RÉPUBLIQUE FRANÇAISE
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COMMISSION DE RÉGULATION DE L'ÉNERGIE

REPORT

JUNE 2022

Analysis and lessons learnt relating to the price peak on 4 April 2022

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This report analyses in detail the fundamental features and the behaviour of the players on 4 April 2022 when the French spot price reached an unprecedented peak for two hours between 7am and 9am. The impact of this episode was to increase the European spot price cap by €1,000/MWh, from €3,000/MWh to €4,000/MWh.

Summary:

An isolated event due to a combination of extremely unlikely adverse events

The price increase observed on 4 April 2022 was the result of an exceptional combination of different events: the night of 4 April was the coldest for an April since 1947; import capacities were low before the daily auction, and were even exceptionally low from Germany and Belgium; EDF announced the unexpected unavailability of the Dampierre 1 nuclear unit, when nuclear availability was already exceptionally low; wind generation during the critical hours of 7am - 9am was underestimated, as was the production of combined heat and power (CHP) plants; the mechanisms for managing peak consumption in France end on 31 March and were therefore not available on 4 April (capacity mechanism, TEMPO tariffs, calls for demand-response tenders, etc.).

In addition, several generation facilities started their maintenance at the end of March and were no longer available; and the RTE's alerts probably led market players prudently to seek a long position, which might have increased the daily auction price.

The combination of these factors led to extremely high prices on 4 April 2022 for 7am and 8am (€2,720/MWh and €2,990/MWh respectively). These prices would have been approximately halved with a small shift in the supply/demand balance of between 500 and 1000 MW (increase in generation, decrease in consumption).

At this stage of its analyses, the CRE has not detected any abnormal or suspicious behaviour during the day-ahead auction itself.

There are many lessons to be learned from this day

Although consumption was as high as expected, it appears that significant capacity was available (import capacities, renewable generation and CHP in particular) but could not be employed and included in the day-ahead auction. The French electricity system must in future be better prepared for such events, so that the day-ahead auction represents accurately the level of stress in the electricity system.

Under the existing rules on harmonised maximum and minimum prices for the single daily coupling[1], reaching such price levels on 4 April 2022 automatically triggered an increase in the price cap of €1,000/MWh for the 24 countries participating in the single daily coupling, from €3,000/MWh to €4,000/MWh five weeks later.

It is not appropriate that an isolated and unlikely event should trigger a structural change such as an increase in the price cap on the daily market in all 24 countries making up the single daily coupling region. In this period of crisis and high uncertainty, the rules triggering the increase of the harmonised price cap for the European single daily coupling should urgently be changed.

[1] The ACER Decision on 14 November 2017 on harmonised maximum and minimum prices for single daily coupling taken pursuant to Article 41(1) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management.

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1. BACKGROUND TO 4 APRIL 2022

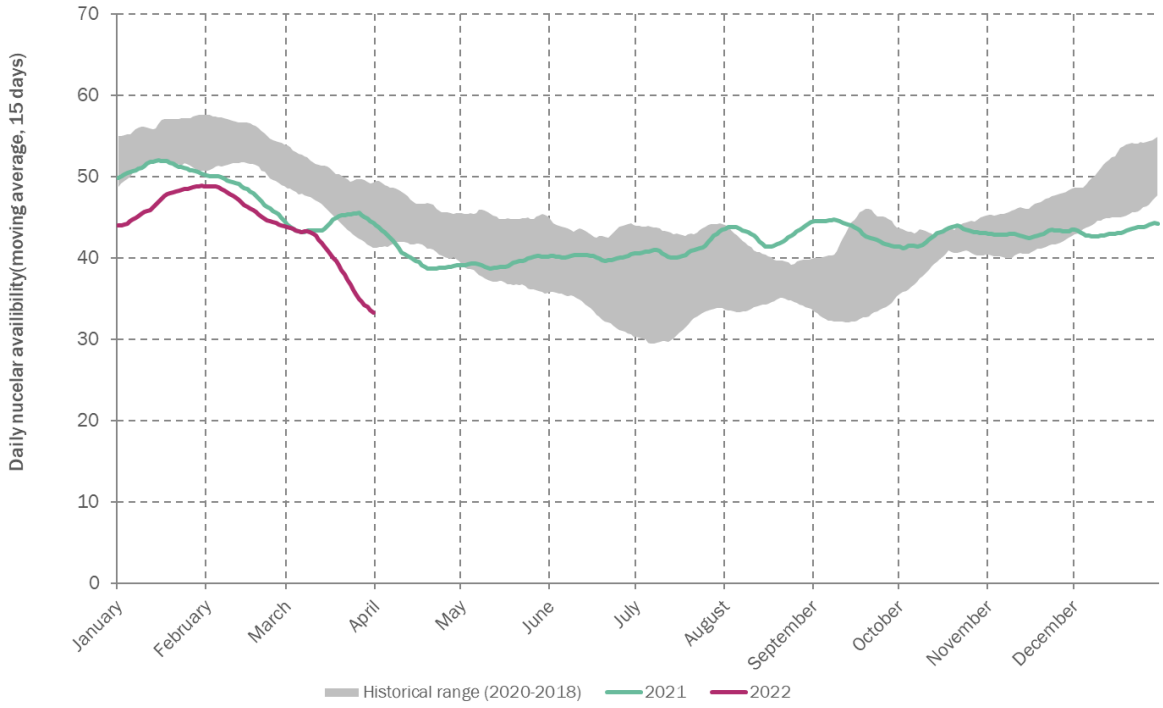
1.1 A tense start to 2022 due to historically low fleet availability

During the ten-year shutdown of reactor no. 1 at the Civaux nuclear power plant, which began on 21 August 2021, EDF carried out an ultrasonic inspection of several welds in the safety injection circuit (RIS). The safety injection system is a backup system that injects borated water into the reactor's main primary circuit to cool the core in the event of a breach in the primary circuit. Its objective is to maintain a high enough level of water in the core to cool the fuel.

The ultrasonic inspections carried out on the Civaux No. 1 reactor showed defects near the welds of certain pipe bends. The initial analysis showed the defects to be due to stress corrosion cracking.

Thinking that this might be a generic flaw applying to all 1450 MW reactors, EDF decided as a precautionary measure on 15 December 2021 to shut down the two reactors of the Chooz B nuclear power plant from 16 December 2021 in order to carry out inspections. These reactors are of the same type as those at Civaux.

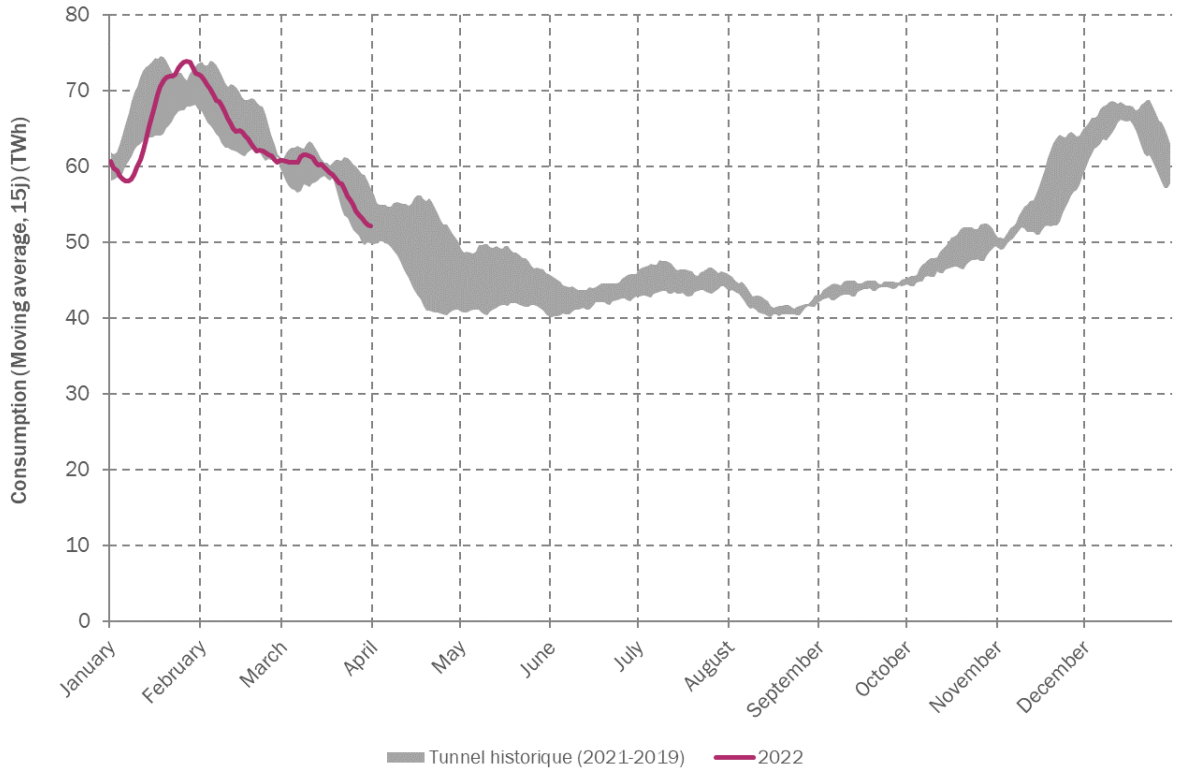
Subsequently, in January and then in February, EDF updated a prioritised list of reactors subject to repeated inspections. The effect of these inspections has been to reduce the availability of the nuclear fleet to historically low levels.



Source: EDF - Analysis: CRE

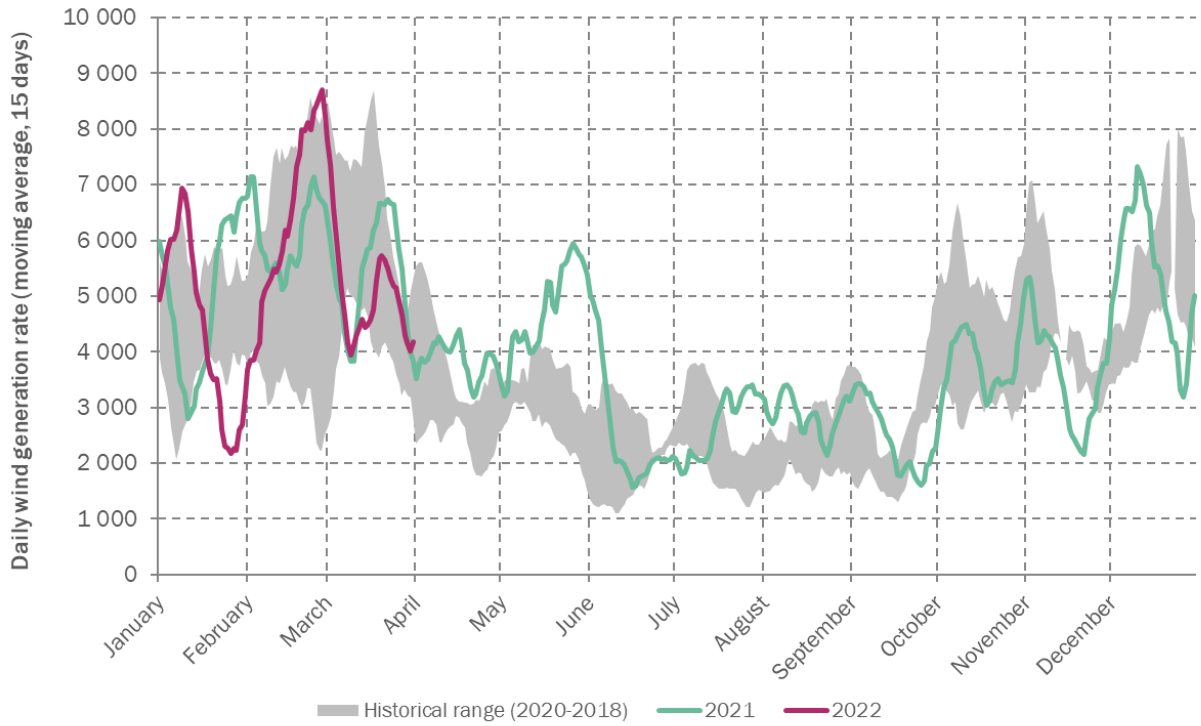
Figure 1: Change in the availability of the French nuclear fleet (GW)

From 4 February 2022, these exceptional conditions required the grid operator (the RTE) to maintain vigilance over the end of the winter. However, the weather in February and March was favourable (high wind-turbine generation in February and normal temperatures hence normal consumption), so no load shedding or price peaks were observed in France.



Source: RTE - Analysis: CRE

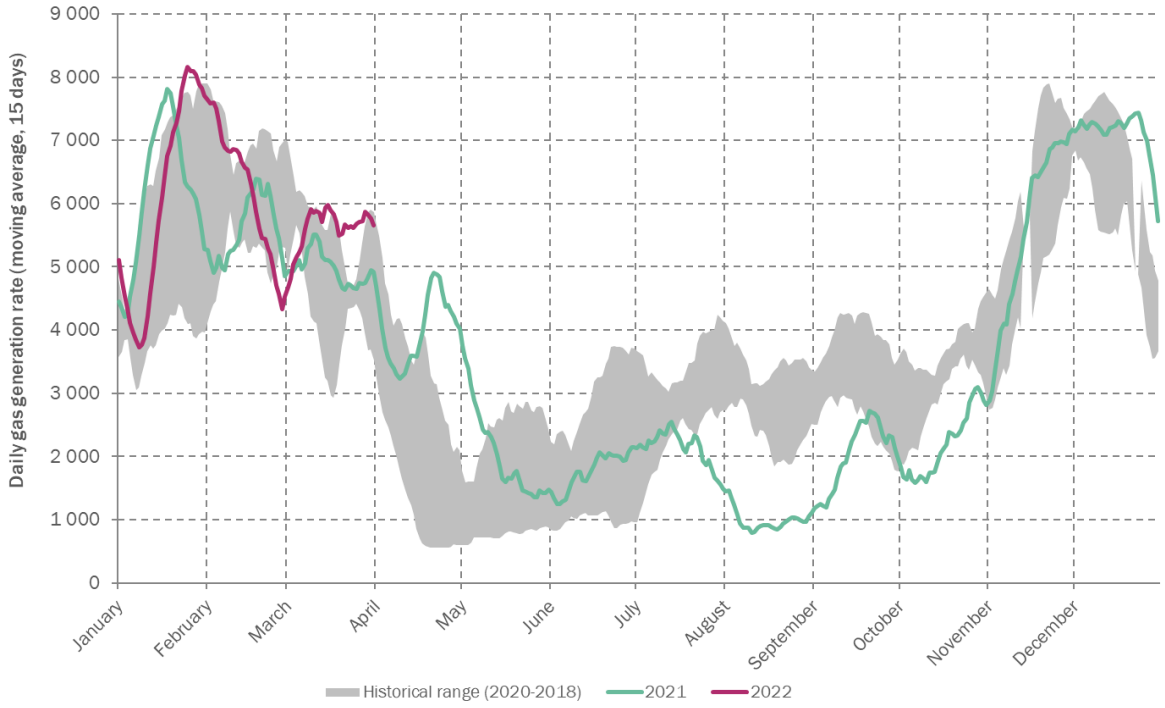
Figure 2: Evolution of consumption in France (GW)



Source: RTE - Analysis: CRE

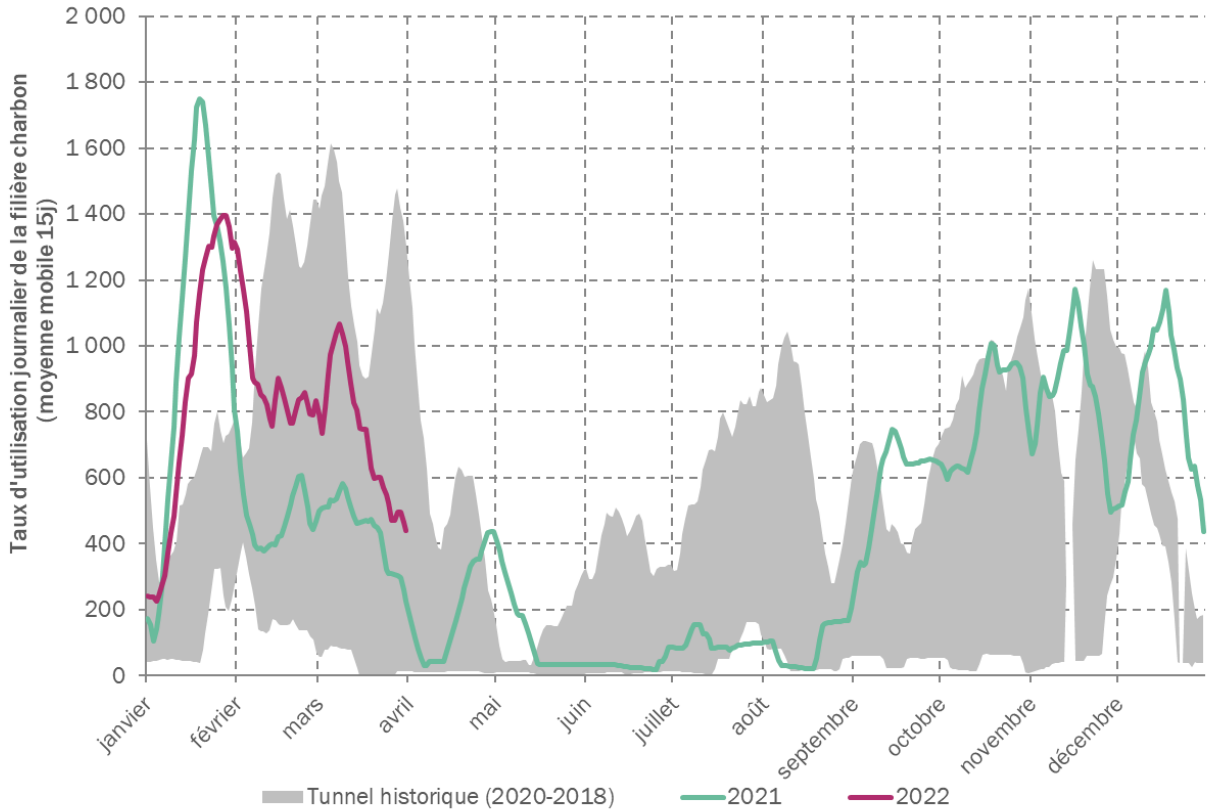
Figure 3: Daily power (MW) from wind turbines

The system was sustained by generation from fossil-fired plants, but also by interconnections, which placed France in a historically importing situation in January and March.



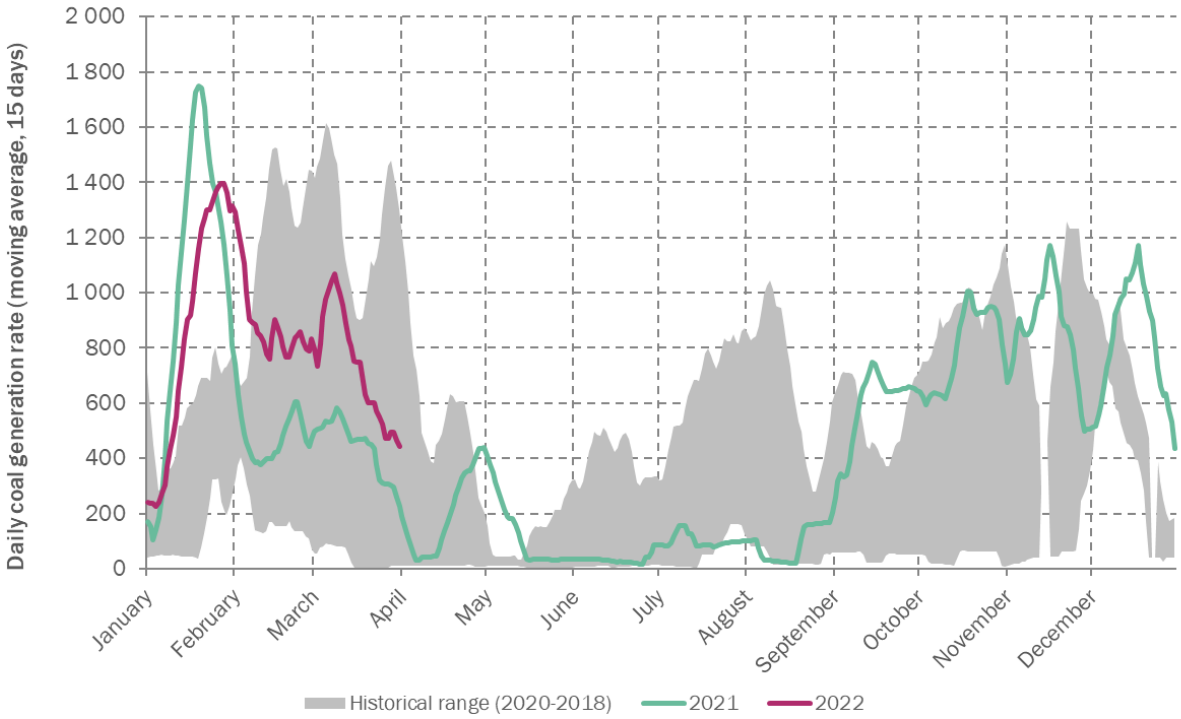
Source: RTE - Analysis: CRE

Figure 4: Daily power (MW) from gas-fired plants



Source: RTE - Analysis: CRE

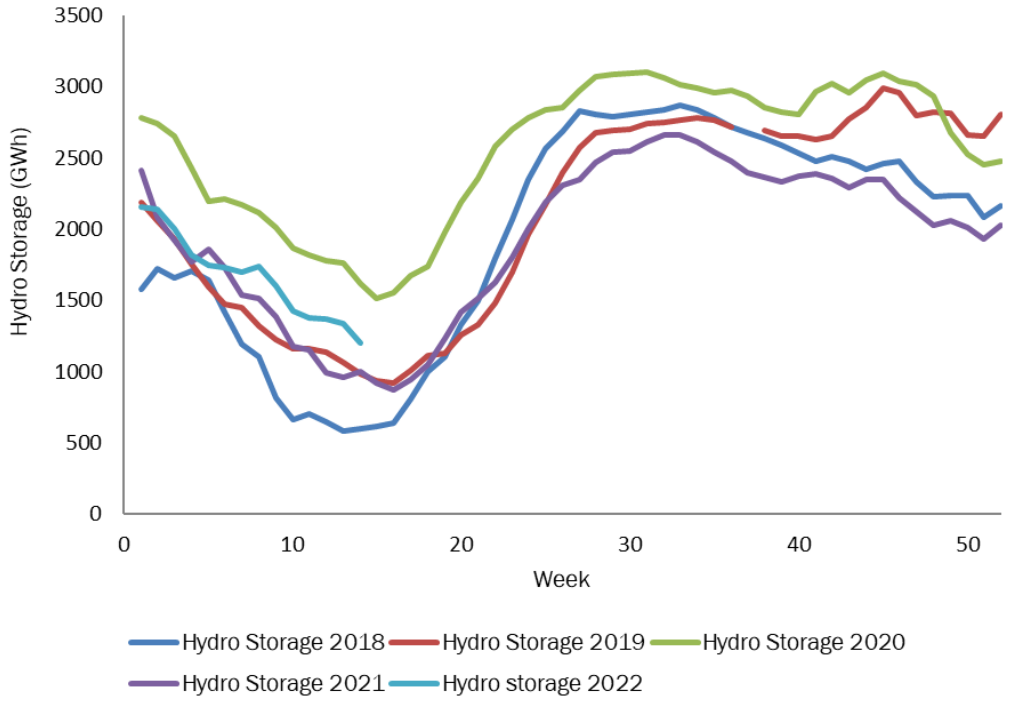
Figure 5: Daily power (MW) from coal-fired plants



Source: RTE – Analysis: CRE

Figure 6: Net daily exports (GW)

Despite a drought since the beginning of 2022, the level of hydraulic stocks was still above those in 2021, 2019 and 2018. This result reflects the operator's prudent management of stocks in anticipation of the winter of 2022-2023 which is likely to be stressed. Managing hydraulic stocks involves calculating the use values of hydraulic generation, which leads to raising its offer price on spot auctions to put less pressure on the sector in the short term. The aim is to conserve producible power for the coming winter, in view of high forward prices.



Source: RTE

Figure 7: Evolution of hydraulic stocks (GWh) - 4 April 2022 (week 14)

1.2 Monday 4 April, an exceptional day anticipated by the market

April usually marks the end of the electrical winter and of stresses in the French supply. 31 March is the pivotal date for the various mechanisms that provide additional capacity: **Red Tempo days, EJP (peak tariff) days and PP2 (peak period) days last until 31 March.**

It is also relevant that the last coal-fired unit in operation at Saint-Avold was shut down on 31 March 2022 and that the nuclear fleet reached an availability low of around 32 GW with 26 reactors out of service.

However, on Tuesday 29 March, fears began to emerge about an exceptional cold snap that would reach France on Monday 4 April.

A press article from Montel on 29 March 2022, was already saying: "*The French electricity network will be highly stressed on Monday because of the coming cold weather, which will increase electricity demand to 68-70 GW at a time when the supply of nuclear energy is very low*. The article stated that temperatures in France were expected to plunge to six degrees below seasonal norms and that demand was expected to peak at 68-70 GW, as against an average of 63 GW. The journalist was reporting the words of the RTE which considered that the peak would be between 68.5 and 69.5 GW on the Monday. The RTE was confident that the grid would support this, and was counting on imports and on wind generation of 10 GW.

Fears increased in the following days because the wind forecast in France was poor and the cold snap was confirmed. Analysts expected 4.7 GW of wind generation during peak hours on Monday 4 April and a temperature of 4.5°C below seasonal norms. To put this in context, the consumption gradient in France is about 2.4 GW/°C in winter.

Wind power forecast (31 March 18:00 UTC)

	01 Apr		02 Apr		03 Apr		04 Apr		05 Apr	
Area	Base	Peak	Base	Peak	Base	Peak	Base	Peak	Base	Peak
Europe	95,233	97,382	69,542	71,817	48,080	45,690	105,453	113,314	99,062	96,209
Germany	29,799	31,585	17,470	18,522	11,618	12,218	37,675	41,661	38,959	40,394
DE-Grid 50Hertz	11,049	11,721	7,341	8,006	3,872	3,874	13,547	15,119	14,347	14,879
DE-Grid Amprion	5,130	5,870	3,707	3,865	943	772	5,480	6,472	6,064	6,048
DE-Grid EnBW	514	588	658	667	142	65	419	461	1,260	1,286
DE-Grid Transpower	13,106	13,407	5,764	5,984	6,660	7,508	18,230	19,610	17,289	18,181
Austria	1,599	1,684	1,987	2,024	1,756	1,769	289	428	467	414
Belgium	3,376	3,680	1,764	1,592	432	286	3,179	3,672	1,917	1,490
Denmark	1,631	1,735	630	474	2,909	3,299	4,455	4,048	4,774	4,872
Finland	139	91	659	793	283	239	898	874	2,445	2,499
France	10,114	10,428	8,047	8,267	3,349	3,282	4,191	4,690	7,511	8,335
Greece	2,101	2,264	1,984	2,227	1,428	1,454	65	56	429	502
Ireland	759	758	674	789	266	252	2,354	2,735	1,530	1,357
Italy	5,858	6,016	6,278	6,507	3,438	3,196	2,223	2,540	2,354	1,722
Netherlands	5,791	5,915	2,457	2,363	1,364	1,441	5,376	5,987	4,467	4,018
Norway	238	174	2,123	2,326	884	676	1,674	1,721	1,503	1,397
Poland	5,035	5,573	4,506	5,051	1,587	1,514	5,465	6,069	5,053	5,014
Portugal	2,295	1,913	1,818	1,310	2,852	2,269	3,692	3,538	2,115	1,413
Romania	2,755	2,747	2,208	2,419	1,199	1,122	449	297	1,081	1,207
Spain	14,814	13,957	11,687	11,633	9,167	7,252	12,969	12,638	7,556	5,330
Sweden	1,110	1,226	2,268	2,521	1,297	1,148	5,567	6,161	5,437	5,298
UK	6,459	6,230	1,830	1,777	3,947	3,820	14,087	14,918	9,785	8,950

Wind power forecasts for countries with >400MW installed capacity

Figure 8: Forecast for wind generation on 31 March 2022 (source: Argus)

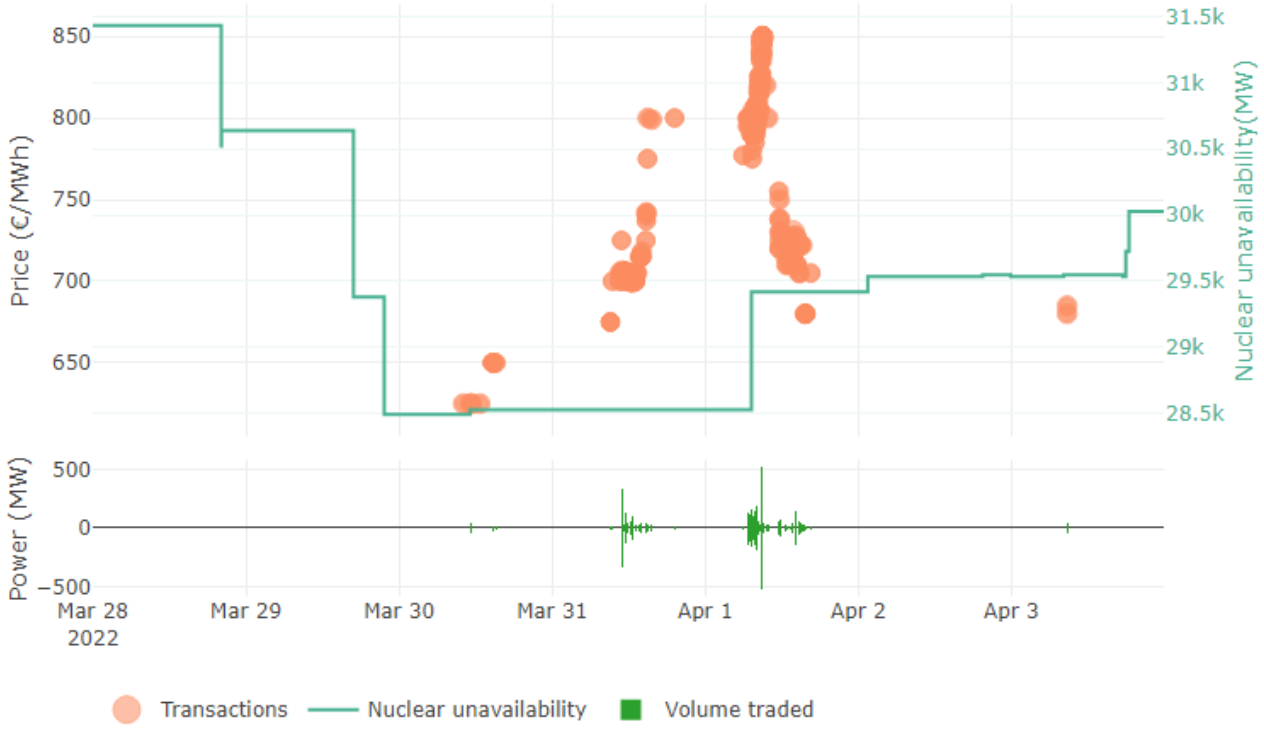
European weather - Departure from normal temperatures												°C
Location	1 Apr		2 Apr		3 Apr		4 Apr		5 Apr		Precipitation (mm)	
	Avg	± normal*	Avg	± normal*	Avg	± normal*	Avg	± normal*	Avg	± normal*	5-day	15-day
UK – London Heathrow	5.2	-4.0	4.8	-4.5	3.9	-5.5	6.8	-2.7	11.1	1.5	4.4	25.3
Norway – Bergen Florida	4.3	-1.3	3.8	-1.9	4.0	-1.9	2.6	-3.4	3.1	-3.0	13.2	44.5
Norway – Oslo Blindern	2.1	-1.9	2.2	-2.0	3.0	-1.4	1.9	-2.7	2.1	-2.7	4.4	21.2
France – Paris Orly	3.5	-6.2	4.4	-5.4	4.1	-5.8	5.5	-4.5	9.9	-0.3	6.4	31.8
The Netherlands – Amsterdam Schiphol	2.8	-5.3	2.8	-5.5	2.5	-5.9	6.2	-2.3	9.2	0.6	15.3	59.1
Germany – Essen	3.8	-4.5	3.8	-4.6	2.2	-6.4	7.1	-1.6	9.1	0.2	15.4	61.1
Germany – Berlin Tempelhof	4.1	-3.5	3.7	-4.1	2.0	-6.0	5.5	-2.7	8.1	-0.2	12.8	37.5
Poland – Warsaw Okecie	2.5	-3.8	1.8	-4.7	0.5	-6.2	0.8	-6.1	4.4	-2.7	12.6	35.7
Czech Republic – Prague Ruzyne	1.4	-5.5	0.0	-7.1	-0.9	-8.2	0.7	-6.8	5.6	-2.1	10.6	30.1
Hungary – Budapest Lorinc	9.6	-0.4	6.6	-3.6	3.7	-6.7	4.4	-6.2	8.2	-2.6	12.9	37.0
Serbia – Belgrade Surcin	16.3	5.3	11.2	0.0	4.7	-6.6	6.0	-5.5	8.8	-2.8	17.3	42.4
Romania – Bucharest Imh	21.0	11.6	16.4	6.9	10.2	0.5	7.6	-2.3	8.9	-1.2	10.4	17.0
Spain – Madrid Barajas	7.5	-3.9	6.7	-4.8	7.4	-4.2	8.5	-3.2	8.0	-3.8	1.4	20.0
Greece – Athens Airport	19.6	4.9	18.0	3.2	16.3	1.4	16.2	1.1	18.8	3.6	0.5	3.0
Bulgaria – Sofia Observatory	14.1	4.6	11.1	1.5	7.5	-2.3	7.8	-2.1	9.2	-0.9	20.7	35.5
Turkey – Istanbul Ataturk	17.9	6.5	16.4	4.9	14.0	2.4	12.9	1.1	14.5	2.6	8.1	20.5
*normal means cleaned 10-year average (2004-2013 inclusive)												
– Ensemble forecasts (12.00 GMT) provided by Speedwell Weather												

Figure 9: Temperatures forecast on 31 March 2022 (source: Argus)

The market prices for 4 April 2022 then spiralled, with the base-load day price on 4 April 2022 reaching almost €850/MWh and the peak-load commodity price €1,000/MWh. On 1 April 2022, an Argus article began: "*French electricity spot prices for delivery on Monday jumped 125 euros to 840 euros/MWh on the EEX, amid fears of a supply shortage due to a cold snap and low nuclear availability*".

The players clearly anticipated the stress on the system before the spot auction, and high liquidity was seen (5 GW traded on the base-load product and 250 MW on the peak-load product).

Exchange and over-the-counter trading were particularly evident during the morning of 1 April: players were possibly reacting to EDF's announcement on 1 April at 7.15am that it was extending the unavailability of Dampierre 1 until 5 April 2022 (due to a fortuitous event that occurred on 26 March 2022).



Source: CRE

Figure 10: Transactions in the base-load product: France 4 April 2022 (EEX and OTC)

1.3 Low import capacity, especially from Germany

It is important to bear in mind that capacities made available for cross-border electricity exchanges are calculated in different ways at the French borders. For borders with EU countries, the method used to calculate capacity is defined within the capacity calculation regions, in order to achieve a capacity calculation that is coordinated between the region's TSOs and thus optimise efficiency. However, the capacity calculation at the border with a third-party country (Switzerland and England for France) depends on the bilateral agreements established between the two countries.

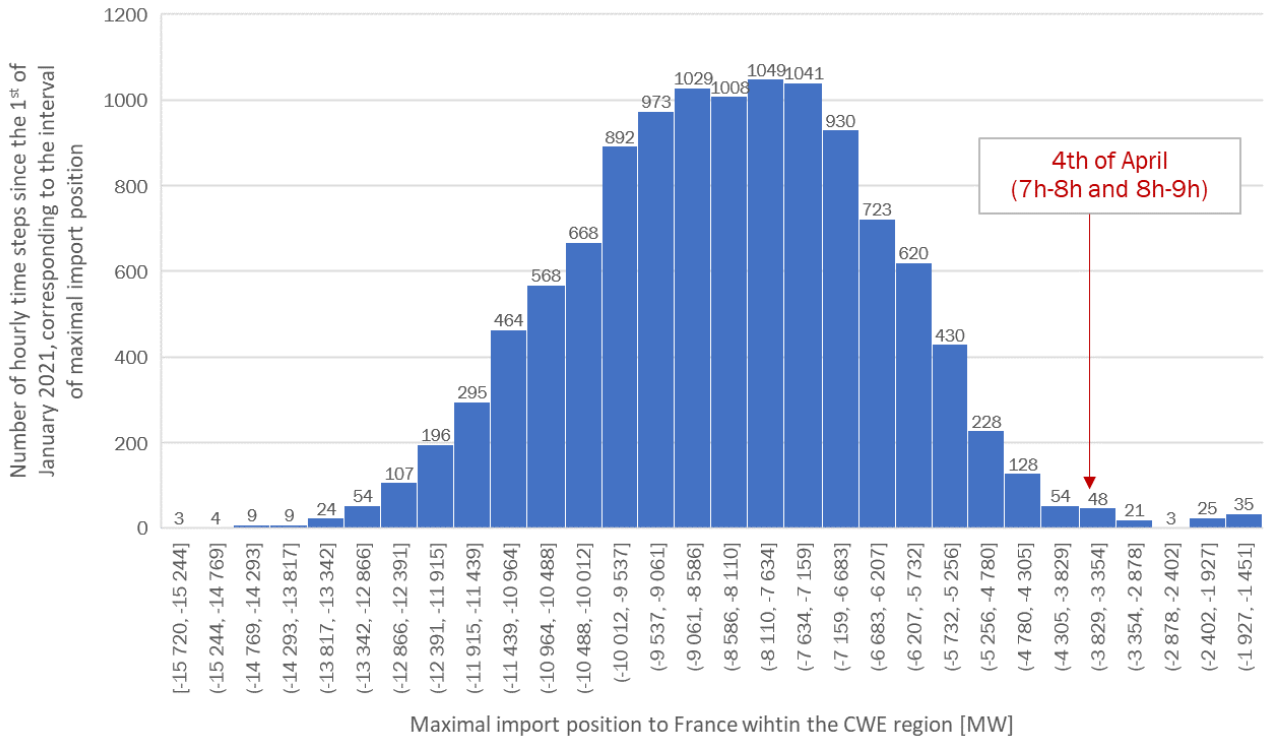
1.3.1 Borders between France-Belgium and France-Germany

The Central West Europe capacity calculation region (hereafter the "CWE")[2] comprises 6 countries (Austria, Belgium, France, Germany, Luxembourg and the Netherlands). For the day-ahead market, the CWE capacity calculation is flow based. A flow-based capacity calculation does not calculate a maximum exchange capacity between two areas but coefficients linking cross-border exchanges to flows over critical parts of the network. The capacity actually available on a particular border is determined later, during coupling, and takes account of all the exchanges. This capacity calculation is more efficient at taking into account the flow interdependencies for price zones within a region characterised by a dense network.

The indicator used to monitor the capacity available for cross-border trade in a region using the flow-based method is the **"Maximum import/export position"**. For France, this indicator corresponds to the available capacity at French borders that are within the CWE region (the France-Belgium and France-Germany borders) when all trades in the CWE region are structured to maximise France's import or export flows. This indicator is therefore one of the possible solutions that the algorithm could choose during the coupling process.

On 4 April 2022, France's maximum import positions within the CWE region were 3,714 MW and 3,600 MW for hours 7 and 8 respectively. This corresponds to extremely low capacity:

- These maximum import positions are among the lowest 1% recorded over the period from 1 January 2021[3] at French CWE borders.
- These maximum import positions are among the lowest 2% recorded over the period from 1 January 2022[1] at the French CWE borders.



Source: RTE - Analysis: CRE

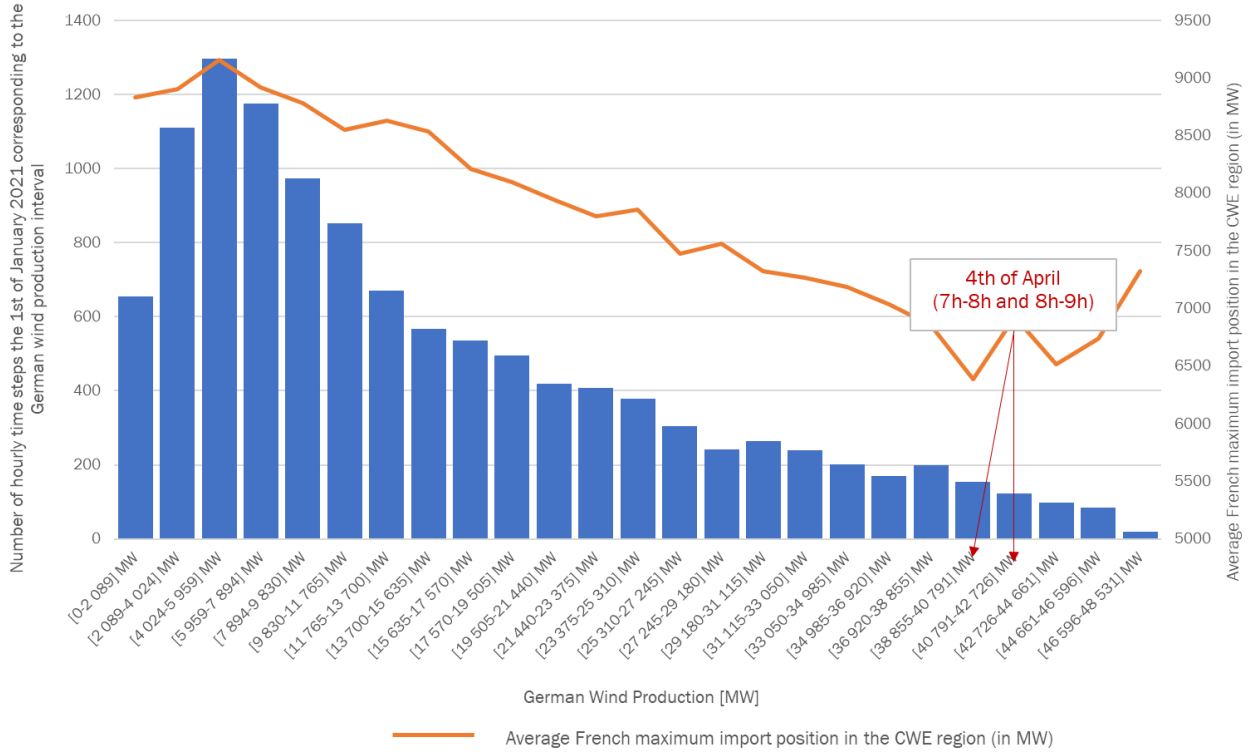
Figure 11 Histogram of France's maximum import position within the CWE region for the period from 1 January 2021 to 30 April 2022.

[2] Since 8 June 2022, the CWE capacity calculation has been replaced by a coordinated capacity calculation for the Core region, comprising 13 countries.
[3] Analysis period ending 30 April 2022.

Nevertheless, this is not an isolated case. As shown in Figure 11, there were more than 89 hours in 2021 where the maximum French import position was lower. Since the beginning of the year, the days of 30 January and of 1, 5 and 6 April in particular show similar patterns.

The weakness of France's import capacity at the FR-BE and FR-DE borders stems from a combination of three main factors.

i. Significant wind-turbine generation in Germany: German renewable energy generation is mainly located in the north of the country (onshore and offshore wind turbines) while the south of the country remains the main centre of consumption. This generates massive north-south flows on a German network that is not appropriately sized and is therefore very heavily loaded. As a result, the parts of the German network included in the capacity calculation for the CWE region have higher reference flows, making the remaining available capacities lower. In addition, the situation generates loop flows corresponding to a transfer of the north-south flows to the networks of neighbouring countries (Belgium and the Netherlands in the case of France). These flows also reduce the available capacities on parts of the networks of Germany's neighbouring countries. France's import capacities in the CWE region are therefore more limited if wind generation in Germany is high. This is illustrated in Figure 12, where it can be seen that the maximum French import position within the CWE region generally decreases as German wind generation increases.



Sources: RTE, ENTSOE - Analysis: CRE

Figure 12 Histogram of German wind generation and French maximum average import position in the CWE region for the period 1 January 2021 to 30 April 2022

German wind generation on 4 April was 36,821 MW and 37,844 MW for hours 7 and 8. These generation levels are very high, being in the 94th percentile over the observed period.

ii. Low French generation near the France-Belgium and France-Germany borders: several French generation facilities were at a standstill on 4 April. The two reactors of the Chooz B nuclear power plant (France-Belgium border) were shut down as a preventive measure (to check for potential corrosion defects). For the same reasons, only two of the four reactors at the Cattenom nuclear power plant (on the France-Germany border) were in operation. Finally, the last unit of the coal-fired power plant at Saint-Avold (France-Germany border) was shut down on 31 March 2022. When in operation, these generation units generate flows that influence the network modelling used to calculate capacity and as a result increase the trading capacity at the borders in the import direction.

iii. Engineering work at the France-Belgium Mastaing-Avelgem interconnection: this interconnection is one of the three 400 kV interconnections between France and Belgium. It has been in maintenance since 21 February 2022 for planned work (change of conductors).

In summary, the import situation observed on 4 April 2022 at 7am and 8am can be explained by a combination of factors, which individually are not unusual, but which together result in extremely low capacities. As long as the problems discussed in paragraphs ii and iii continue, the capacities available at the FR-DE and FR-BE borders will remain low when wind generation is high in Germany.

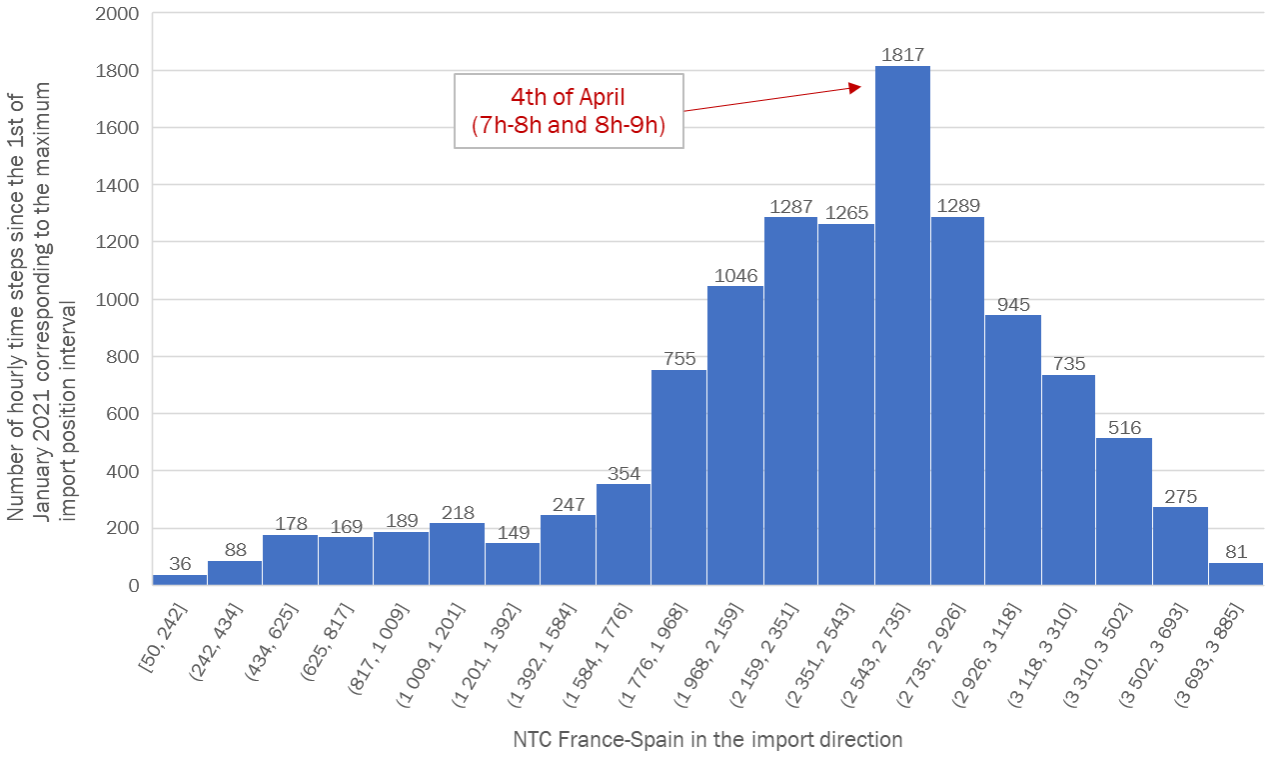
In view of the coming winter, there is an evident need for the RTE to approach its German and Belgian counterparts to review the measures they might take to increase France's import capacity from the CWE zone, if the situation of the French electricity supply becomes critical.

1.3.2 France-Spain border

France, Spain and Portugal form the South West Europe (hereafter the "SWE") capacity calculation region. The co-ordinated capacity calculation is based on the Net Transmission Capacity (hereafter the "NTC") method. The NTC calculation provides a maximum available capacity for cross-border trade across each border in each direction (import and export).

On 4 April, the coordinated capacity calculation at the French-Spanish border, in the import direction, gave a low value of 1050 MW available. This was due to a data problem for the network model under consideration.

To remedy this, the RTE and its Spanish counterpart the REE carried out a bilateral capacity calculation to obtain a value that reflected the real network. This procedure is not automatic and was decided jointly by the RTE and the REE, chiefly because of the French supply difficulties anticipated for 4 April. The result was an NTC at the French-Spanish border in the import direction of **2550 MW** available for cross-border exchanges. This capacity is above the average of 2302 MW over the observed period.
The capacity available for single day coupling was 2519 MW for hours 7 and 8, (i.e. with 31 MW subtracted from the NTC for long-term rights nominations). As shown in Figure 13, these values are in line with the values observed on the FR-ES border in the import direction.



Source: RTE - Analysis: CRE

Figure 13 Histogram of the interconnection capacity offered in the import direction by daily coupling at the French-Spanish border for the period from 1 January 2021 to 30 April 2022.

No additional capacity had been made available during intraday trading for cross-border exchanges across the FR-ES border in the import direction.

1.3.3 North Italy

France, the North Italy bidding area, Austria, Slovenia and Switzerland (as a technical partner) form the North Italy capacity calculation region. Within this region, the coordinated capacity calculation is based on the Net Transmission Capacity method, which aims to calculate a maximum available capacity available for trade across each border in each direction (import and export). However, the project to implement a methodology for coordinated capacity calculation is not yet complete. At present, the coordinated calculation only exists in the sense of an import as seen from Italy.

On 4 April 2022, there was therefore no coordinated capacity calculation for the IT > FR direction, which was the intended direction of trade. The value used for the coupling was in this case a value defined annually by the TSOs, which can be adjusted depending on withdrawal-from-use or damage. This value was set at 995 MW of available capacity (NTC) for the two relevant hours on 4 April 2022.

It should be noted that of the 995 MW of capacity offered to the market, 150 MW had been allocated to long-term nominations. The capacity offered for the Single Day-ahead Coupling was therefore 845 MW. The events on that day highlight the pressing need for a coordinated capacity calculation in the import direction so that optimal capacities can be offered for cross-border trade.

1.3.4 England

Since the UK's exit from the European Union, there is no longer a coordinated capacity calculation at the France-England border and this border is no longer included in the European Single Day-ahead Coupling. Capacity is now sold via an explicit auction system. The France-England border is therefore not integrated into the European Single Day-ahead Coupling, and as such does not contribute directly to spot-price setting.

The maximum capacity of the IFA and IFA2 France/England Interconnections is 3,000 MW. This capacity may be reduced in the event of maintenance or damage. Since 15 September the available capacity (NTC) on **the IFA interconnection has been reduced to 1,000 MW (as against 2,000 MW normally) following a fire at the facility. A return to nominal mode is expected in autumn 2022.**

On 4 April, the NTC at the FR-GB border in the import direction was 2,014 MW, which is the maximum possible capacity in view of the incident.

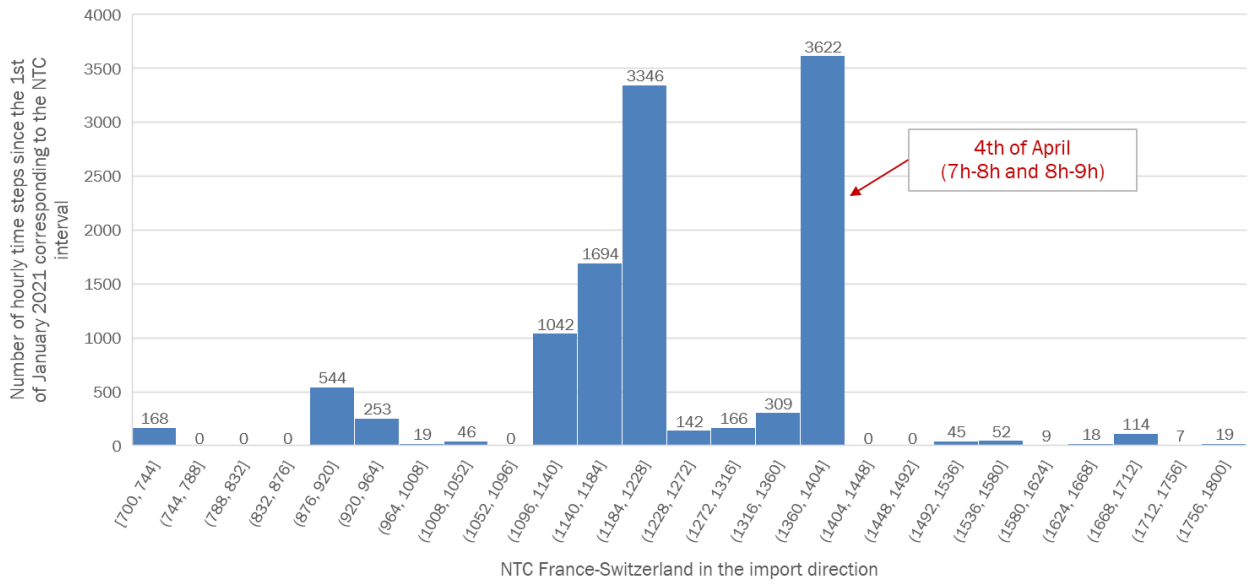
1.3.5 Switzerland

Switzerland is not part of the European Single Day-ahead Coupling. Exchange capacity is therefore not implicitly allocated at the same time as the energy exchanges, as it is the case for the borders with Spain, Italy, Belgium, Luxembourg and Germany.

The special feature of this border is that many long-term contracts giving the right to use exchange capacities still exist today. Additional trading capacity is also allocated to market participants through explicit auctions.

On this border, the theoretical maximum exchange capacity is calculated by the RTE and Swissgrid using the NTC method. For 4 April, for hours 7 and 8, the capacity available for trading for day-ahead capacity (capacity calculated the day before delivery) was 1400MW (NTC), a rather high value for this border.

As the actual time draws nearer, the TSOs have a clearer view of the status of the network at delivery time and can sometimes make additional trading capacity available to the market. On 4 April, for hours 7 and 8, an additional 300 MW was added to the exchange capacity and made available for intraday exchanges.



Source: RTE - Analysis: CRE

Figure 14 Histogram of the interconnection capacity offered on the market in the import direction (before taking the intra-day calculation into account) for France/Switzerland: period from 1 January 2021 to 30 April 2022.

1.3.6 Summary of the capacities available at interconnections

The total French import capacity on 4 April was low compared with the average levels, as shown in Tables 1 and 2. The weakness was mainly at the France-Belgium and France-Germany borders. **This pattern of import capacity is unusual, but it can occur during the year.**

All the capacity available for French imports was used apart from that at the France-Belgium and France-Germany borders (because of their special flow-based calculation, and because of the notion of maximum import position described in part 2.2 of this Note).

In conclusion, the analysis of import capacities gives ambivalent results.

Although the risk of load shedding in France during the 2 hours in the morning had been known for several days, the interconnections within the European Union gave disappointing results:

- an extremely low level from the CWE zone (Germany-Belgium), classed in the 1% of hours offering historically the lowest capacity;
- an average level for Spain and Italy.

		4 April at hour 7	
Border	**Average available capacity[4] (in MW)**	**Available capacity for day-ahead cross-border trade[5] (in MW)**	**Day-ahead allocated capacity (in MW)**
BE>FR and DE>FR	8,364	3,714	3,104
ES>FR	2,419	2,550	2,550
IT>FR	1,031	995	995
GB>FR[6]	*2,247*	*2,014*	*2,014*
CH>FR[5]	*1,223*	*1,400*	*1,400*
Total		10,673	10,063

Table 1: Day-ahead available and allocated capacities at the French borders, in the import direction, on 4 April 2022 for hour 7.

[4] Over the period from 1 January 2021 to 30 April 2022.
[5] These are the capacities made available for cross-border exchanges (NTC) except for the FR-BE and FR-DE borders, where it is the maximum French import position within the CWE region.
[6] The FR-GB and FR-CH borders do not participate in the single European daily coupling and therefore do not participate directly in the spot price setting.

		4 April at hour 8	
Border	Average available capacity[3] (in MW)	Available capacity for day-ahead cross-border trade[4] (in MW)	Day-ahead allocated capacity (in MW)
BE>FR and DE>FR	8,364	3,597	3,102
ES>FR	2,419	2,550	2,550
IT>FR	1,031	995	995
GB>FR[5]	*2,247*	*2,014*	*2,014*
CH>FR[5]	*1,223*	*1,400*	*1,400*
Total		10,556	10,061

Table 2: Day-ahead available and allocated capacities at the French borders, in the import direction, on 4 April 2022 for hour 8.

1.4 The RTE activated the ecoWatt orange signal on Saturday 2 April 2022

The forecast temperatures for Monday had continued to fall, reaching almost -5 °C below normal late on Friday.

Recognising this, the RTE activated the ecoWatt signal[7] to encourage French consumers to put off using electricity as much as possible. This time, the RTE stated that due to the drop in temperatures, electricity consumption could reach **73,000 MW** by 9.00am. Electricity generation was expected to be 65,000 MW, but France should be able to import up to **11,000 MW**.

However, the RTE did not envisage any power cuts on Monday morning, unless any unforeseen events occurred over the weekend.

2. COURSE OF THE SPOT AUCTION ON 3 APRIL FOR 4 APRIL

2.1 The day-ahead coupling had to be reallocated because the price cap had been reached

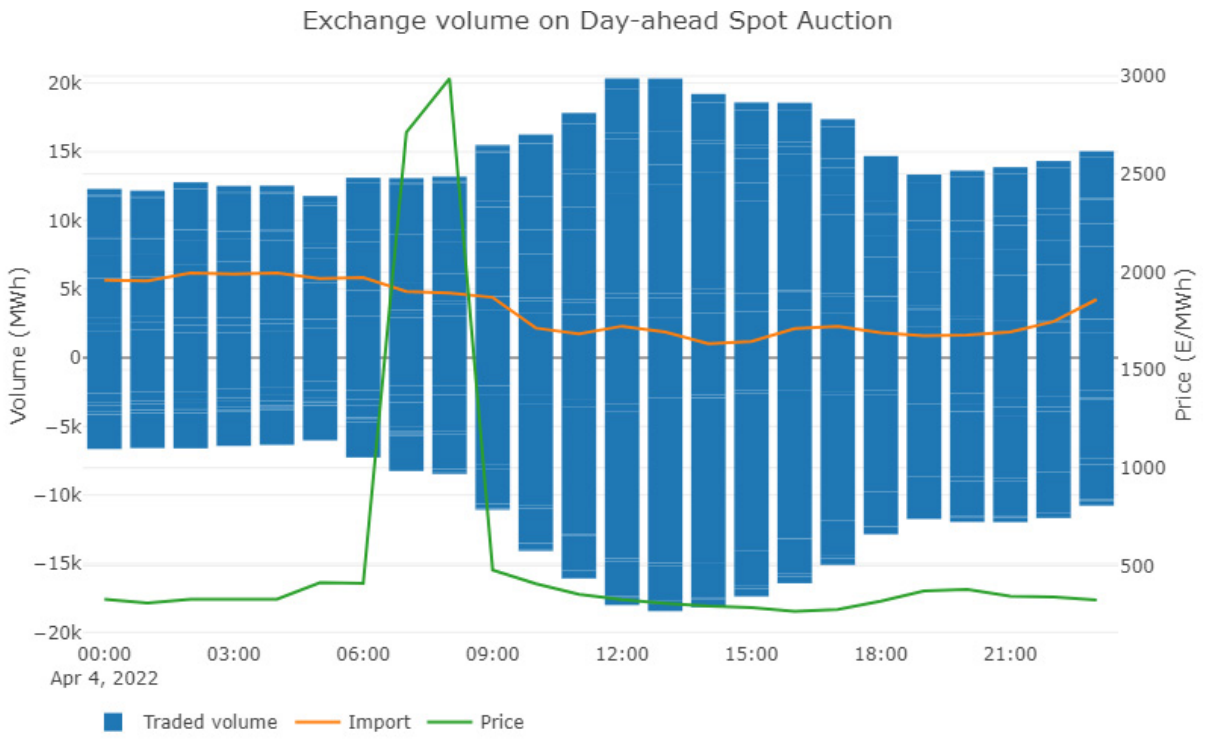
The day-ahead auction for 4 April 2022 took place on Sunday 3 April 2022 at 10.00am. Initially, the auction set the following prices at 12.48pm for 7am and 8am: €2,758.54/MWh and €3,000/MWh (reaching the cap).

According to the procedure in place for the Single Day-ahead Coupling, EPEX reopened the auction at 12.50pm and gave players 15 minutes to change their orders if necessary. A European-wide recalculation took place and extremely high prices were again obtained for hours 7 (€2,712/MWh) and 8 (€2,987/MWh), but without reaching the cap or rationing.

The average day price was €551/MWh.

As the prices had reached 60 % of the ceiling, the price cap was increased by €1,000/MWh[8] in all zones of the market included in the Single Day-ahead Coupling, covering 24 countries, in accordance with the ACER decision[9] on the maximum and minimum prices for fay-ahead coupling. The consequences of the situation encountered on the morning of 4 April were therefore very important not only for France but also for the entire European market.

[7] https://www.rte-france.com/actualites/baisse-temperatures-rte-active-signal-orange-national-ecowatt-lundi-4-avril-2022
[8] 5 weeks after the auction, i.e. on 10 May 2022
[9] Harmonised maximum and minimum clearing prices for single day-ahead coupling in accordance with Article 41(1) of Commission Regulation (EU) 2015/1222 of 24 July 2015 establishing a guideline on capacity allocation and congestion management (CACM Regulation): https://www.nemo-committee.eu/assets/files/nemo_committee_files/acer-sdac-anex.PDF



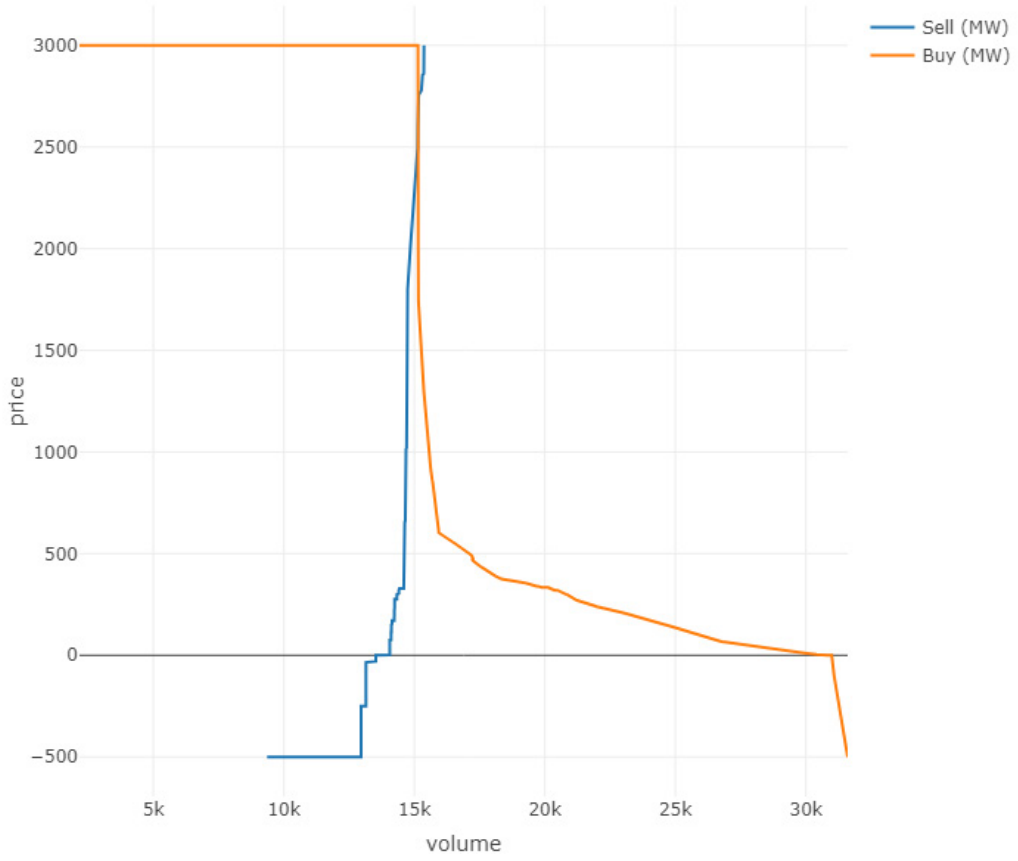
Source: EPEX SPOT - Analysis: CRE

Figure 15: Volumes traded on the EPEX SPOT auction (MWh), clearing price (€/MWh) and implicit daily import (MWh)

The auction did not show exceptional trading volume, for instance, for 7am and 8am. Trades with neighbouring countries calculated implicitly during the day-ahead coupling (Germany, Italy, Belgium, and Spain) were not observed to be especially higher during the stress hours, indicating that the trading capacities available to the market were saturated. The capacities had not specifically been increased by the TSOs before the day-ahead auction.

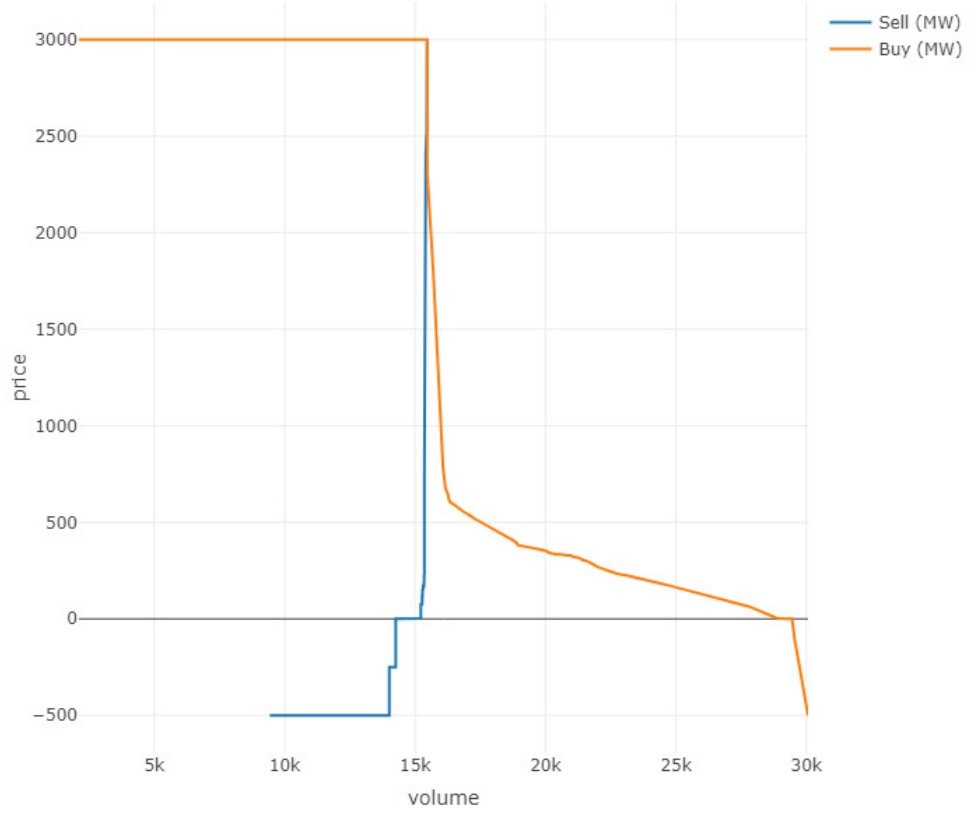
The auction showed little depth to trades (apart from sales at any price) over the stressed hours, as illustrated by the supply/demand curves below. The cap was reached within 230 MW at 7 am and within 0.3 MW at 8am.

Conversely, a favourable shift of 1,000 MW (an increase in supply (for instance at interconnections) or a decrease in demand) would have brought the price down very sharply, to around €1,000/MWh or €1,500/MWh.



Source: EPEX SPOT - Analysis: CRE

Figure 16: Aggregate supply and demand curves for the French day-ahead auction on 04/04/2022 at 07:00



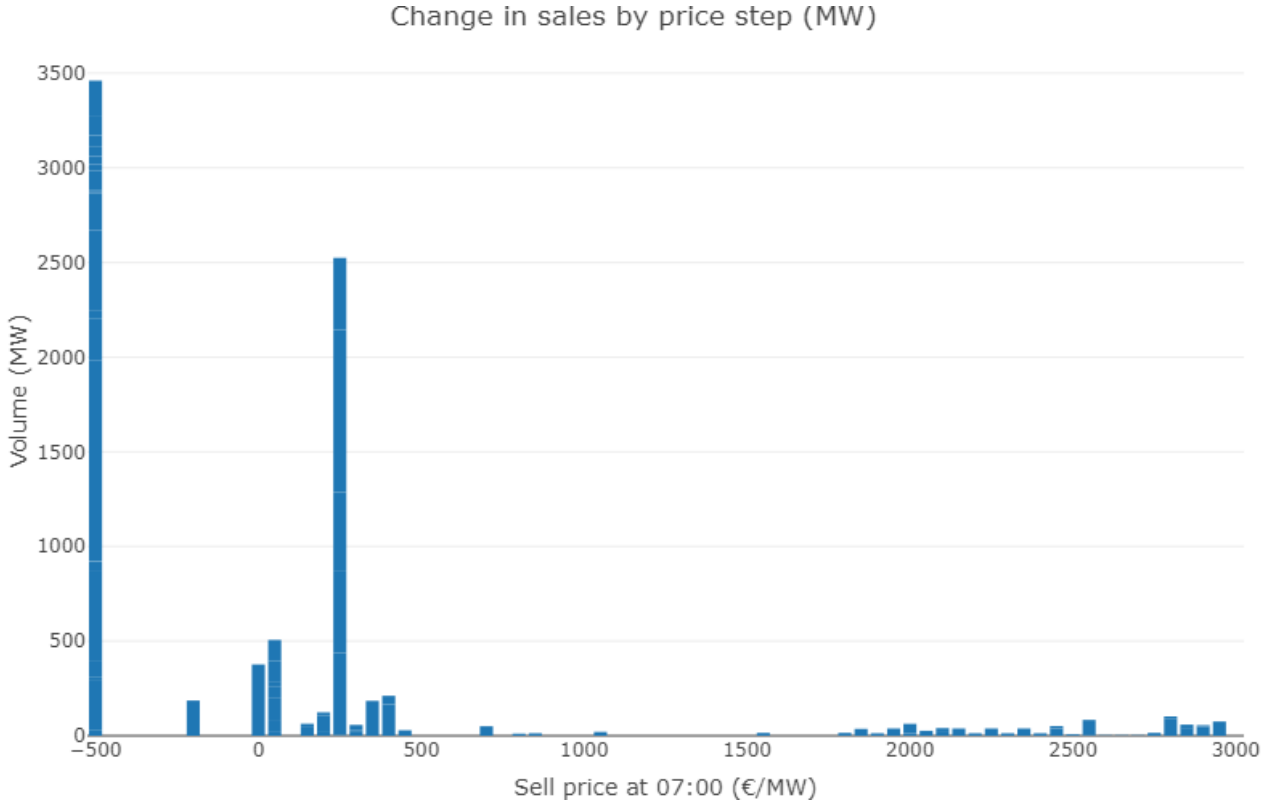
Source: EPEX SPOT - Analysis: CRE

Figure 17: Aggregate supply and demand curves for the French day-ahead auction on 04/04/2022 at 08:00

As the sales curve was steep, the price was particularly sensitive to a small change in supply or demand. At 8.00am, an increase in supply of 500 MW would have reduced the price by about €1,700/MWh. At 7.00am, the same increase would have reduced the price by about €1,100/MW.

Looking more closely at the French order books (excluding imports) for 7am and 8am, it appears that the volumes sold were mainly offered at -€500/MWh (i.e. at any price) and at €250/MWh. Hardly any volumes were offered above €500/MWh (295 MWh at 8am and 946 MWh at 7am).

On that day, the PEG price was €110/MWh and the CO_2 price €78.5/t, so that the peak in supply volume at €250/MWh is easily explained by the cost of generation using combined-cycle gas turbines. These levels of supply price therefore appear to be consistent with the fundamentals and do not point to an "economic" capacity retention strategy (i.e. with prices not correlated with variable costs) during peak hours.



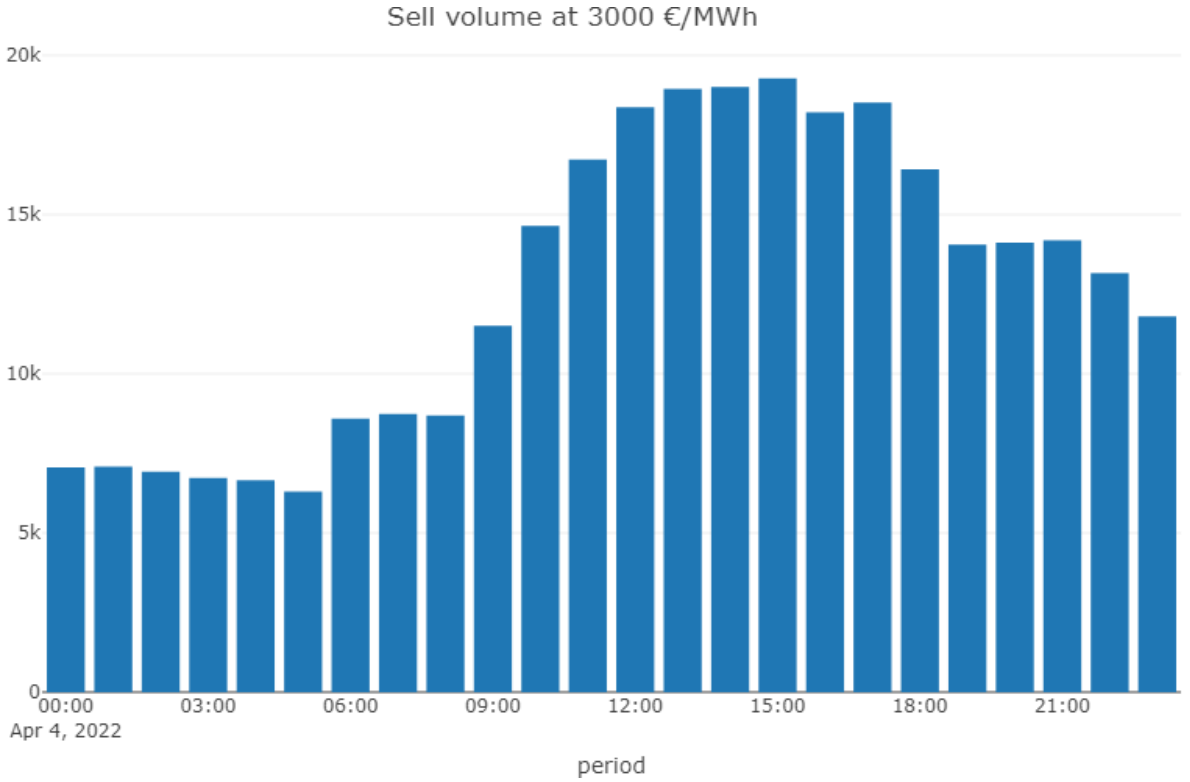
Source: EPEX SPOT - Analysis: CRE

Figure 18: Volume of offers for sale by proposed price band (€50/MWh) at 07:00

Source: EPEX SPOT - Analysis: CRE

Figure 19: Volume of offers for sale by proposed price band (€50/MWh) at 08:00

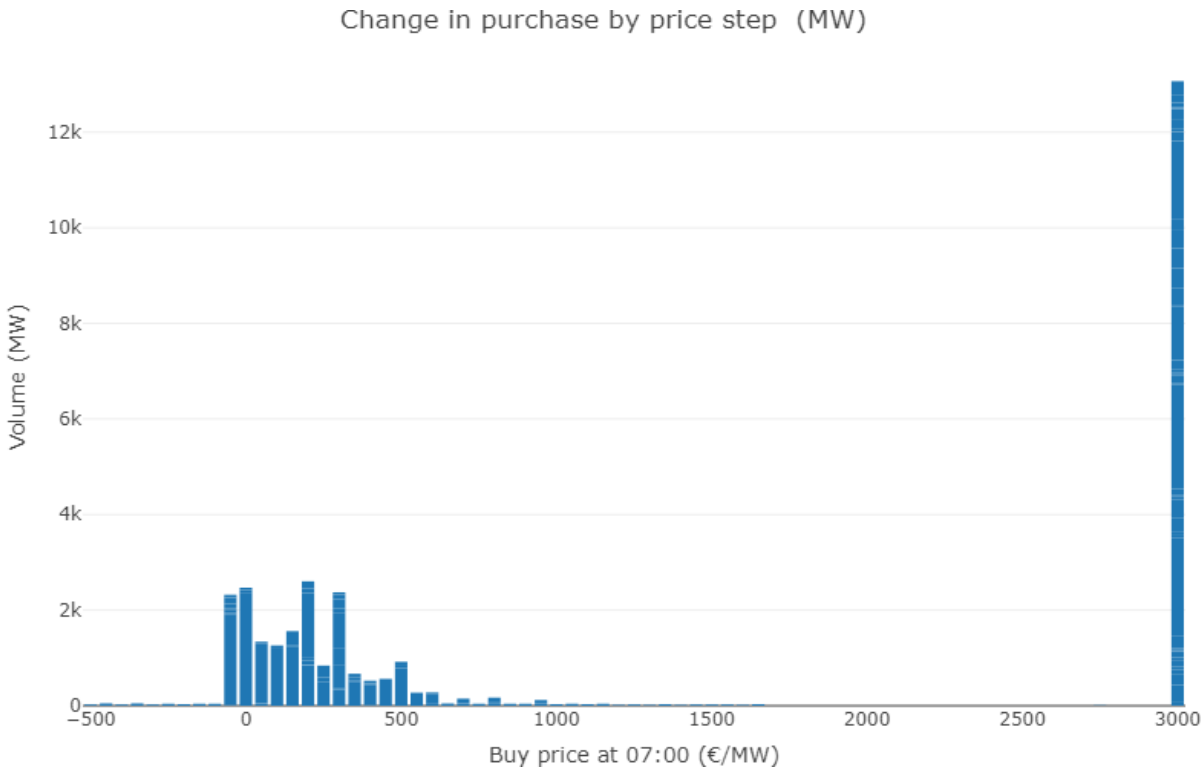
The volumes offered at 7am and 8am were relatively low compared with the rest of the day (see Figure 20), but higher than those for the night. Given the growth in wind generation, the order of magnitude of these volumes does not, at first sight, seem odd, thus ruling out any suggestion that volume capacity is being held back. Had volume capacity been withheld, with units abnormally shut down, excess intraday volumes or significant positive imbalances would have been visible during these hours, which was not the case (see next section).



Source: EPEX SPOT - Analysis: CRE

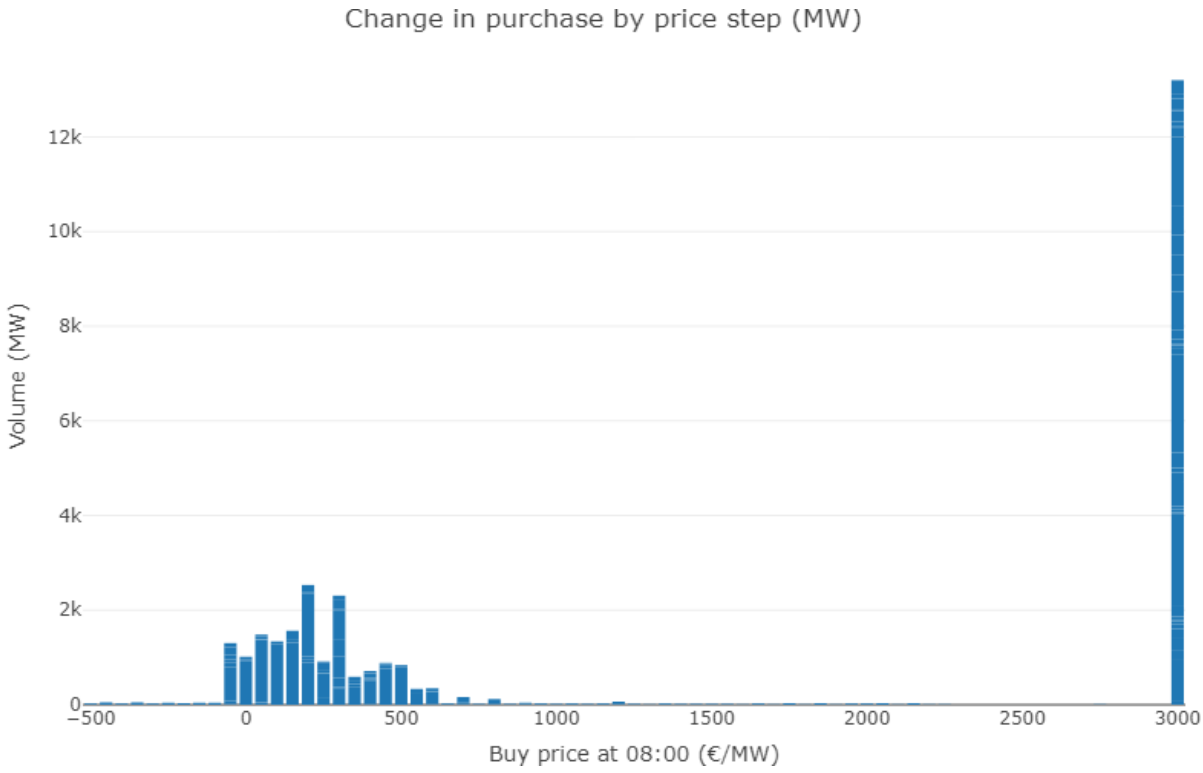
Figure 20: Volume of offers for sale proposed on the French daily market on 4 April by hour (MWh)

As regards purchase orders, the majority of players positioned themselves at any price. Purchase orders at between €500/MWh and €0/MWh were placed but did not predominate compared with volumes at €3,000/MWh. A buy-at-any-price strategy was consistent for physical players (supplier or consumer) but also for players who had hedged using financial products with a spot settlement.



Source: EPEX SPOT - Analysis: CRE

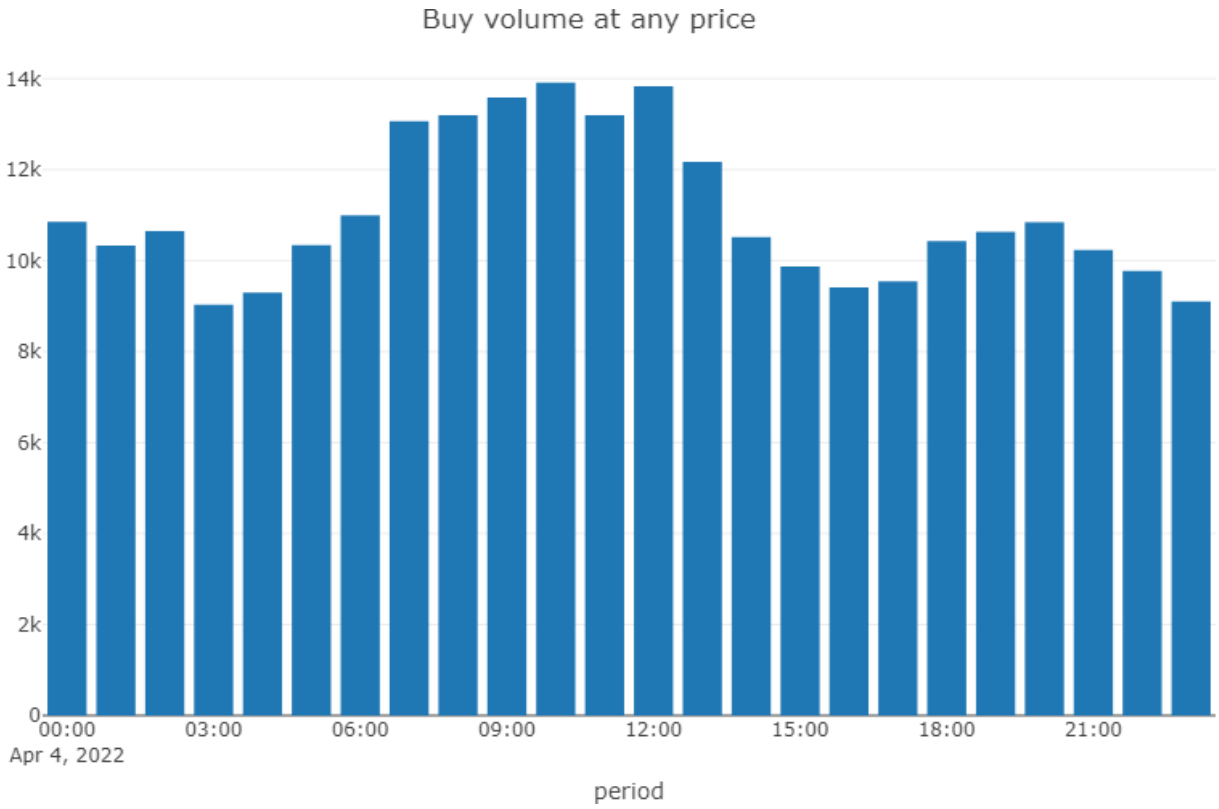
Figure 21: Volume of purchase offers per price band (€50/MWh) for 7h



Source: EPEX SPOT - Analysis: CRE

Figure 22: Volume of offers to buy by price band (€50/MWh) at 8am

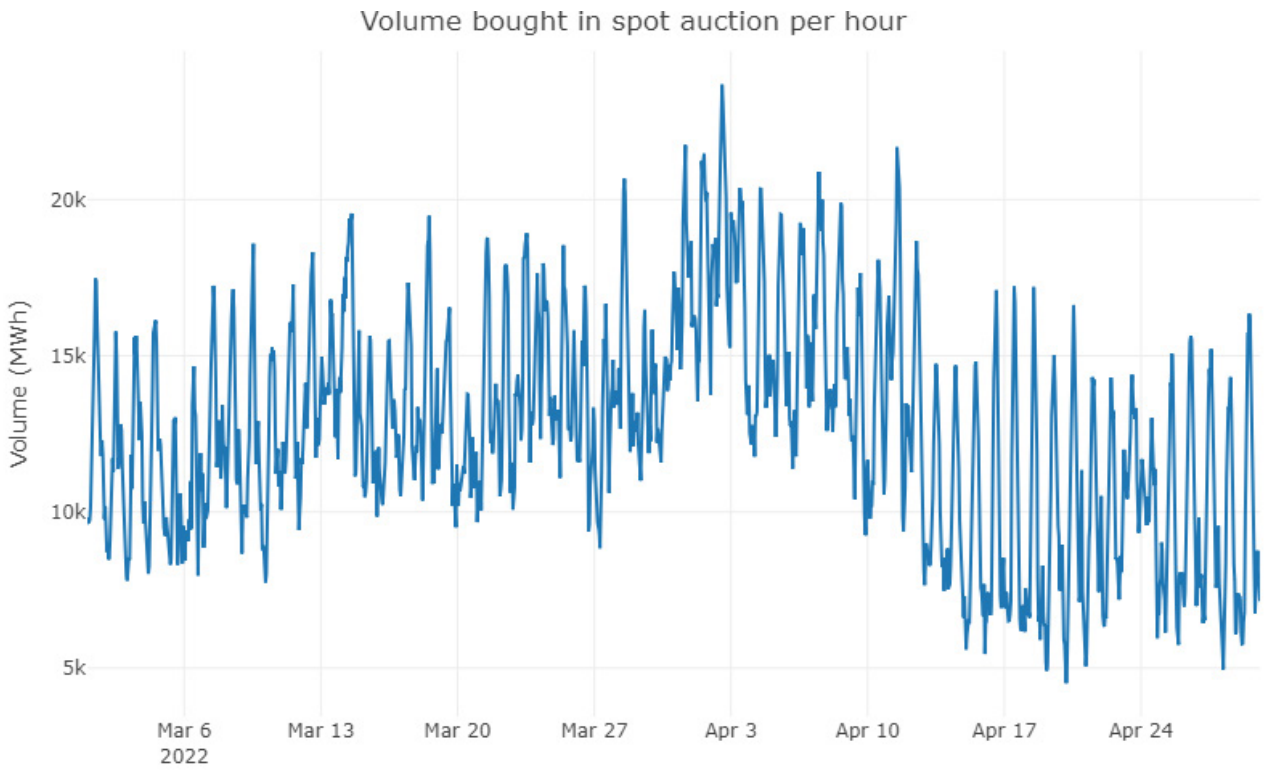
The volumes of purchases at any price for 7am and 8am were of the same order of magnitude as those for the other morning hours and seem to reflect high consumption anticipated from 7am onwards. A tendency towards a slight over-coverage could be observed here, compared with the consumption profile.



Source: EPEX SPOT - Analysis: CRE

Figure 23: Volume of purchases proposed at €3,000/MWh on the spot market on 4 April 2022 by hour (MWh)

When purchases for 7am and 8am are compared with those for the end of March and beginning of April, they show no significant discontinuity. The market was more active for the auction on 1 April, when for instance more than 23.6 GW was offered for purchase for Saturday 2 April 2022 at 1pm. The period at the beginning of April was therefore characterised overall by high bidding volumes, with the hours of the peak on 4 April not standing out in particular.



Source: EPEX SPOT - Analysis: CRE

Figure 24: Purchase volumes on the French spot market (MWh)

In conclusion, an analysis of the auction results and order books shows no sign of manipulation. Prices were very sensitive to the volume of offers made that day because of the high demand and low volume available in France. A few hundred MW could have changed the prices very significantly in either direction.

2.2 Euphemia did not completely saturate the available day-ahead import capacity

The Euphemia pan-European coupling algorithm maximises the overall surplus (“welfare”) created on a European scale without favouring one price zone participating in the coupling over another, except in the event of a recognised shortage in one zone. (This was not the case in France on 4 April during the 2nd auction for hours 7 and 8, since the price cap was ultimately not reached.)

Within the CWE region, the available capacities on one border are determined using the flow-based method, and therefore depend on the exchanges at the other borders in the region. Maximum import or export positions for a country can only be achieved by constraining exchanges between other areas of the CWE region, and this only exceptionally leads to maximum European “welfare”. Therefore, in order to maximise this welfare, the positions retained by Euphemia are mainly "intermediate" positions and not the maximum positions for a particular area. This was the case for hours 7 and 8 on 4 April.

During those hours, France was in competition with Austria to import German electricity. Indeed, the three network factors that were the most limiting from a market point of view were three network factors influenced by flows from Germany to both France and Austria. An increase in French imports led to a change in Austria's import/export position, so Euphemia had to arbitrate between France and Austria. With Euphemia’s solution, Austria imported 2 GW from Germany and France imported 3.1 GW from Germany on its CWE borders.

If French imports had increased by 600 MW to reach its maximum import position, Austria would have had to become an exporter to Germany of 3.7 GW, changing radically its situation. As an example, the analysis carried out by EPEX SPOT shows that reducing imports from Austria by 200 MW would have increased French imports only by 24 MW due to the configuration of the German grid that day (the remaining 176 MW would have been "blocked" in Germany). Euphemia therefore logically favoured a "middle" position maximising European welfare.

In fact, the three operators in the coupling who own Euphemia (the “nominated electricity market operators”, or NEMOs) run the algorithm in parallel during the European Single Day-ahead Coupling, using the same data. Only the NEMO in charge of the coupling for that day transmits its results, which are the solution used for the Single Day-

ahead Coupling. On 4 April, for hours 7 and 8, Euphemia gave exactly the same solution to all three NEMOs, indicating that it had worked normally and that the results were the best possible on a European scale.

2.1 The RTE maintained its alert after the auction on 3 April

At the end of the auction, the RTE issued two alert messages on the service portal to warn players of the limited margins. The RTE increased the significance of the alert at 11.23pm.

Date et heure d'émission	Date d'application	Type	Nature	Sens	Heure début	Heure fin
03/04/2022 23:23	04/04/2022	Dégradé	Equilibre offre/demande	Hausse	05:00	14:00
03/04/2022 18:51	04/04/2022	Information	Equilibre offre/demande	Hausse	05:00	14:00

Figure 25 Message from the RTE on the service portal

The RTE also published, as it usually does, details of the available margins as seen the previous day. As shown in the graph below, the RTE still saw some margins the day before, even if at certain times (7am but also 5pm) it might have lacked margins in terms of its safety criteria.

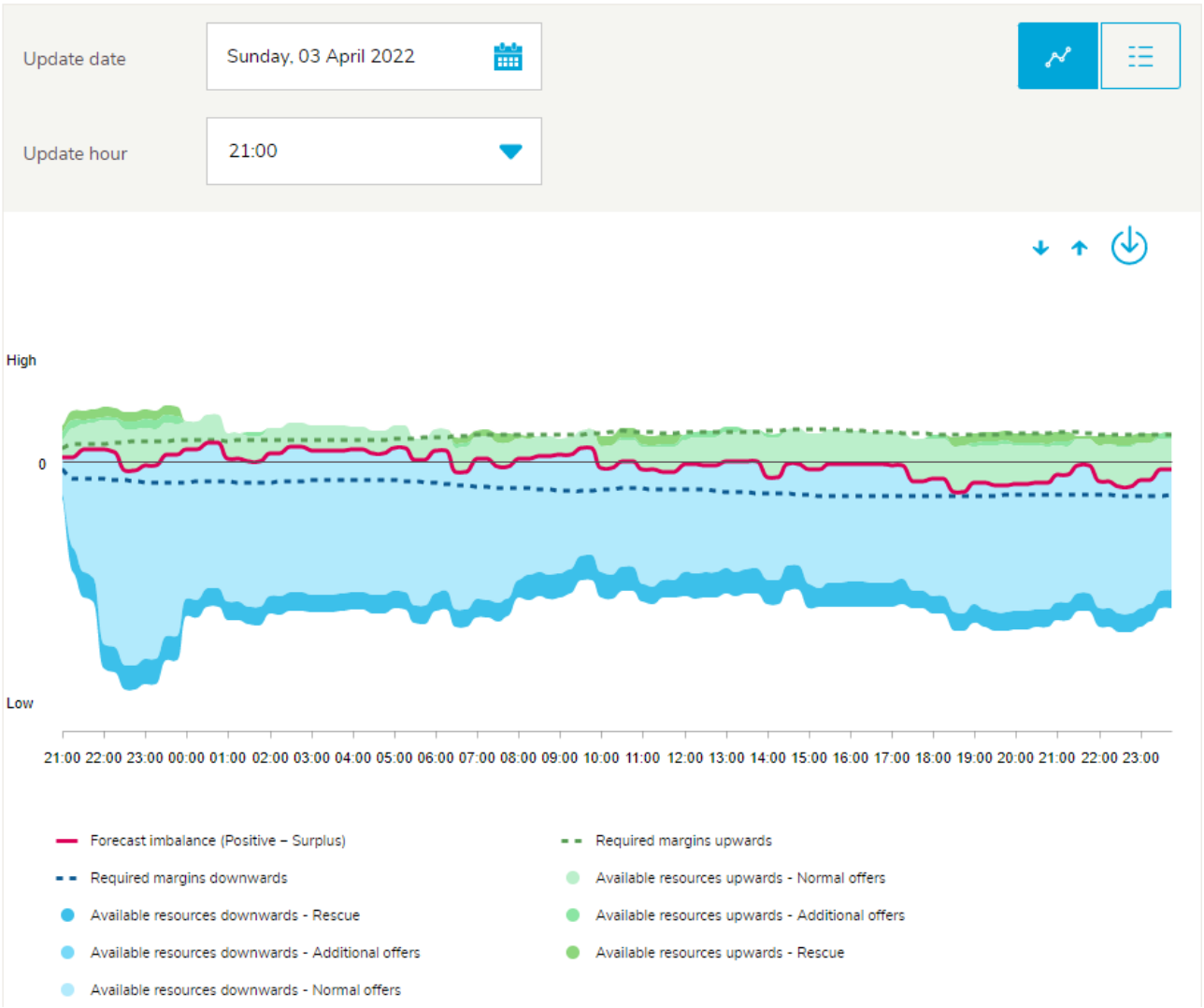


Figure 26 The RTE's view of the system margins as seen at 9pm the previous day

However, the RTE did not activate the red signal indicating that power cuts would be unavoidable. From a physical point of view, the day therefore appeared stressed, but unless there were a major unforeseen event, the system would have sufficient margin to avoid load shedding.

3. ACTUAL COURSE OF EVENTS ON 4 APRIL 2022

3.1 Consumption as high as expected

As expected, 4 April 2022 was a particularly cold day[10]. Between 4am and 9am, the smoothed recorded temperature was about 6 °C lower than the smoothed normal temperature (source: Enedis[11]), or about 4 °C lower than the average in France. The rest of the day was also very cold, about 4 °C colder than the seasonal norm.

The RTE's estimated real-time consumption[12] (or the "D" forecast) peaked at 71.7 GW at 9am. The graph below shows that the D-1 and D forecasts were close until 7am. The D forecast then fell significantly below the D-2 forecast. At the 9am peak, the estimated consumption on D-2 was 74 GW, i.e. 2.3 GW more than the RTE's real time estimate.

[10] The night of 03 - 04 April was the coldest April night since 1947 https://www.france24.com/fr/france/20220404-m%C3%A9t%C3%A9o-la-france-a-connu-pour-un-mois-d-avril-sa-nuit-la-plus-froide-depuis-1947
[11] https://data.enedis.fr/
[12] eco2mix real-time data

The RTE then stated[13] in a press release that it considered the difference could partly be explained by a drop in consumption by private individuals, businesses and local authorities who had postponed their usage because of the ecoWatt signal (800 MW); and by activating demand-response capacities (a mechanism for reducing consumption promoted on the electricity market, chiefly for industrial companies).

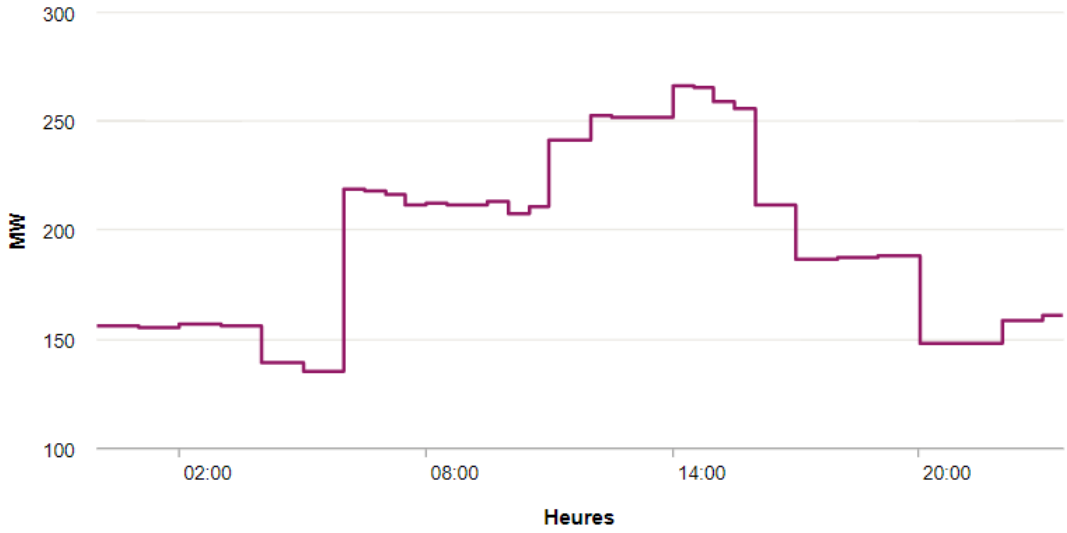
Source: RTE - Analysis: CRE

Figure 27 Consumption in real time (forecast D) and forecast ahead (D-1 and D-2) (source RTE eco2mix real time)

The rest of the day showed significant differences between D and D-2 (about 4 GW) and D and D-1 (about 3 GW). The differences between D and the other forecasts diminished after 7pm. The evening peak was less pronounced (65 GW), because the temperature had risen during the day.

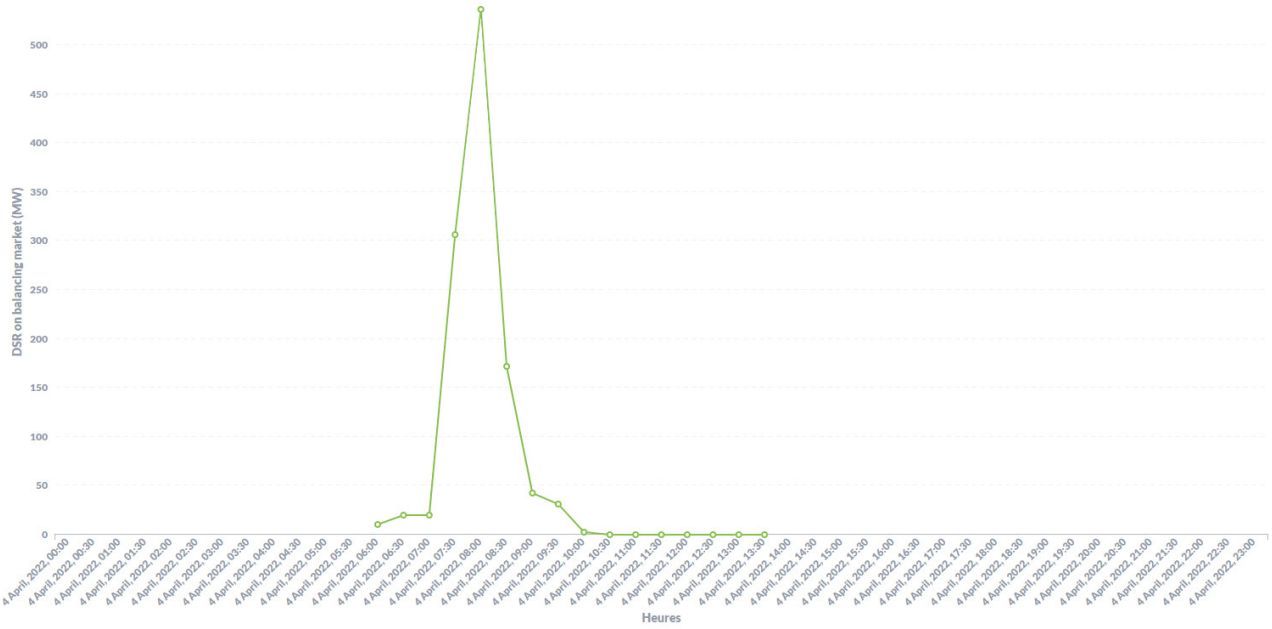
The significant difference between the forecasts seems difficult to explain by the effect of demand-response capacities. An analysis of the activated demand-response volumes shows they are significant, both on the NEBEF market (up to 250 MW, a record for the last few years) and for the balancing mechanism (peak of 536 MW[14]), but do not fully explain the difference of more than 3 GW between the forecast on D-1 and the estimate on D. Especially since April 4 2021 does not correspond to a day of compulsory presence for most of the operators who had been awarded the demand-response tender (it was not a PP2 day).

[13] https://www.rte-france.com/actualites/mobilisation-francais-permis-reduire-consommation-electricite-lundi-4-avril
[14] A high, but not exceptional, value. Over 810 MW had been activated in January 2021 for example.



Source: RTE - Analysis: CRE

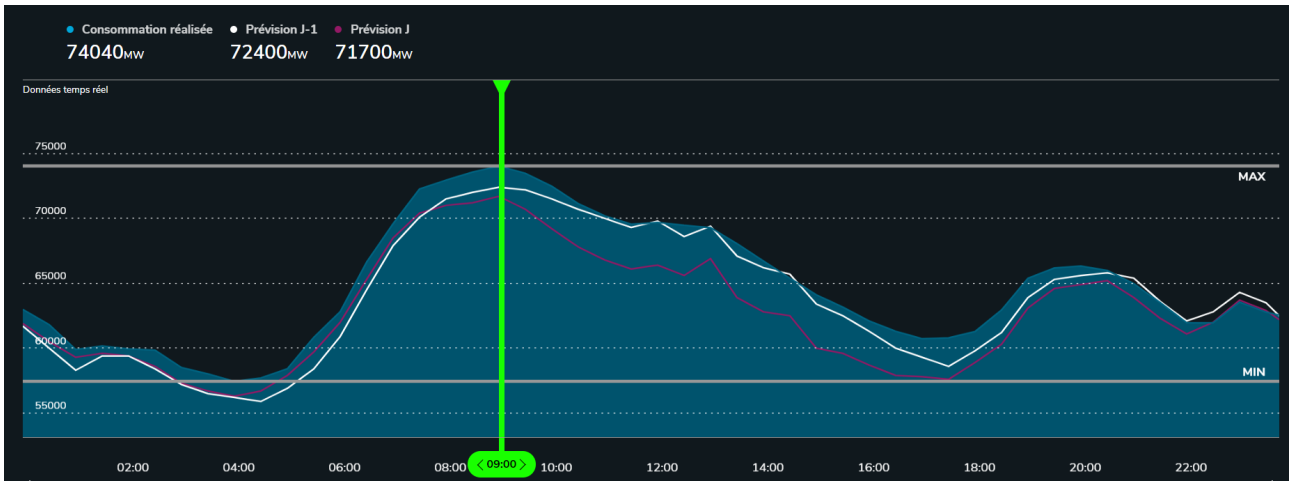
Figure 28 Activated NEBEF volume (MW)



Source: RTE - Analysis: CRE

Figure 29 Demand-response capacities activated for the balancing mechanism (MW)

A more likely explanation of the discrepancy is an error in the RTE's estimate of real-time consumption, due chiefly to the absence of an advance declaration of generation from CHP units. Indeed, the RTE's reconstruction of demand from consolidated data (available a few weeks after the event) shows that consumption in France was actually very high and that the forecast peak of 74 GW was reached.



Source: RTE

Figure 30 Consumption in France (source eco2mix consolidated RTE)

To understand how such a difference can appear, it is important to remember that the RTE does not measure consumption directly in real time, but deduces it from remotely-read generation data, from generation forecasts on the distribution network excluding renewable energies, from an estimated model for wind and solar energy, and from imports. For these reasons, there is always some difference between forecast and actual electricity consumption, even when the times between them are as short as a few hours (as for "D" forecasts).

In this case, it appears that the RTE's model significantly underestimated generation, chiefly because CHP plants had not scheduled their generation with the RTE. The table below (for 9am) shows the difference between the generation estimated in real time and the consolidated generation.

Technology	Generation estimated in real time (9am)	Consolidated generation (9am)
Nuclear	32,149 MW	32,254 MW
Hydraulic	14,765 MW	15,006 MW
Gas (including CHP)	7,555 MW	8,546 MW
Oil	1,229 MW	1,256 MW
Coal	471 MW	465 MW
Wind	4,212 MW	4,590 MW
Solar	2,155 MW	2,368 MW
Biomass	747 MW	1,012 MW
Total	63,283 MW	65,497 MW

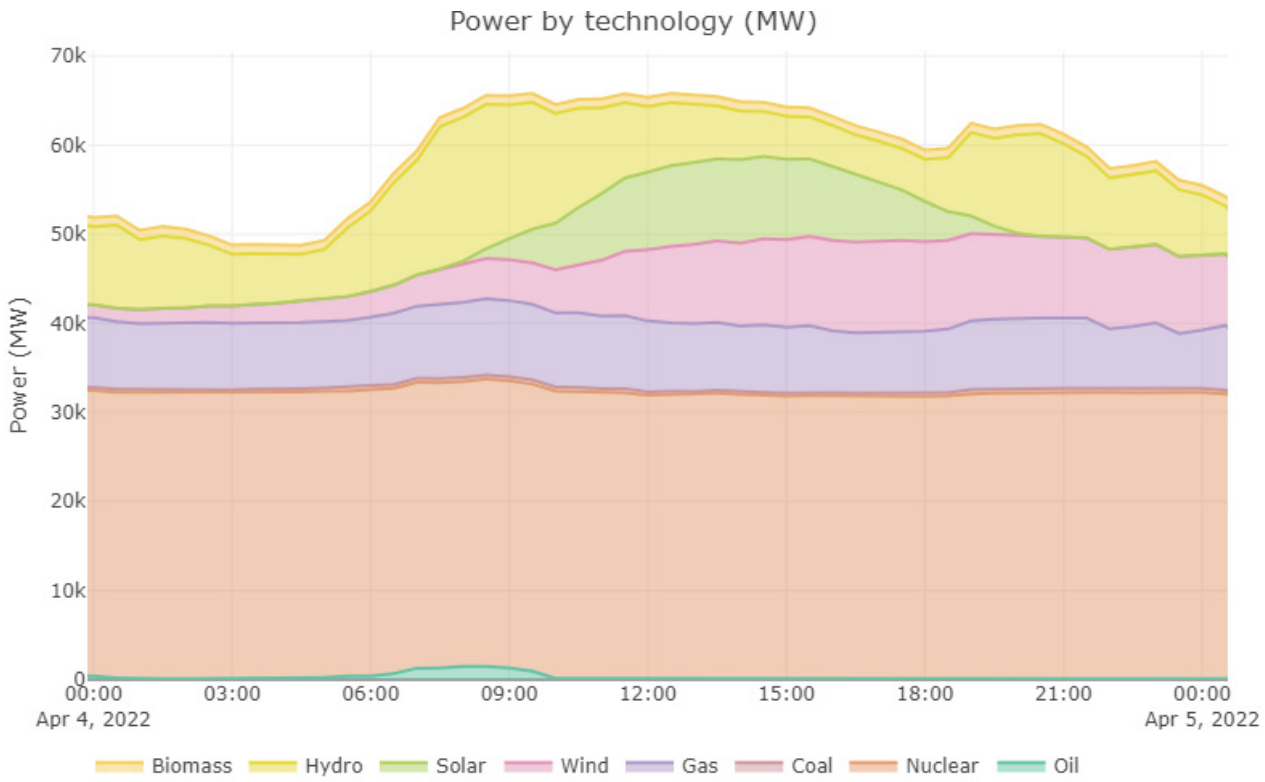
Assuming that the consolidated data are correct, it appears that French generators have in fact generated over 2.2 GW more at 9am than the power estimated by the RTE on 4 April. In particular, the difference is significant for CHP (gas and biomass: underestimate of over 1.25 GW) and renewables (underestimate of ~ 600 MW).

The estimation error increases later for renewable energies, which would explain the difference observed between the D-1 and D forecast during the day.

EcoWatt's contribution seems at first sight to be less clear cut and the effectiveness of the ecoWatt signal must be reviewed.

3.2 Generation handicapped by the low availability of nuclear power

The RTE's consolidated data can be used to reconstruct the state of French generation on 4 April.

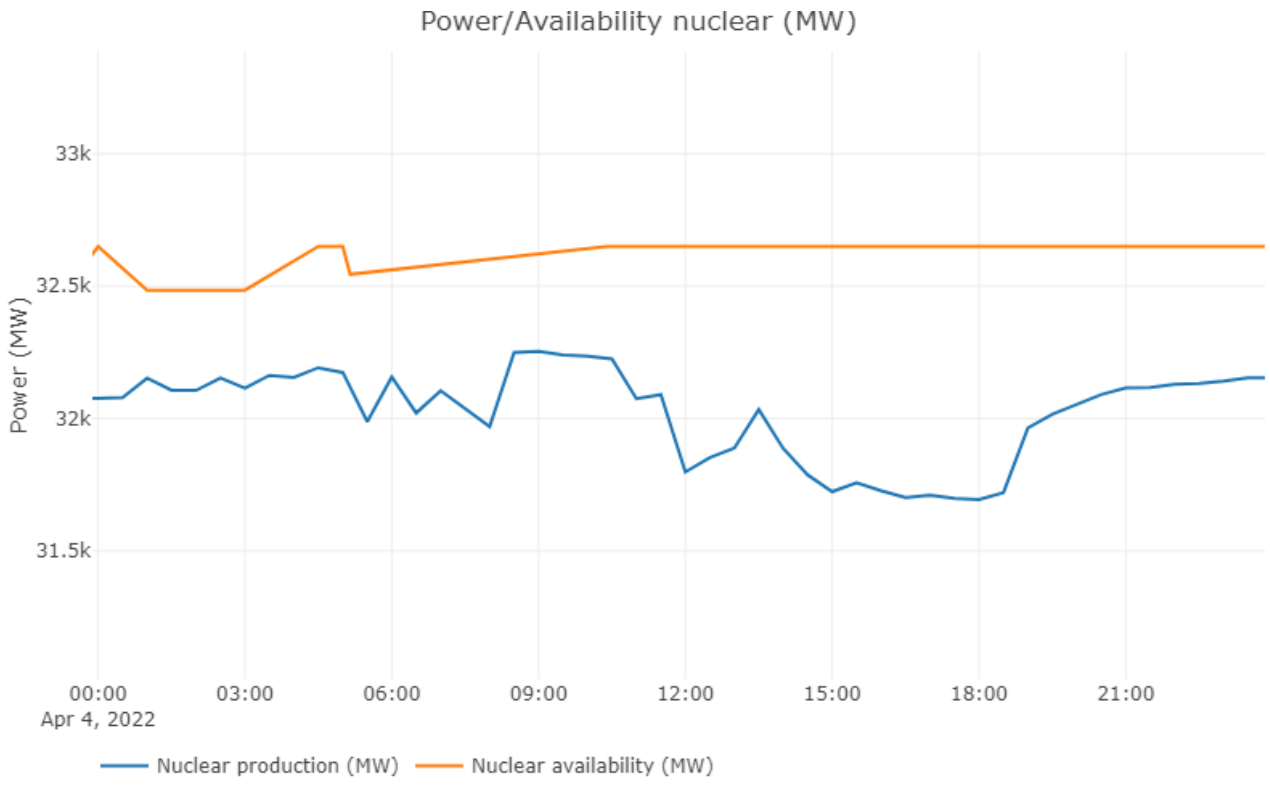


Source: RTE - Analysis: CRE

Figure 31 Power generated in France broken down by technology (MW) (source: RTE consolidated data)

The generation peak (about 65.8 GW) was observed at about 9.30am. Nuclear and gas generation operated in base-load, and hydraulic provided the flexibility necessary to manage the significant variation in renewables generation on that day. Fuel oil was used mainly during the morning peak. Coal was virtually absent, as only one unit is available in France.

The nuclear fleet produced about 32.3 GW throughout the day for a historically low availability of 32.6 GW. The rate of use was however good, illustrating the lack of load balancing by EDF units. The drop in nuclear generation during the day was because the RTE requested several units (Blayais 4, Tricastin 4, Saint Alban 1, Paluel 1, Penly 2, Nogent 2 and Cruas 2) to make a downward adjustment. Gravelines 6 was not available on that day: EDF had announced the extension of its unavailability the day before at 6.26pm. This unavailability did not in theory influence the spot price.

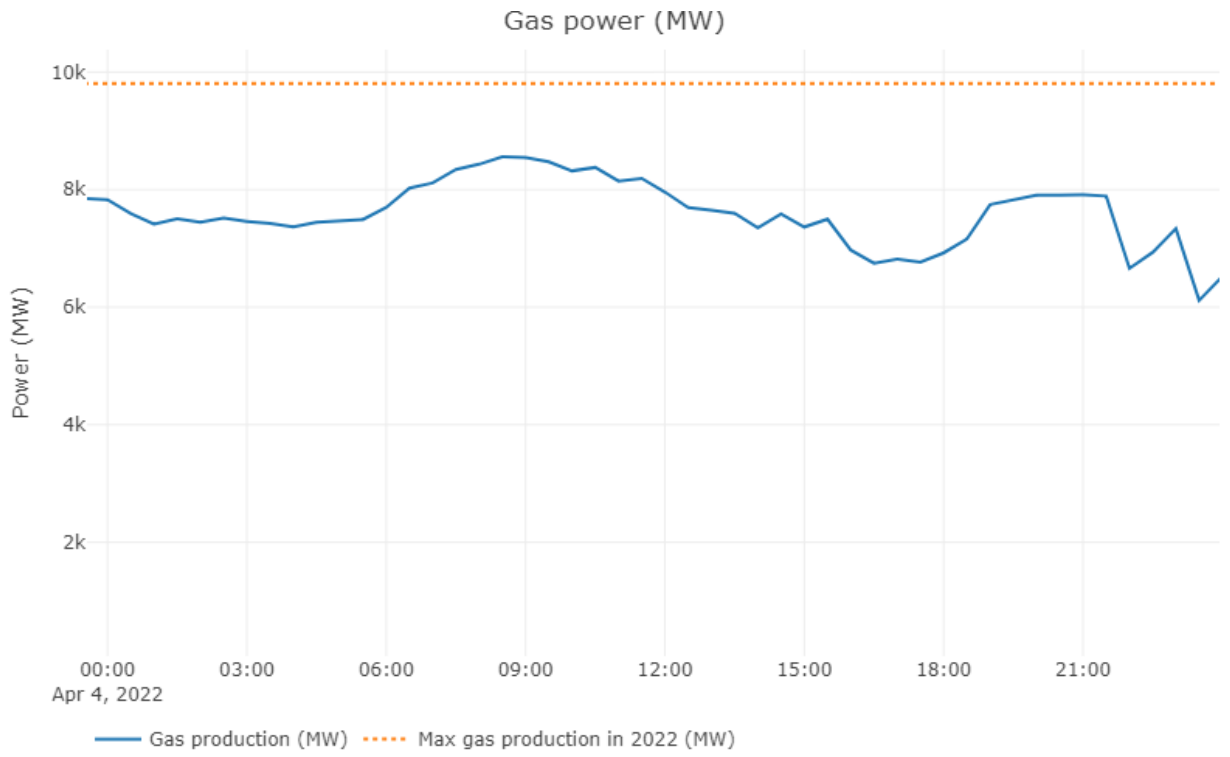


Sources: RTE, EDF - Analysis: CRE

Figure 32 Comparison of nuclear availability and generation (MW)

Natural gas-fired power generation reached 8.6 GW at peak and remained above 6 GW. All combined-cycle power plants were in operation, except for the SPEM (Montoir power plant) which was in maintenance. The Landivisiau power plant, officially commissioned on 31 March 2022, was also operating at 446 MW[15].

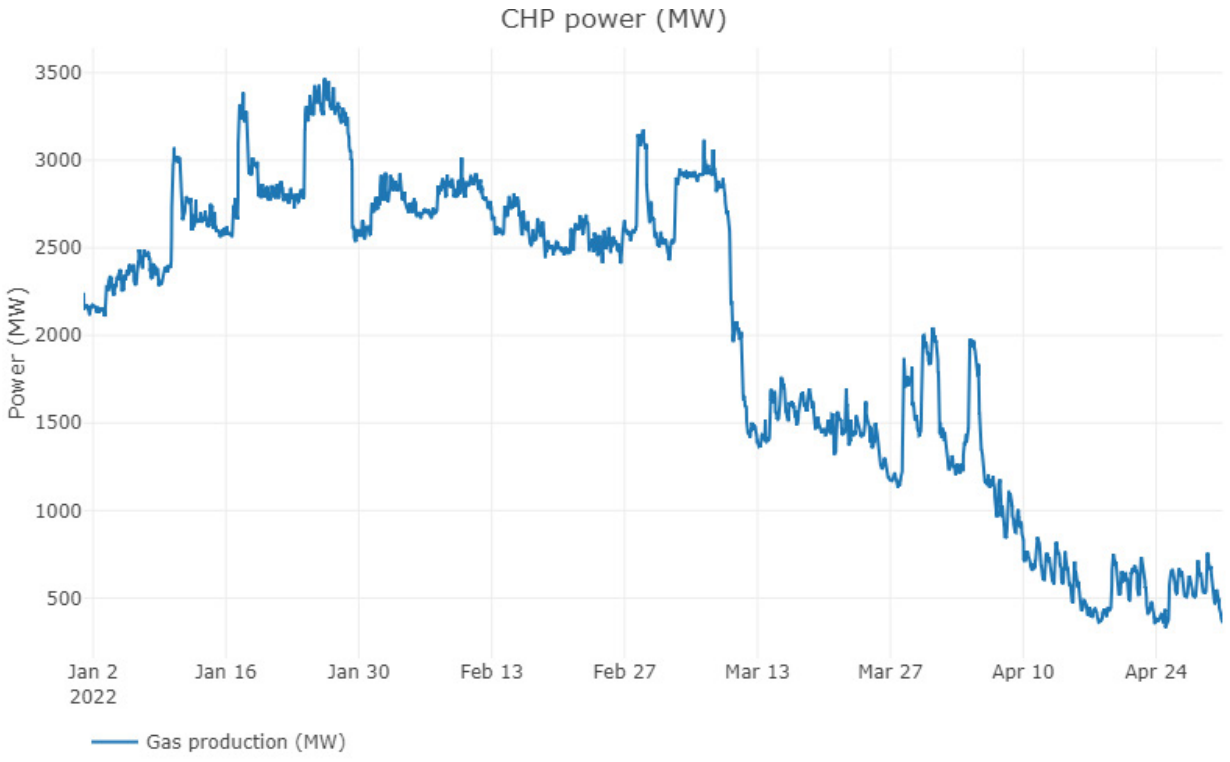
[15] The Landivisiau plant was able to operate intermittently before 31 March 2022 and provided energy during the winter. This explains why the difference in gas generation did not become more pronounced since its official commissioning.



Source: RTE - Analysis: CRE

Figure 33 Gas generation (all technologies) on 4 April 2022 (MW)

The highest gas-fired power generation in 2022 was 9.8 GW. Gas-fired generation on 4 April 2022 did not reach this level because less power was supplied by the CHP units. They were only able to supply 2 GW compared to 3.5 GW in winter. Nevertheless, this represents an increase of almost 1,000 MW compared with the normal level at the beginning of April.



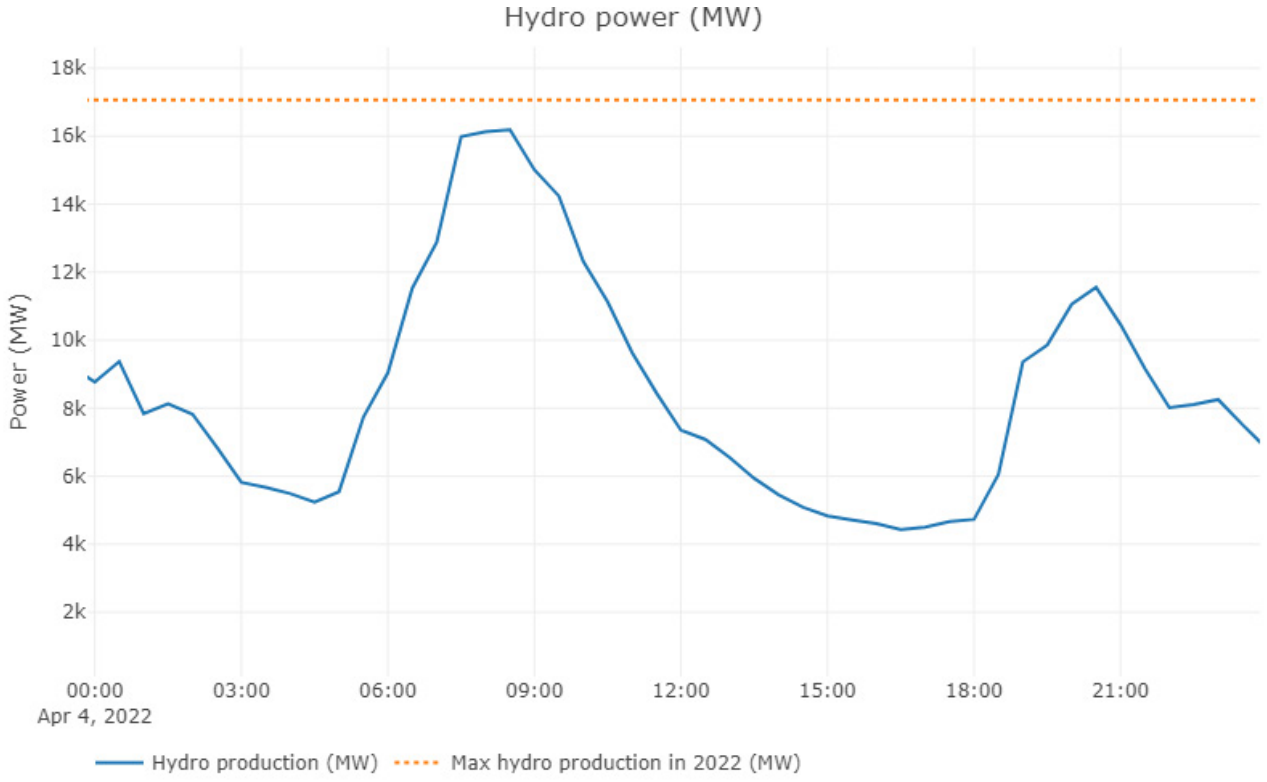
Source: RTE - Analysis: CRE

Figure 34 Gas CHP generation in 2022 (MW)

Coal-fired generation was low (460 MW): only the Cordemais 5 unit could produce energy, as Cordemais 4 had been unavailable since 26 March 2022 and Saint-Avold had been shut down on 31 March 2022.

Oil-fired generation reached 1.5 GW, which was also exceptional for the season. All the combustion turbines in France provided electricity, except for Arrighi 2, which had been in maintenance since 27 March 2022.

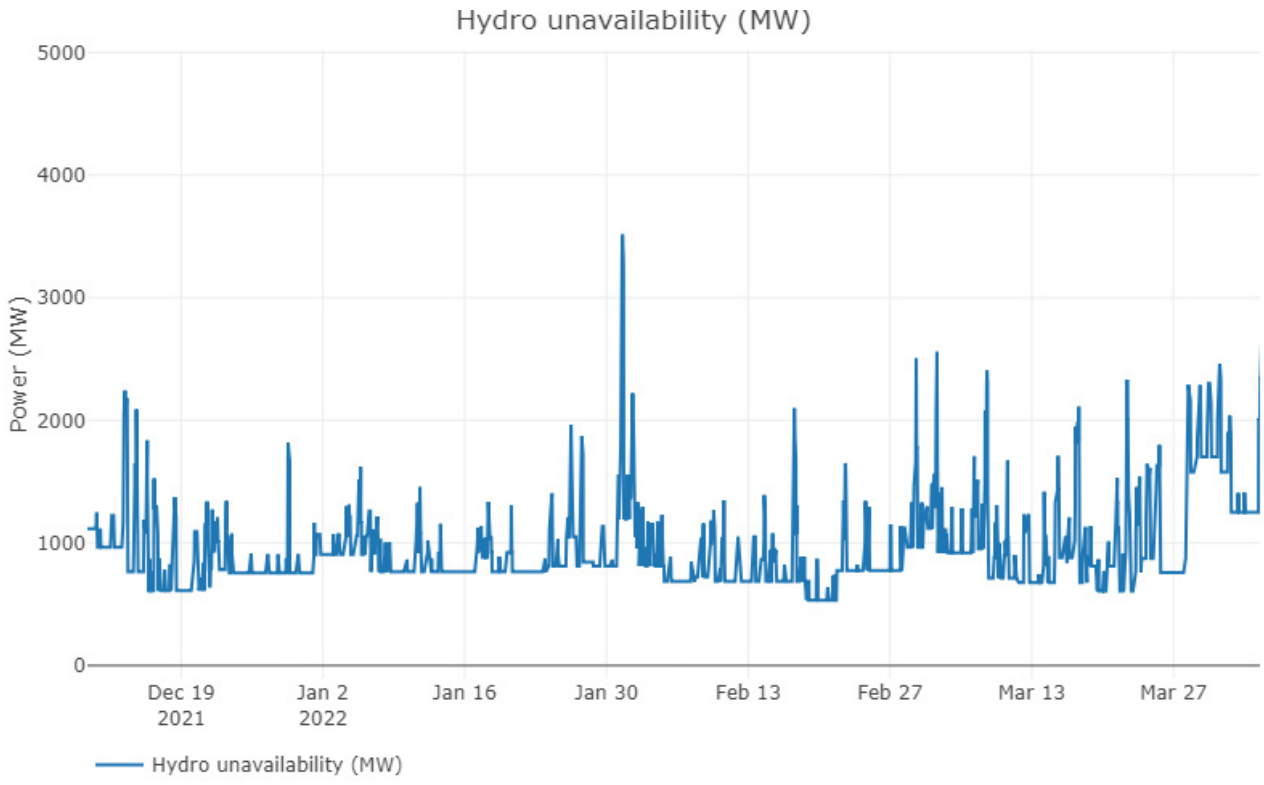
Hydro generation rose to 16 GW during the morning peak, just 1 GW below the maximum recorded in France in 2022 (14 January 2022). All available lake and pumped energy transfer stations (STEP) generated during the peak in consumption.



Source: RTE - Analysis: CRE

Figure 35 Hydro generation (all technologies) on 4 April 2022 (MW)

The power from hydraulic units providing more than 100 MW (lakes, STEP and run-of-river) that was not available on 4 April at the time of the peak was 2.1 GW. This is a higher value than in winter (between 1 and 2 GW), but still comparable to the level of unavailability generally observed at this season.



Source: RTE - Analysis: CRE

Figure 36 Declared unavailabilities of hydraulic units over time (lakes, STEP & run of river) (MW)

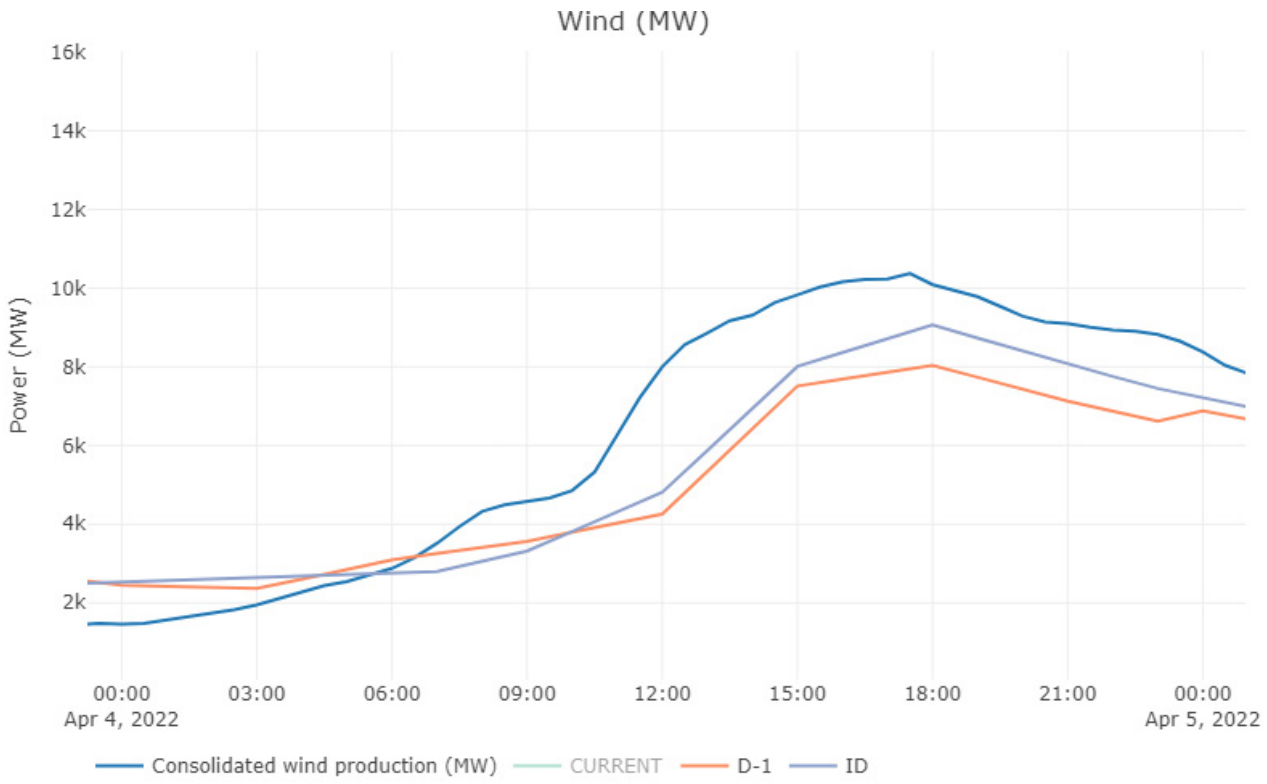
Run-of-river and pondage generation rose to 6.4 GW during the peak, higher than the 2022 average (4.7 GW).

In conclusion, it appears that the French fleet was using its maximum available capacity to generate. Generation flexibility was fully exploited, including combustion turbines. The availability of gas and hydraulic was still very good, and to a certain extent compensated for the lack of nuclear power.

3.3 Renewable generation exceeded the forecast

The anticipated weakness of wind-turbine generation was one of the major factors that led the players and the RTE to raise an alert for 4 April 2022. About 3.5 GW of wind power was expected for the morning peak, compared with 9 GW on the previous Friday (also a stressed day for the grid).

The RTE forecast that generation would increase during the day and stabilise after 6pm. *Ex-post* measurements showed that generation had been much higher than expected. From 6am, wind generation was higher than forecast on D-1 (+300 MW at 7am and +900 MW at 8am): the difference rose to 2 GW at 6pm (10 GW as against 8 GW). These variations could explain part of the positive imbalance in the system in France (more generation than consumption) during peak hours.



Source: RTE - Analysis: CRE

Figure 37 Forecast for wind generation on D-1 and Intraday (RTE). Consolidated wind generation (MW)

The same applies to solar energy: the RTE's forecast shows a peak generation of 8.5 GW as against 9.3 GW actually generated.

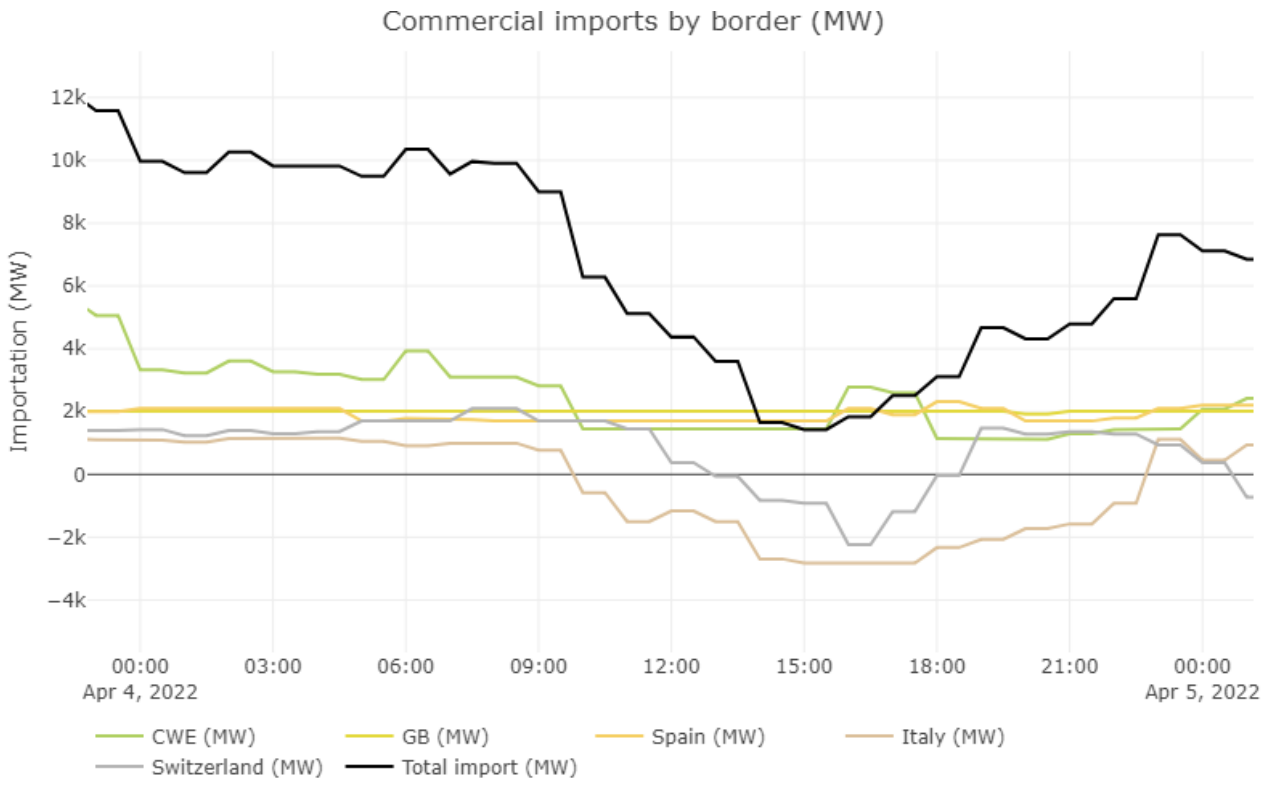
The difference between the forecast and the actual generation illustrates the difficulty of operating a stressed electricity system that is subject to significant uncertainties. It seems that on 4 April 2022, generation was higher than expected, particularly during peak-price hours. This allowed margins to be rebuilt, whereas otherwise, real difficulties might have occurred, as anticipated by the spot market.

3.4 Interconnections contributed to the system's flexibility

France remained a net importer for every hour of the day on 4 April 2022. However, significant variations in flows were observed: until 9.30am France imported around 10 GW; but from 10am onwards imports dropped significantly, particularly from Switzerland and Italy. Imports rose again shortly after 3pm and reached 8 GW by the end of the day.

At first sight, the import profile seems to follow that for renewable energy generation. Renewable energy therefore helped the French system manage excess generation by providing more flexibility. At the lowest level of imports, France exported energy to Italy and Switzerland.

It should be noted that the RTE used imbalance netting (an automatic process that compensates for imbalances between TSOs) and counter-trading (a manual process that changes the flows at interconnections) to reduce imports from neighbouring countries during the day (see next section).



Source: RTE - Analysis: CRE

Figure 38 Actual trades by border (MW)

As regards the hours of stress, the following table shows the actual imports at 7am and 8am compared with the announced daily capacities.

		4 April at hour 7	
Border	**Available capacity for day-ahead cross-border trade (in MW)**	**Actual commercial imports (in MW)**	**Reason for the difference**
BE>FR and DE>FR	3,714	3,104	Optimisation of Euphemia
ES>FR	2,550	1,750	800 MW of RTE countertrading
IT>FR	995	995	-
GB>FR	*2,014*	*2,014*	-
CH>FR	*1,400*	*1,700*	*Increase of 300 MW in the intra-day NTC on the Swiss side*
Total	10,673	9,563	

		4 April at hour 8	
Border	**Available capacity for day-ahead cross-border trade (in MW)**	**Actual commercial imports (in MW)**	**Reason for the difference**
BE>FR and DE>FR	3,597	3,102	Optimisation of Euphemia
ES>FR	2,550	1,700	850 MW of RTE countertrading
IT>FR	995	995	-
GB>FR	*2,014*	*2,014*	-
CH>FR	*1,400*	*2,100*	*Increase of 300 MW in the intra-day NTC on the Swiss side + Backup contract 400 MW*
Total	10,556	9,911	

In view of the capacity available for cross-border trade, imports from Italy, England and the CWE zone were increased to their maximum (taking into account Euphemia optimisation). Imports from Spain were reduced at the request of the RTE owing to the failure of a phase-shifting transformer on the Spanish side of the border. Counter-trading was therefore used to compensate for this incident and manage network congestion.

At the same time, imports from Switzerland exceeded available day-ahead capacity.

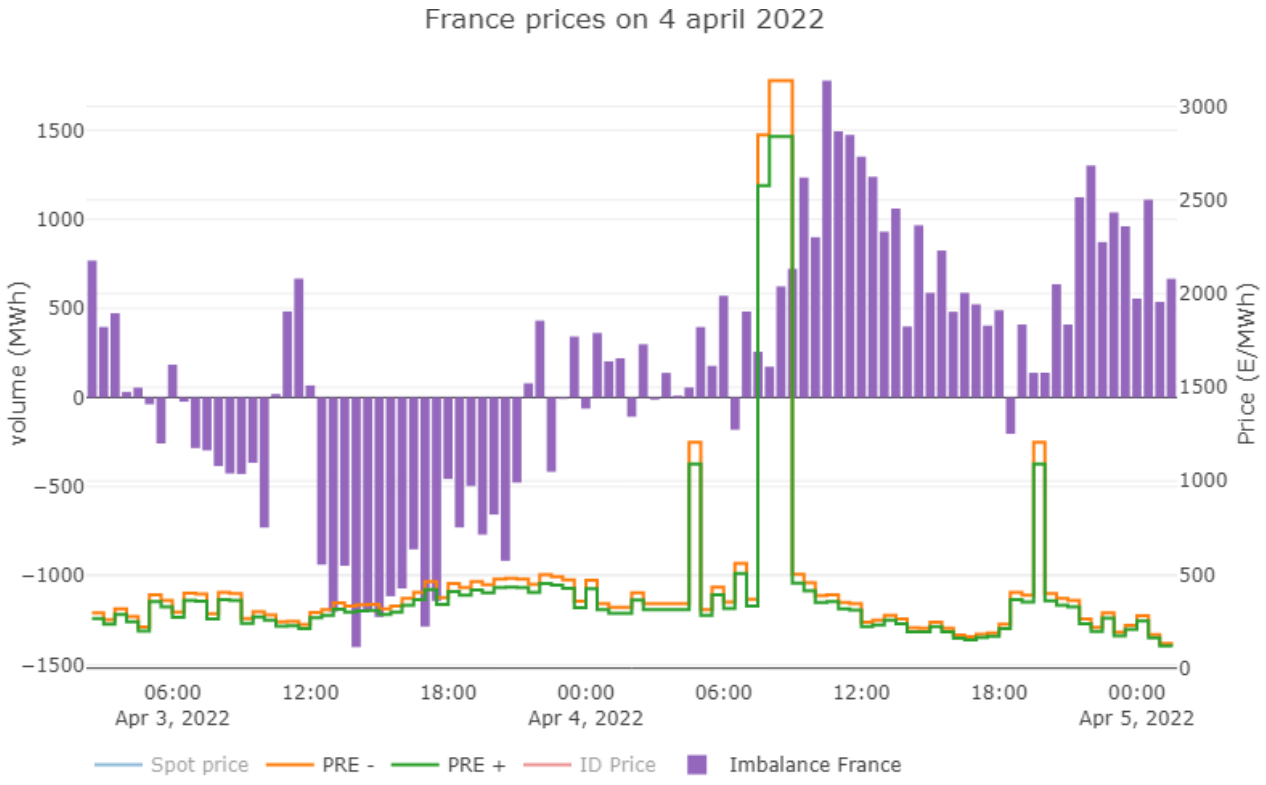
3.5 A system in positive imbalance close to real time

The system's imbalance at each time step corresponds to the difference between the injections and the withdrawals by the players. As consumption and fatal generation carry a degree of uncertainty, the imbalance reflects the players' errors in forward planning and their ability to adapt in real time.

On 4 April 2022 there was on average a strong positive imbalance in France, implying excess generation or a shortfall in consumption. The figure below shows that the imbalance was strong from 9am onwards and continued throughout the day, with a noticeable drop during the evening peak. For the 30-minute time step at 10.30am, the system was in positive imbalance by more than 1,700 MWh, corresponding to overgeneration or underconsumption of more than 3.4 GW[16] at that precise time.

However, the critical hours of 7am and 8am show only a small positive imbalance, showing that the previous day's day-ahead auction had indicated quite clearly the extreme stress in the system.

The source of this imbalance, according to the RTE's consolidated data, seems to be an excess of renewable generation and cogeneration rather than a decrease in consumption.

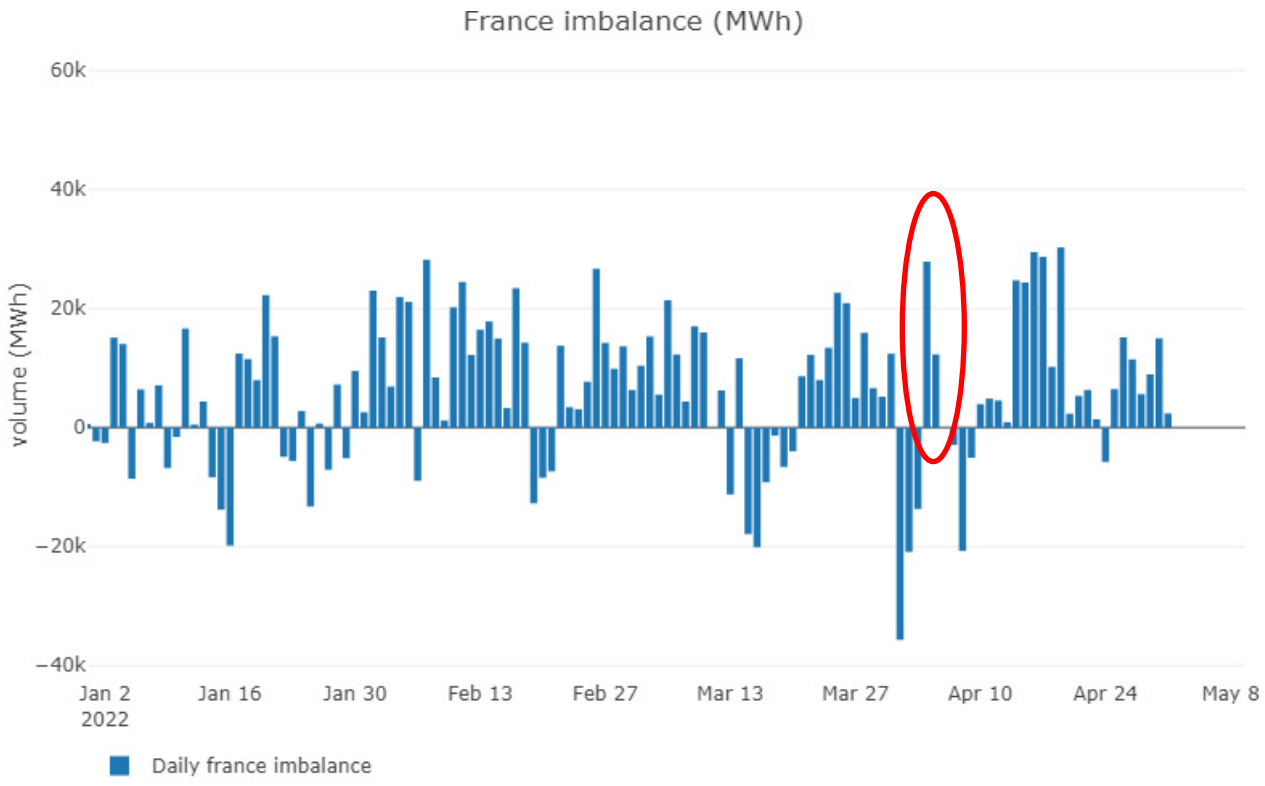


Source: RTE - Analysis: CRE

Figure 39 Imbalance for France (MWh) for each 30 min period and settlement price for positive and negative imbalances (€/MWh)

Although the day showed a pronounced imbalance, it was not exceptional in terms of volume. Similar patterns were seen in January, February and later in March.

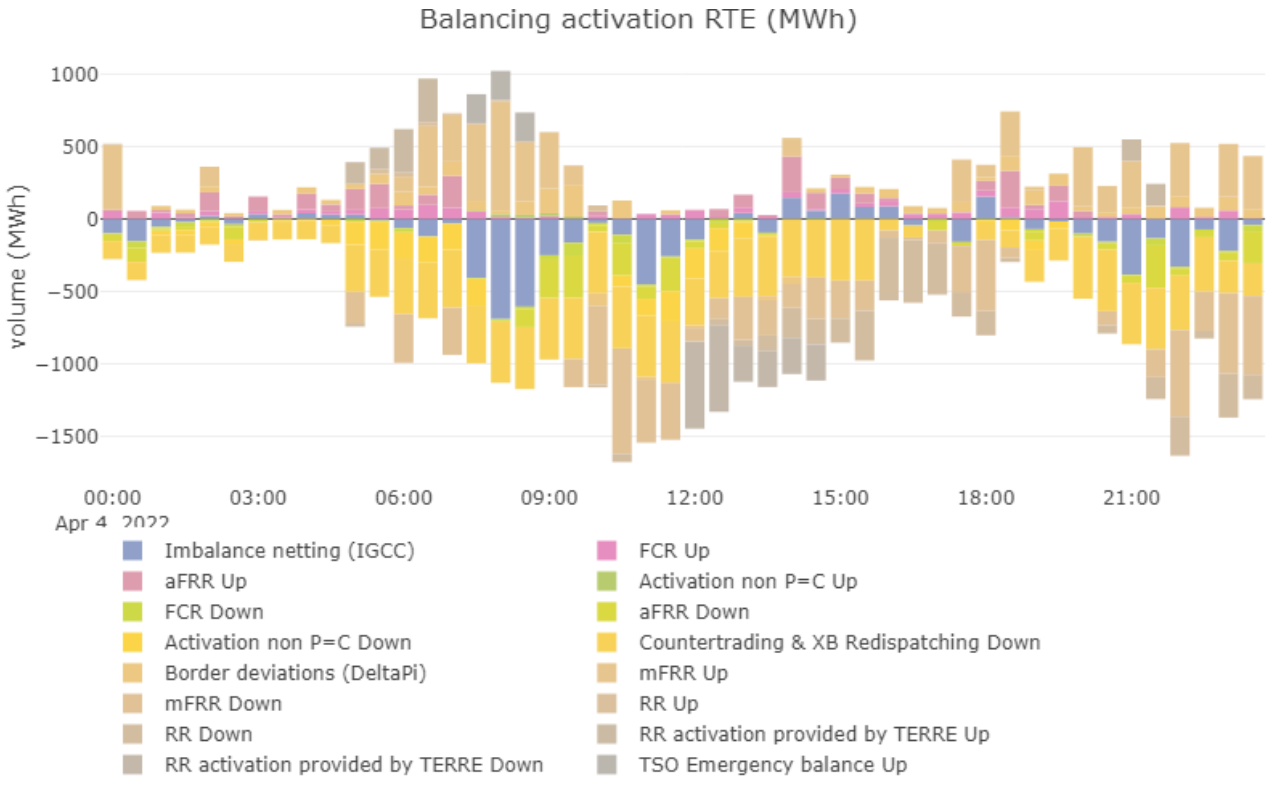
[16] The positive half-hourly imbalances averaged 386 MWh in 2021, with a maximum of 2,281 MWh and a standard deviation of 324 MWh



Source: RTE - Analysis: CRE

Figure 40 Daily imbalance for France early 2022, 4 April 2022 circled in red (MWh)

To balance generation and consumption in real time, the RTE uses its reserves (primary, secondary, fast and complementary), the balancing mechanism and the neighbouring TSOs.



Source: RTE - Analysis: CRE

Figure 41 Balancing energy (30 min time step) on 4 April (MWh)

During the day of 4 April 2022, the RTE used mainly the balancing mechanism (mFRR and RR) and border exchanges (imbalance netting and counter-trading) to reduce generation in France and limit imports. These adjustments explain why the interconnections were not saturated with imports during the day.

In order to give players a financial incentive to balance the electricity system, the RTE charges players for their imbalance at the imbalance settlement price (PRE). There are two prices, depending on whether the imbalance is positive or negative. A positive imbalance means that the player earns income; a negative, that it incurs an expense.

The PRE is calculated as the weighted average price of all balancing energies activated, upwards or downwards, in the direction of the system imbalance (i.e. "counter-trend" activations are not included in the price). The energies in the primary reserve, the secondary reserve, the border spread, and the imbalance netting are valued at spot. From this weighted average price, the prices of the positive and negative deviations are obtained by subtracting or adding 5 % (i.e. the prices of negative deviations are always ~10 % higher than the prices of positive deviations, so that each player always tries to minimise its imbalance.

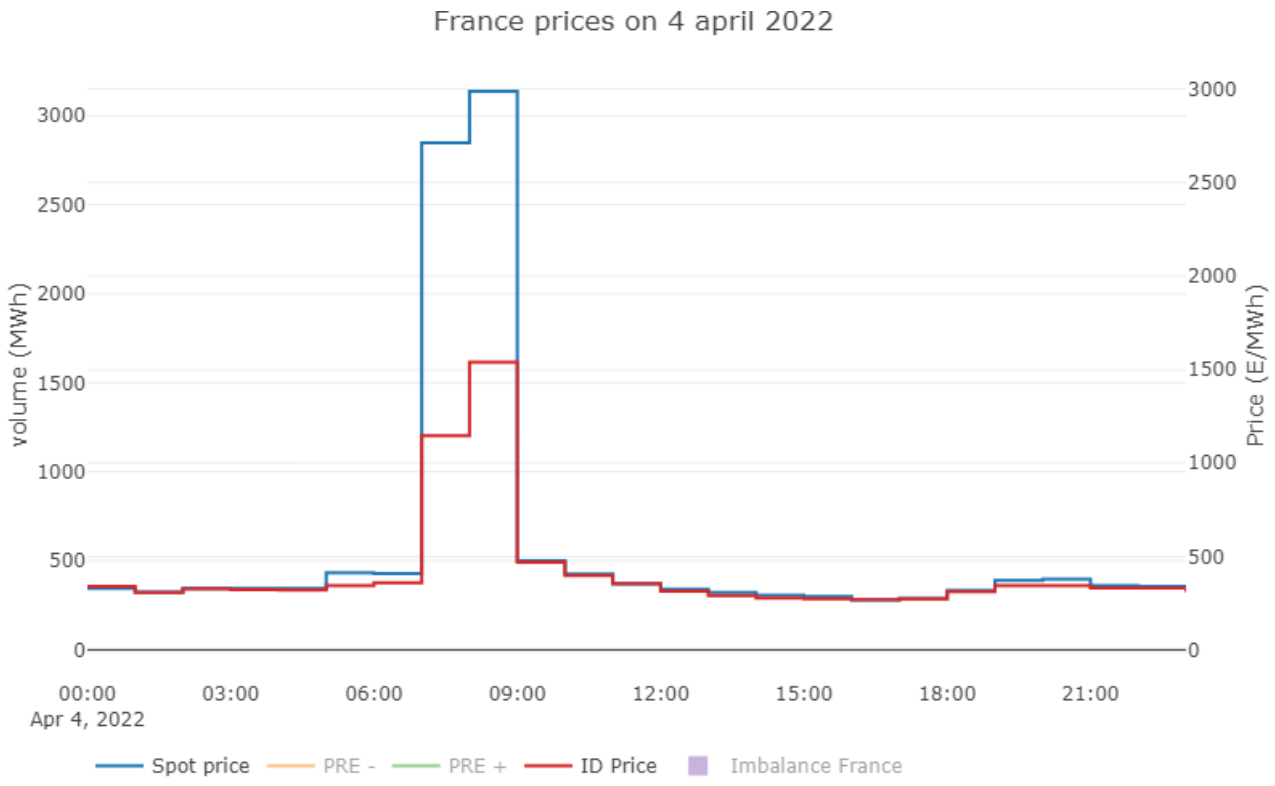
For the morning peak price, there were no activations for the balancing mechanism (because there was a downward trend in P=C) so all falling energies were valued at spot. The system trend was positive, so the positive PRE was equal to spot minus 5 %, and the negative PRE to spot plus 5 %.

Source: RTE - Analysis: CRE

Figure 42 Positive and negative PRE (€/MWh) and spot price France (€/MWh)

Players can use the intraday market to rebalance their positions, so they are not exposed to the imbalance settlement price. On 4 April 2022, the intraday-market price was lower than the price on the spot auction, particularly during the peak hours when the intraday price was almost half the spot price.

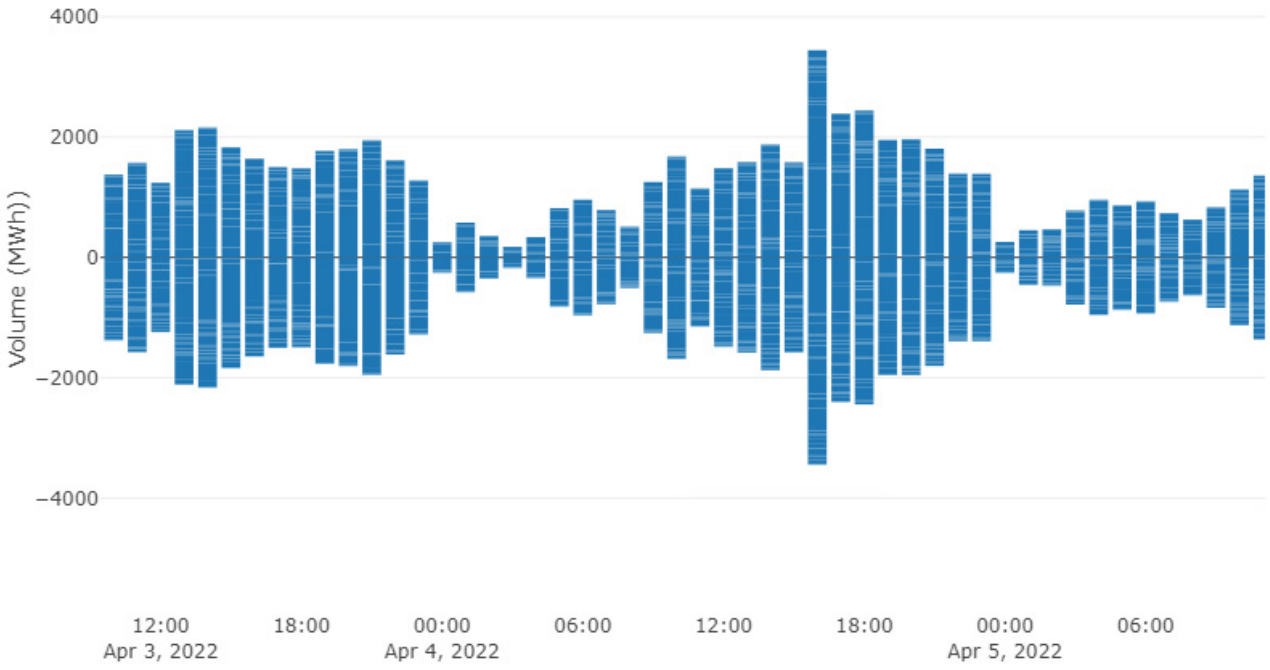
These prices illustrate the apparently more relaxed situation during the day where players were able to find much cheaper volumes than those from the spot auction.



Source: EPEX SPOT - Analysis: CRE

Figure 43 Comparison of spot price and intraday price index France (€/MWh)

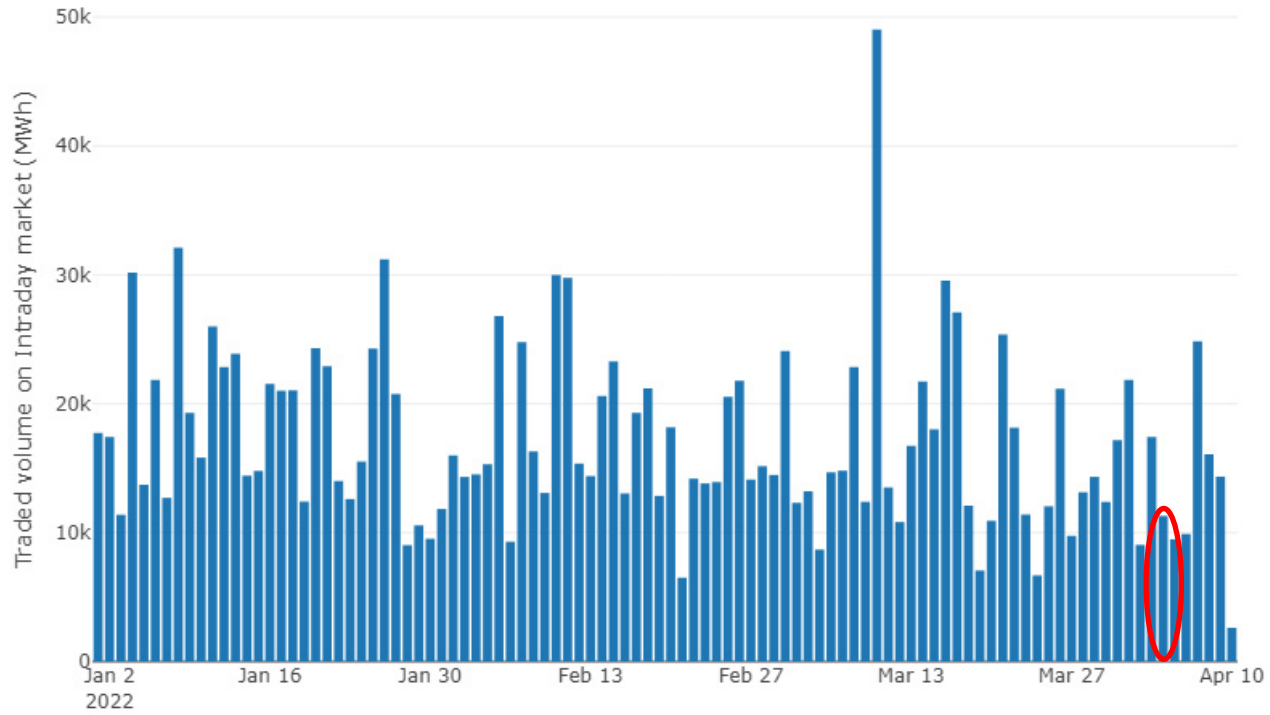
Nevertheless, the trading volumes on this day remained relatively low, given the final system imbalance and the history. The players had obviously not anticipated their imbalance and did not use the market sufficiently. It should nevertheless be noted that during peak hours, it was ultimately better for a player in a long position to be exposed to the price of positive differences, because the energy was valued at spot price in the PRE calculation, particularly for imbalance netting. However, this trade-off is difficult for players to anticipate.



Source: EPEX SPOT - Analysis: CRE

Figure 44 Volumes bought and sold on the intraday market by hour (MWh)

Given the trading volumes on the intraday market, it seems unlikely that a player had voluntarily purchased significant volumes on the day-ahead market in order to offer them during the day.



Source: EPEX SPOT - Analysis: CRE

Figure 45 Net traded volume on the French intraday market, 4 April 2022 circled in red (MWh)

4. LESSONS LEARNT

The auction on 3 April 2022 for delivery on 4 April showed that high stress was anticipated on the supply-demand balance, indicated by very high spot prices for two hours of the day, at 7am and 8am. This stress resulted from an extremely unlikely combination of adverse factors, most of which had a low probability of occurrence. Scarcity did not ultimately materialise, particularly due to generation underestimation. This high stress episode on the day-ahead auction, however, had real consequences:

- it made European market players aware in practice of the current fragility of the French electricity system, and this could have contributed to the increase in French prices for the winter of 2022-2023 observed in recent weeks;
- it led to price levels close to the daily-auction ceiling of €3,000/MWh, thus automatically increasing the cap to €4,000/MWh, as directed by the decision of the Agency for the Cooperation of Energy Regulators (ACER). The increase in the cap price was also likely to contribute to higher futures prices, as players expect this kind of incident to occur again next winter.

However, this was an isolated event resulting from an exceptional combination of different events (in addition to the low availability of the nuclear fleet):

- the night of 4 April was the coldest for an April since 1947;
- import capacities were low before the daily auction, and exceptionally low from Germany and Belgium;
- EDF had announced the unplanned unavailability of the Dampierre 1 nuclear unit, with nuclear availability already exceptionally low;
- wind generation during the critical hours of 7am to 9am was underestimated, as was CHP generation;
- the mechanisms for managing peak consumption in France ended on 31 March and were therefore not available on 4 April (capacity mechanism, TEMPO tariffs, calls for demand-response tenders, etc.). Similarly, several generation facilities began maintenance at the end of March and were no longer available;
- alerts from RTE probably led players, out of caution, to seek a long position, and this might have prompted an increase in the day-ahead auction price.

The combination of these factors resulted in extremely high spot prices for 7am and 8am on 4 April 2022 (€2,720/MWh and €2,990/MWh respectively). These prices would have been approximately halved with a small shift in the supply/demand balance of between 500 and 1000 MW (increase in generation, decrease in consumption).

In terms of physical balance, the system went through the two critical hours of 4 April relatively easily. Wind generation and especially CHP generation were higher than forecast, and the RTE did not have to intervene heavily in the balancing mechanism.

On the other hand, consumption was very high, in line with the forecasts made two days before. The RTE's ecoWatt signal was probably insufficient to regulate consumption, perhaps because it was triggered in the middle of a weekend (4 April was a Monday) and outside the winter season.

This event calls into question the appropriateness of the rule for automatically raising the wholesale electricity price cap

The price spike on 4 April 2022 was quite exceptional and the result of circumstances specific to France, but it had serious consequences for all the countries in the Single Day-ahead Coupling region. Under the current rules, an increase in the price cap of €1,000/MWh was automatically triggered in the 24 countries making up the Single Day-ahead Coupling region, because prices reached 60 % of the price cap in a particular hour in a single market area. The observation that the increase in the price cap was the result of a highly unlikely and exceptional event specific to one country calls into question the appropriateness of the current methodology for dynamic increases in the price cap.

Moreover, the existence of additional capacities at prices between €3,000 and €4,000/MWh that could be made available in the short term in the form of either generation or demand-response capacity seems very unlikely, at least on the French market.

The CRE considers that the rules for automatically increasing harmonised price caps should be changed. Because the procedure for amending the current methodology could take some time, and given the current energy-price crisis in Europe, the CRE considers that automatic increases to price caps should be suspended until the rules are revised.