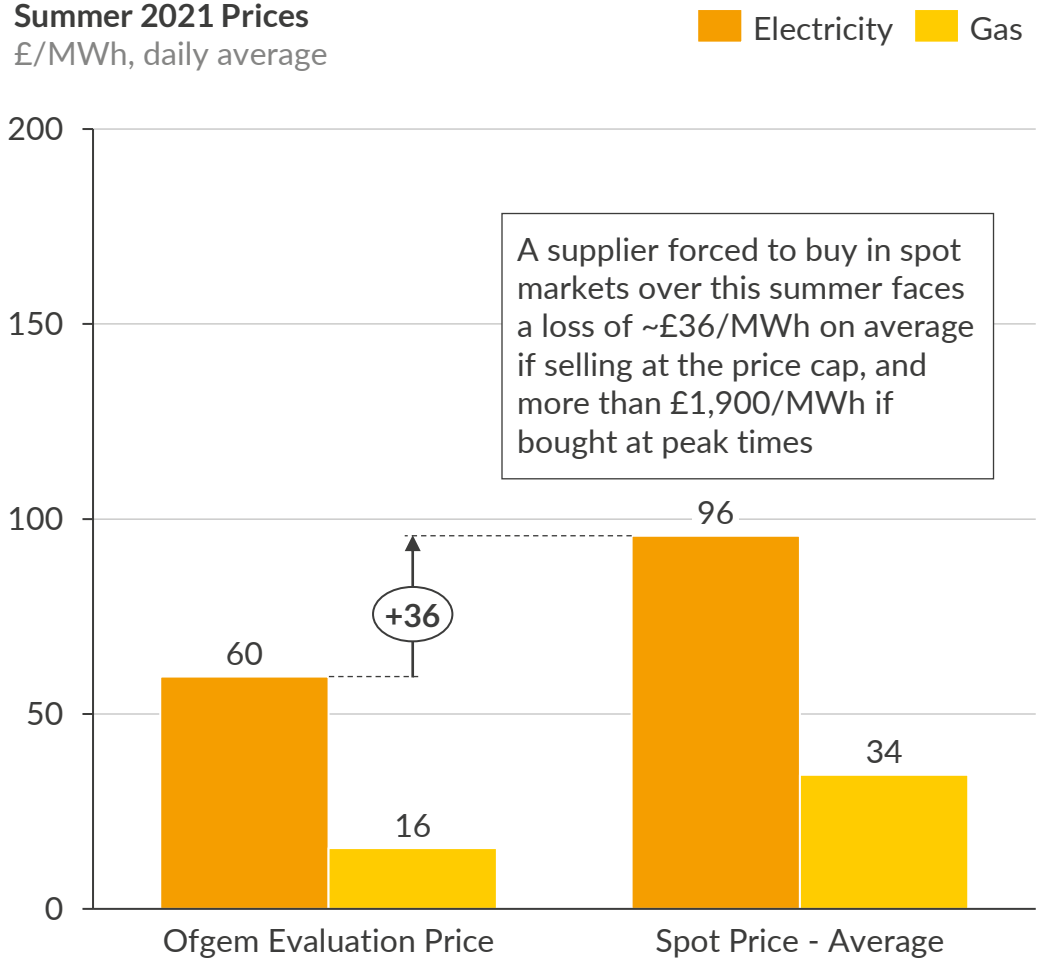


1) Includes EBIT, VAT, Headrom Allowance and Direct Debit Payment Allowance

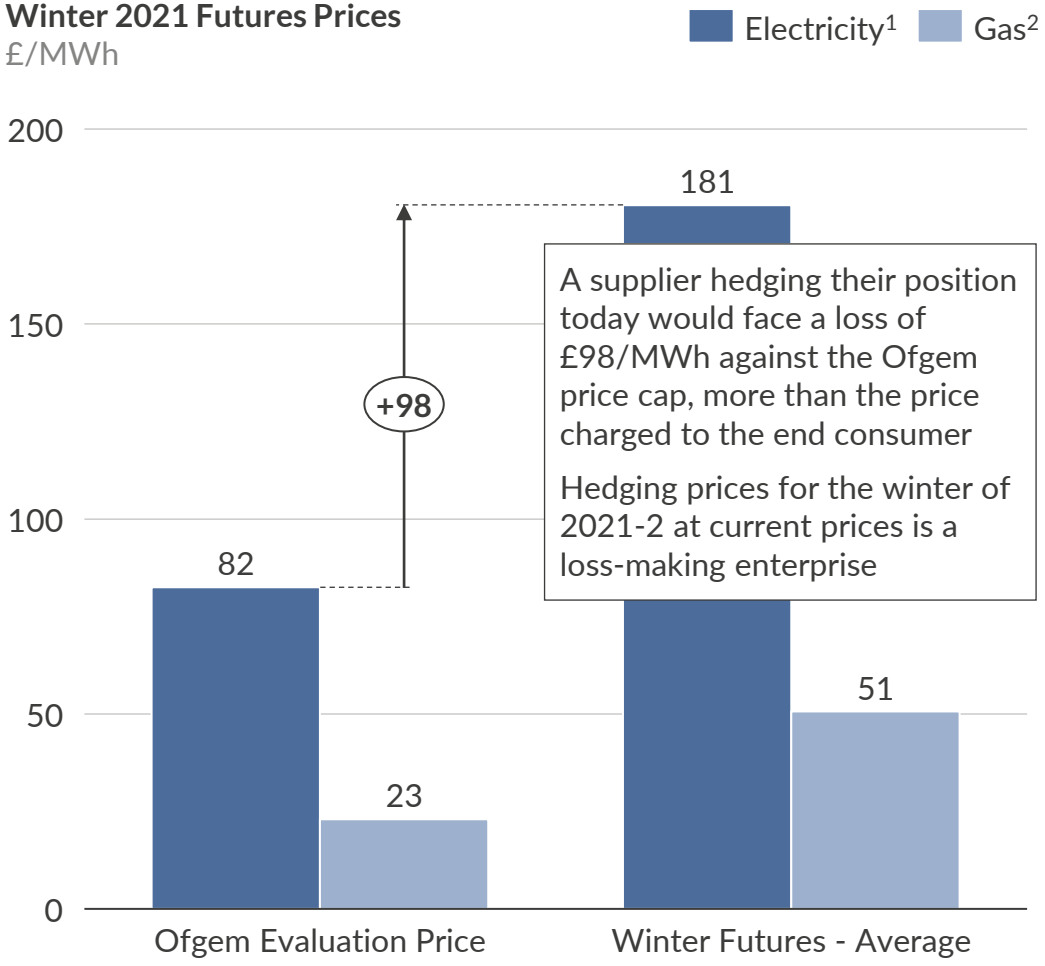
GB energy suppliers now face costs higher than those set in the Ofgem price cap, with futures trading 120% higher for winter 2021

AURORA

Summer 2021 Prices
£/MWh, daily average



Winter 2021 Futures Prices
£/MWh



1) Retreived 23/09/2021 2) 3-week average as of 23/09/2021

Key takeaways

1. The ARA coal price reached an average of $147/tonne in August - up nearly 200% year on year. Coal demand is high in China and India as economies recover from COVID restrictions. The high demand, combined with disruptions in supply from Mongolia, Indonesia and China, has led to a tight market in Asia – with knock on effects for coal prices in Europe.

2. European gas prices have been rising steadily since February 2021, with the TTF hub price averaging €44/MWh in August – up fivefold year-on-year. European gas demand was above pre-pandemic levels in Spring, whilst indigenous production was hit by a number of disruptions in the North Sea, leading to higher storage withdrawals. A tight coal market has led to coal to gas switching in Asia, creating a tight LNG market. Russia has not increased its supply.

3. The rapid increase in gas prices has pushed coal power stations into merit in European power systems – with the gap between the short-run marginal cost of gas CCGTs and coal widening since May. This has increased emissions and the demand for EUA permits, leading the EUETS price to reach an average of €56.6/tonne in August, and daily prices above €60/tonne in September.

4. In 2021, GB wholesale power prices have steadily climbed with rising gas and carbon prices, reaching >£100/MWh in August. A combination of exceptionally low wind speeds and plant outages led to de-rated system margins falling as low as 2GW on 7th ,9th and 15th of September. During the tightest system periods on these days, a handful of plants set power prices in excess of £2,500/MWh in the wholesale market, and over £4,000/MWh in the Balancing Mechanism[1].

5. GB energy suppliers are subject to retail price caps to end consumers for gas and electricity, set by the market regulator, Ofgem. The unforeseen price rise in gas and electricity markets has resulted in power costs for suppliers that are currently trading ~120% higher than price cap assumptions for winter 2021. As a result, GB has seen a wave of energy suppliers enter administration in recent weeks, with those still operating facing a challenging operating environment.

1) The GB Balancing Mechanism determines the 'system price' referred to in this presentation.

Sources: Aurora Energy Research

Details and disclaimer

The energy crunch: why have UK and European energy prices spiked?

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