Evaluation of the probability of interruption, as established in the Commission Regulation (EU) 2017/460, 16th March

VIP Ibérico and High-pressure Network / LNG Terminal Interconnection

Gas Year 2023 / 2024

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1 Framework

The publication of Commission Regulation (EU) 2017/460 of 16th March 2017 establishing a network code on harmonised transmission tariffs structures for gas (Tariff Network Code) has defined, among others, the rules for the calculation of reserve prices for standard capacity products for interruptible capacity. In particular, Article 16 (1) specifies that reserve prices for standard capacity products for interruptible capacity should be calculated by applying a discount to the reserve prices of their respective firm standard capacity products, according to the following formula[1]:

$$Discount_{ex-ante} = Pro \times A \times 100\% \qquad (1)$$

- (Pro) – probability of interruption;
- (A) – adjustment factor, applied to reflect the estimated economic value of the type of standard capacity product for interruptible capacity.

Additionally, Article 183 (17) of the Portuguese Tariff[2] Regulation for the gas sector regarding the information to be delivered to the NRA, foresees that, for the establishment of the prices to be applied to standard capacity products for interruptible capacity for the use of the national transport network, the transmission system operator must provide to the NRA, on an annual basis, the evaluation of the probability of interruption, according to the above-mentioned Comission Regulation. This assessment shall include:

1) a list of all types of standard capacity products for interruptible capacity offered, including the respective probability of interruption and level of discount to be applied;
2) an explanation on how the probability of interruption is calculated for each type of product;
3) the data used to calculate the probability of interruption.

Regarding the prices for standard capacity products for interruptible capacity, according to Article 167 (2) of the Portuguese Tariff Regulation, the transmission system operator shall also suggest a value for parameter A, the adjustment factor that reflects the estimated economic value for each of these products, as also mentioned in Article (16) of the (EU) 2017/460 of 16th March 2017.

This document sets out the proposals of the transmission system operator for each of these parameters, in accordance with the definitions considered in the Tariff Regulation for the gas sector, for the application of the ex-ante discount on the following points:

- VIP Ibérico;
- Interconnection between the high-pressure network and the LNG Terminal.

[1] As an alternative to applying an ex-ante discount, as established in Article 16 (4) the National Regulatory Authority may decide to apply an ex-post discount, whereby network users are compensated after the actual interruptions incurred.
[2] Regulation nº 368/2021.

2 Methodology

2.1 Probability of interruption

The probability of interruption must be calculated for each type of standard capacity product offered, for which the following equation shall apply, according to Article (16) of the (EU) 2017/460 of 16th March 2017:

$$Pro = \frac{N \times D_{int}}{D} \times \frac{CAP_{av.\ int}}{CAP} \qquad (2)$$

- (N) is the expected number of interruptions over D;
- (Dint) is the average duration of expected interruptions (in hours);
- (D) is the total duration of the respective type of standard capacity product for interruptible capacity (in hours);
- (CAP av.int) is the expected average amount of interrupted capacity for each interruption where such amount is related to the respective type of standard capacity product for interruptible capacity;
- (CAP) is the total amount of interruptible capacity for the respective type of standard interruptible capacity product.

2.1.1 Capacity Management in the interconnection points

In practice, when all firm capacity (where additional capacity is included) is contracted for a certain gas day, its underutilisation, either due to a low nomination or to a decrease in a renomination cycle, will produce an interruptible capacity available, as shown in Figure 1.

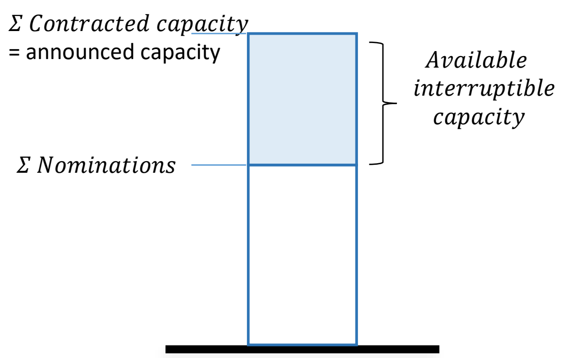

Figure 1

Such interruptible capacity may be contracted as shown in Figure 2, according to the rules defined in (EU) 2017/460 of 16th March 2017.

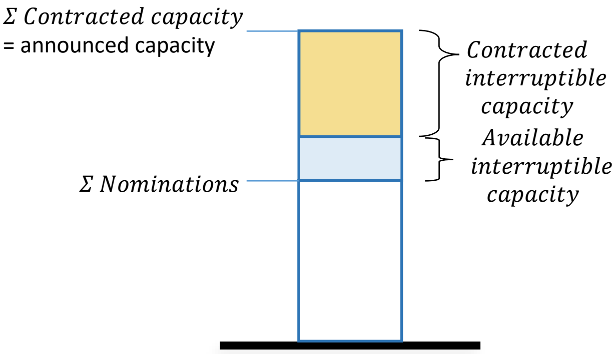

Figure 2

Under these circumstances, any further renominations for higher values within the respective firm capacity contracted, will imply a shortage on the previously announced interruptible capacity. This occurrence may affect the interruptible capacities that had already been assigned, and thus creating an interruption of capacity, as shown in Figure 3.

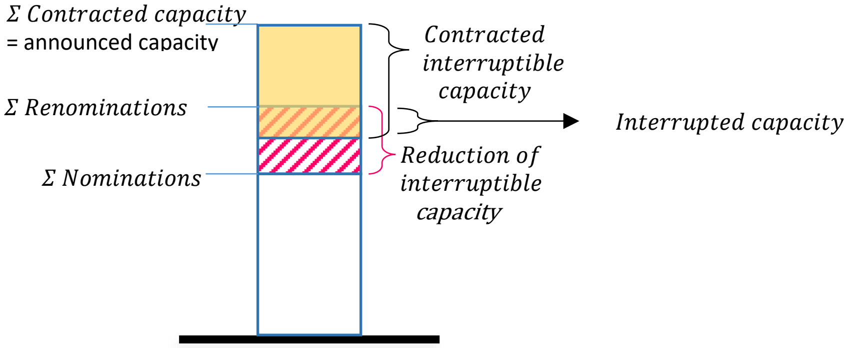

Figure 3

2.1.2 Interruption of interruptible capacity

Interruptible capacity products may be offered when all firm capacity is contracted but is not being requested and thus not being used. This idle capacity, altough eventually previously confirmed could be interrupted due to the subsequent renominations performed by the network users entitled to the corresponding firm capacity.

Assuming that the market's historical behaviour regarding the use of the contracted firm capacity has identical statistical significance in situations where the firm capacity is sold out, it is reasonable to accept that the probability of interruption of interruptible capacity on a given gas day results from the product between (i) the probability of contracting available interruptible capacity due to underuse of contracted firm capacity, illustrated in Figure 1, and (ii) the probability of reducing the available interruptible capacity (variation of use by renomination to a higher value), illustrated in Figure 3.

The following equation (3) shall apply:

$$\frac{N \times D_{int}}{D} = C \times PC(d) \times PR(d) \times R \qquad (3)$$

- (C) - Ratio of the number of days on which interruptible capacity is expected to be contracted, in relation to the period considered.
- (PC(d)) - Probability of contracting a certain interruptible capacity on gas day d.
- (PR (d)) – Probability of reduction of a given interruptible capacity available on gas day d, obtained as a function of increases in the use of firm capacity in renomination processes occuring in a relevant historical period.
- (R) - Ratio of the number of days on which the increase in the use of firm capacity is expected in renomination processes, in relation to the period considered.

For the purpose of this analysis, it is assumed that the frequency of occurrences in the contracting interval PC(d) behaves identically to the frequency distribution found for PR(d).

It is considered that variable C is maximized to the unit value, in order to simplify the methodology and because, for the time being, there is not sufficient data available for its modelling.

2.2 Factor ‘A’

According to Article 167 of the Portuguese Tariff Regulation, factor ‘A’ is applied to reflect the estimated economic value of the type of standard capacity product for interruptible capacity, calculated for each, some or all interconnection points, and shall be no less than 1.

For the present analysis, it is appropriate to apply a unit value (A=1) to each of the standard capacity products for interruptible capacity at any of the interconnection points concerned.

3 Analysis of the VIP Ibérico

3.1 Offer of standard capacity products for interruptible capacity

Regulation (EU) 2017/459, establishing a network code on capacity allocation mechanisms in gas transmission systems, requires transmission system operators to offer standard capacity products for interruptible capacity in VIP Ibérico according to the following:

- daily capacity product for interruptible capacity in both directions at interconnection points where the respective standard capacity product for firm capacity was sold out day-ahead or was not offered, to be allocated through an auction process;
- within-day capacity products for interruptible capacity, in both directions, shall only be allocated when firm capacity (additional capacity included), is sold out and shall be allocated through an over-nomination procedure.

These products shall be offered according to the rules defined in Regulation (EU) 2017/459, regarding capacity allocation mechanisms in gas transmission system.

3.2 Historical use of capacities

The virtual interconnection point, VIP Ibérico, had no interruption of interruptible capacity due to physical congestion during the period under analysis. The following graph, Figure 4, presents the utilisation of this interconnection point, in both directions, between October 2016 and September 2022, in which a positive flow corresponds to an entrance to the Portuguese system (flow direction from Spain to Portugal).

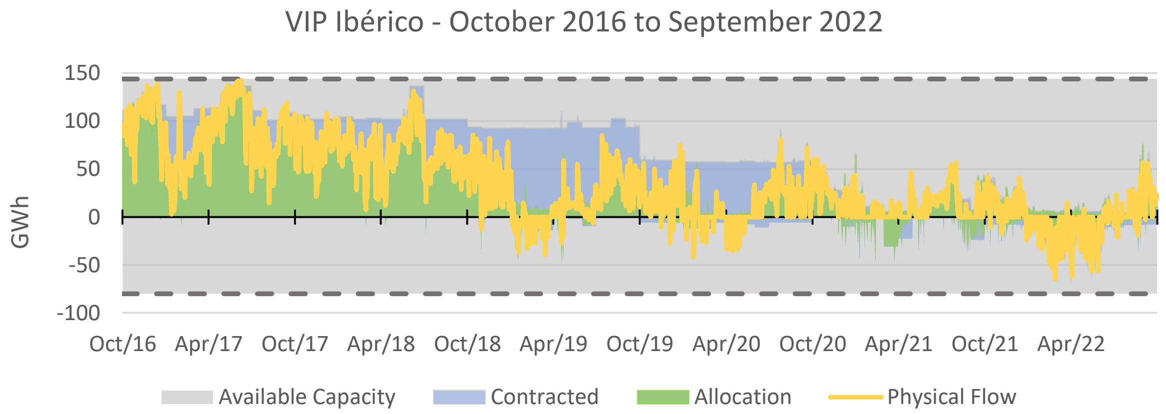

Figure 4: VIP Ibérico between October 2016 and September 2022 (capacities, allocation and physical flow).

The following Tables (1 and 2) show the levels of contracting and utilisation of contracted capacities referred to the contracting of firm capacities in VIP Ibérico in biannual periods from October 2016 to September 2022.

- Direction Spain - Portugal

Table 1: Contracting capacities and utilisation of contracted capacity levels referred to firm capacities – SP -> PT.

Biennium	% Contracted	% Utilised
2016/17 and 2017/18	76.92%	70.07%
2017/18 and 2018/19	69.46%	45.91%
2018/19 and 2019/20	53.02%	26.75%
2019/20 and 2020/21	27.29%	39.79%
2020/21 and 2021/22	11.66%	79.39%

- Direction Portugal - Spain

Table 2: Contracting capacities and utilisation of contracted capacity levels referred to firm capacities – PT -> SP.

Biennium	% Contracted	% Utilised
2016/17 and 2017/18	0.12%	1.50%
2017/18 and 2018/19	3.59%	16.38%
2018/19 and 2019/20	9.24%	36.30%
2019/20 and 2020/21	12.74%	43.34%
2020/21 and 2021/22	17.83%	50.12%

The highest levels of contracting were verified in the direction Spain - Portugal, between 2016 to 2018, prone to higher dynamic renomination cycles, compatible with the assumptions of statistical significance of the methodology applied. Therefore, the period between October 2016 and September 2018 is considered the relevant historical period that best characterizes the expected occurrence of interruption of interruptible capacity products for the gas year 2023/24. The following graphs (Figures 5 and 6) detail the utilization of capacity in the specified period.

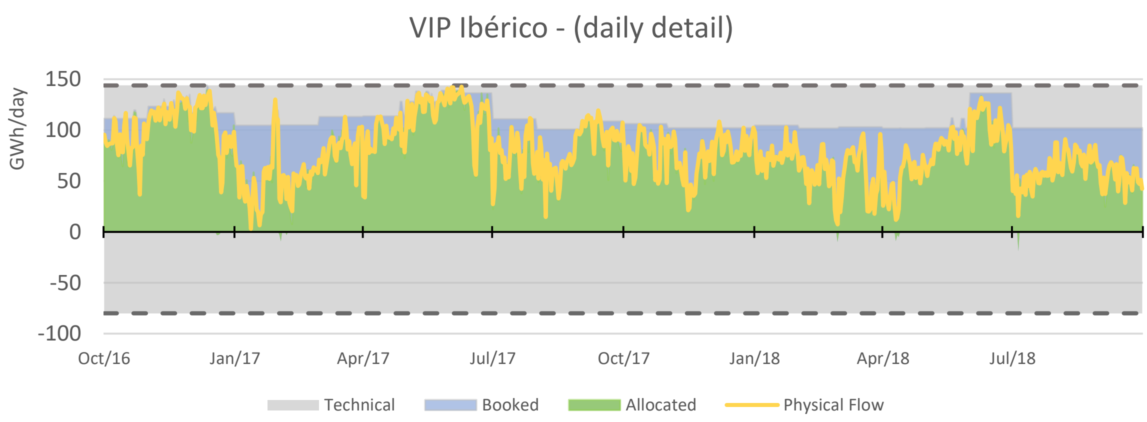

Figure 5: VIP Ibérico between October 2016 and September 2018 (capacities, allocation and physical flow).

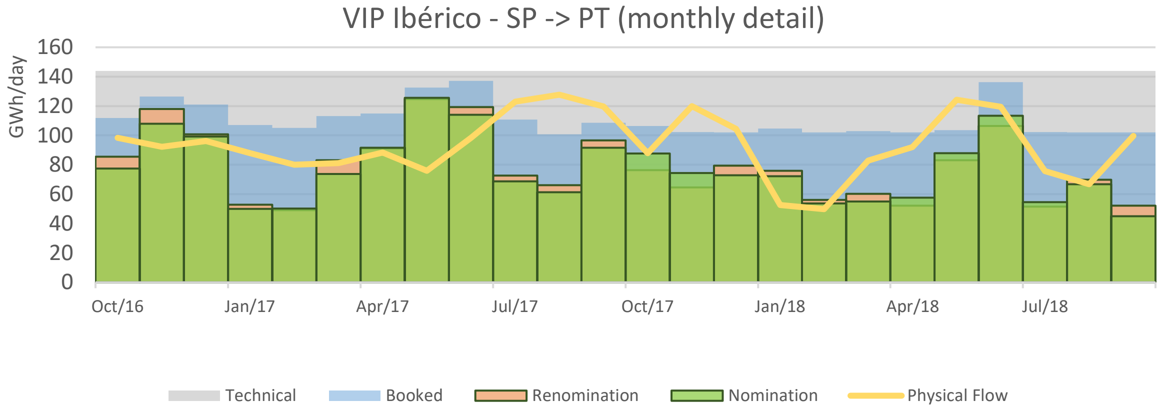

Figure 6: Monthly average of VIP Ibérico between October 2016 and September 2018. Upwards renominated quantities displayed in orange, downwards renominated quantities shown in darker green.

3.3 Calculation of the probability of interruption for the period 2023/24

Through the analyses of the increase in the use of capacity resulting from the renomination processes, it was possible to calculate the frequency of reduction applied to the interruptible capacity (referred to the available interruptible capacity), thus determining the distribution of reduction of this capacity, PR(d), expected on gas day d, as shown in Figure 7.

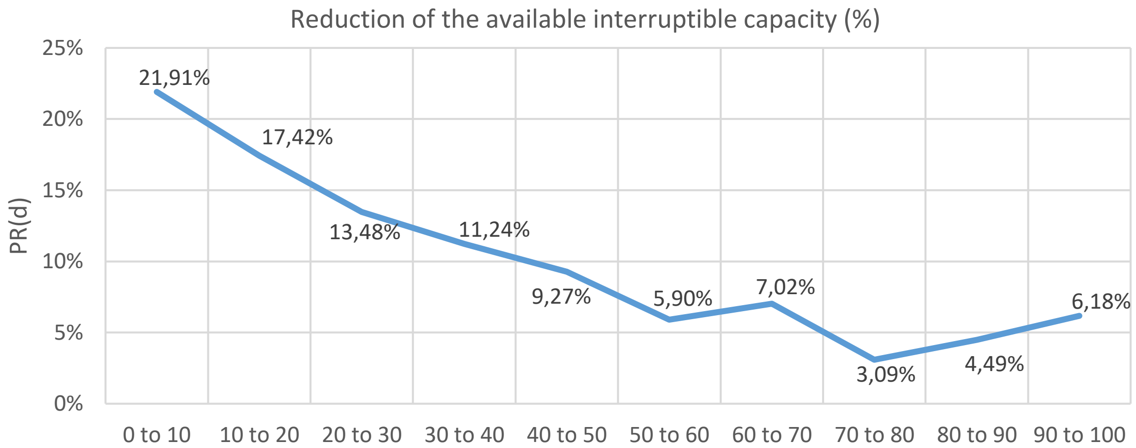

Figure 7: Reduction of interruptible capacity for each gas day, PR(d).

As already mentioned in paragraph 2.1.2, it is assumed that the probability of contracting interruptible capacity, PC(d), presents the same distribution as the reduction of the available interruptible capacity, determined for PR(d), with the former competing with the latter in the reduction of this capacity, but in the opposite direction. The expected number of interruptions for each set of interruptible capacity reduction hypothesis by contracting, PC(d), and by renomination, PR(d), for each available interruptible capacity interval, is shown in the matrix in Table 3, by multiplying the second by the third term of the equation (3).

Table 3: Expected interruptions for each set of hypothesis of reduction of interruptible capacity, by contracting, PC(d), and by renomination, PR(d).

		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
		PR(d)									
	PC(d)	21,91%	17,42%	13,48%	11,24%	9,27%	5,90%	7,02%	3,09%	4,49%	6,18%
90 to 100	6,18%	1,354%	1,076%	0,833%	0,694%	0,573%	0,365%	0,434%	0,191%	0,278%	0,382%
80 to 90	4,49%		0,783%	0,606%	0,505%	0,417%	0,265%	0,316%	0,139%	0,202%	0,278%
70 to 80	3,09%			0,417%	0,347%	0,286%	0,182%	0,217%	0,095%	0,139%	0,191%
60 to 70	7,02%				0,789%	0,651%	0,414%	0,493%	0,217%	0,316%	0,434%
50 to 60	5,90%					0,547%	0,348%	0,414%	0,182%	0,265%	0,365%
40 to 50	9,27%						0,547%	0,651%	0,286%	0,417%	0,573%
30 to 40	11,24%							0,789%	0,347%	0,505%	0,694%
20 to 30	13,48%								0,417%	0,606%	0,833%
10 to 20	17,42%									0,783%	1,076%
0 to 10	21,91%										1,354%

No interruption: PC(d) x PR(d) = 0

Example: If in a given time when there is available interruptible capacity, a level of contracting of this capacity occurs in the interval up to 10% (an event which has a probability of occurrence PC(d) = 21.91%), the reduction of interruptible capacity up to 90% cannot have any impact. Only when the level of reduction in the capacity level is in the 90 to 100% range (independent event with probability of occurrence PR(d) = 6.18%) will an interruption occur, with a 1.354% probability. The same interpretation should be made for each contracting interval, but for this purpose the accumulation of probabilities along the intervals of successively reduced capacities should be taken into account.

For each interval of available interruptible capacity, the quotient between the interruptible capacity hypothesis ($CAP_{av.int}$) and contracted interruptible capacity (*CAP*) is the interrupted contracted interruptible capacity. The matrix in Table 4 shows the contracted interruptible capacities likely to be interrupted for each combination of the variables mentioned ($CAP_{av.int}$) and (*CAP*). With the definition of this variable, it will be possible to quantify the amount affected by each expected interruption record, from Table 3.

Table 4: Interrupted contracted interruptible capacity for each set of hypothesis of interrupted capacity ($CAP_{av.int}$) and contracted interruptible capaciy (CAP): $CAP_{av.int}/\ CAP$.

		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
		Interrupted Capacity (C)									
	Contracted Interruptible Capacity (L)	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
90 to 100	95%	0%	11%	21%	32%	42%	53%	63%	74%	84%	95%
80 to 90	85%		0%	12%	24%	35%	47%	59%	71%	82%	94%
70 to 80	75%			0%	13%	27%	40%	53%	67%	80%	93%
60 to 70	65%				0%	15%	31%	46%	62%	77%	92%
50 to 60	55%					0%	18%	36%	55%	73%	91%
40 to 50	45%						0%	22%	44%	67%	89%
30 to 40	35%							0%	29%	57%	86%
20 to 30	25%								0%	40%	80%
10 to 20	15%									0%	67%
0 to 10	5%										0%

Example: Each entry in the table results from the application of the following expression: Max{L+C-100%;0}/L - where "C" and "L" correspond to each value in the "interrupted capacity" column and to each value in the "contracted interruptible capacity" line, respectively. Applying the example described, "C" = 25%, "L" = 85%, and so the contracted interruptible capacity interrupted will be Max{85%+25%-100%;0}/85% = 12%.

Taking as reference the days where the use of firm capacity increases in renomination processes, the probability of interruption will be obtained through the product of the probability of occurrence of an interruption (PC(d) x PR(d)), from Table 3, by the contracted interruptible capacity affected, i.e. interrupted ($CAP_{av.int}/CAP$), referred to the available interruptible capacity (Table 4). The result of this operation is shown in Table 5.

Table 5: Product beween the probability of occurrence of aninterruption, PC(d) x PR (d) from Table 3, by the interrupted contracted interruptible capacity, $CAP_{av.int}/\ CAP$ from Table 4.

		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
		Interrupted Capacity									
	Interrupted Contracted Interruptible Capacity	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
90 to 100	95%		0,113%	0,175%	0,219%	0,241%	0,192%	0,274%	0,141%	0,234%	0,362%
80 to 90	85%			0,071%	0,119%	0,147%	0,125%	0,186%	0,098%	0,166%	0,261%
70 to 80	75%				0,046%	0,076%	0,073%	0,116%	0,064%	0,111%	0,178%
60 to 70	65%					0,100%	0,127%	0,228%	0,134%	0,243%	0,401%
50 to 60	55%						0,063%	0,151%	0,099%	0,193%	0,331%
40 to 50	45%							0,145%	0,127%	0,278%	0,509%
30 to 40	35%								0,099%	0,289%	0,595%
20 to 30	25%									0,242%	0,667%
10 to 20	15%										0,718%
0 to 10	5%										
							Σ [PC(d) x PR(d) x $CAP_{av,int}$/CAP] =				9,527%

By applying the sum to the set of probability distributions calculated in the matrix presented in Table 5, it is possible to calculate the probability of interruption, considering the days of increase in firm capacity due to renomination processes as a reference. Since the probabilities calculated so far were determined in the scope of the ratio of available firm capacity increase in renomination processes, R, it is necessary to transpose this reality to the referential of the period considered in the study, applying the last term of equation (3). The value calculated for R for the period under consideration is 48.77%, resulting in a calculated PRO of:

$$PRO \ = \Sigma \left[PC(d) \times PR(d) \times \frac{CAP_{av.int}}{CAP} \right] \times R = \ \mathbf{4.646}\%,$$

being this the probability of interruption that shall be considered, applied equally to both directions.

4 Analysis of the high-pressure network/LNG Terminal connection

4.1 Types of standard capacity products for interruptible capacity

According to *Manual de Procedimentos de Acesso às Infraestruturas* do setor do gás natural, published in Diretiva nº 07/2020, Procedure nº 4 establishes that the transmission system operator shall offer standard interruptible capacity products for:

- within-day interruptible capacity on regaseification, in case all firm capacity, including additional capacity eventually offered, has been sold-out, to be confirmed through a renomination mechanism.

These products shall be offered according to the same rules that apply to VIP Ibérico, as defined in Regulation (EU) 2017/459, establishing capacity allocation mechanisms in gas system networks, applied to the regaseification capacity.

4.2 Historical use of capacities

The following graph (Figure 8) presents the utilisation of the connection point between the high-pressure network and the LNG Terminal between October 2016 and September 2022.

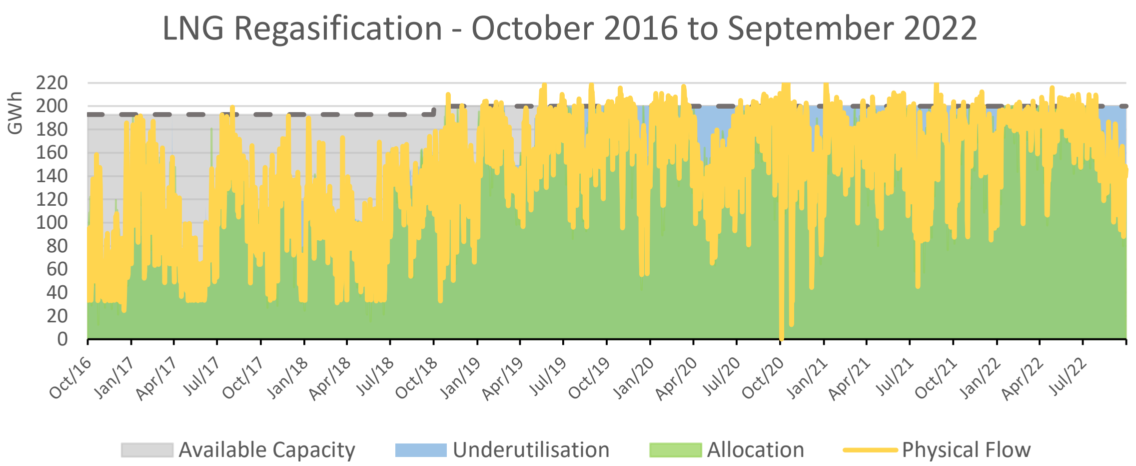

Figure 8: LNG Regasification between October 2016 and September 2022 (capacities, allocation and physical flow).

As a result of the renewed *Manual de Procedimentos de Acesso às Infraestruturas* for the gas sector, published on March 2020, interruptible capacity products started to be offered on October 2020. Contracting of this product was registered on the biennium 2020-2022 by overnomination mechanisms as well as capacity interruption resulting from an increase in capacity related to renomination processes.

4.2.1 Evaluation of the total interrupted capacity

From the analysis of the capacity contracting and capacity interruption processes of interruptible capacity, during the gas-years of 2020/21 and 2021/22, the following data, presented in Table 6, were obtained.

Table 6: Contracting capacities and utilisation of contracted capacity levels referred to firm capacities – Regasification

Interruptible Capacity	2020/21	2021/22
Contracted by overnomination	930.0 GWh	88.4 GWh
Interrupted capacity due to renomination	76.7 GWh	1.3 GWh
Percentage of interruption	8.2%	1.5%

It can be observed that interrupted capacity due to renomination decreased in the last year, from around 8.2% to 1.5% of the total interruptible capacity contracted. Further analysis to the interruption occurrences during gas year of 2021/22 can be found in Appendix A.

4.2.2 Determination of the reference period

The following table shows the levels of contracting and utilisation of contracted capacities referred to the contracting of firm capacities in VIP Ibérico in biannual periods from October 2016 to September 2022.

Table 7: Contracting capacities and utilisation of contracted capacity levels referred to firm capacities – Regasification.

Biennium	% Contracted	% Utilised
2016/17 and 2017/18	55.86%	92.09%
2017/18 and 2018/19	74.61%	89.29%
2018/19 and 2019/20	94.65%	87.06%
2019/20 and 2020/21	100.00%	82.89%
2020/21 and 2021/22	100.00%	84.52%

It is observed that the 2020-22 biennium reached the highest levels of contracting, prone to higher dynamics of renomination compatible with the assumptions of statistical significance of the methodology in application. Therefore, the period between October 2020 and September 2022 is considered a relevant historical period, suitable for the intended analysis.

The following graphs (Figures 9 and 10) show the levels of contracting and utilisation of regasification capacity during the period from October 2020 to September 2022. It can be seen throughout this period that regasification capacity utilisation is high, due to the interest of the market agents in supplying their customers through LNG. The utilisation rate of regasification capacity has been increasing over the considered period, with the market successively contracting more capacity for longer periods, culminating in the sale of all capacity for gas year 2019/20 and subsequents at the annual capacity auction. Demand for regasification capacity resulted in 89% of the announced technical capacity being contracted in gas year 2018/19, with this figure reaching 100% in gas year 2019/20, 2020/21 e 2021/22. Regarding utilisation, it represented 82% of the technical capacity in 2020/21 and 87% in 2021/22. It is also worth mentioning that in 5% of the period in analysis (2020-22 biennium), capacity utilisation equalled the contracted capacity, and in 12% of the time period, there was no more available capacity, meaning that the regasification capacity available to the market was completely taken. Thus, and considering the behaviour explained in the use of regasification capacity, it is considered that there are favourable conditions for the occurrence of capacity interruption due to congestion.

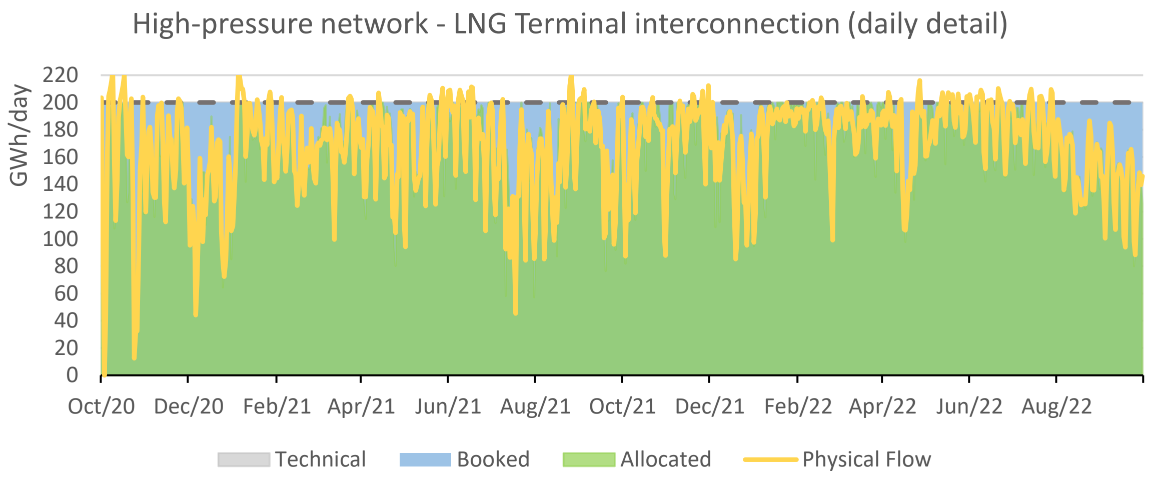

Figure 9: LNG Regasification between October 2020 and September 2022.

As can be seen on the previous graph, there were a few days when the physical flow was greater than the available capacity. These values correspond to a TSO's management choice resulting from the operating conditions verified in the RNTIAT infrastructures.

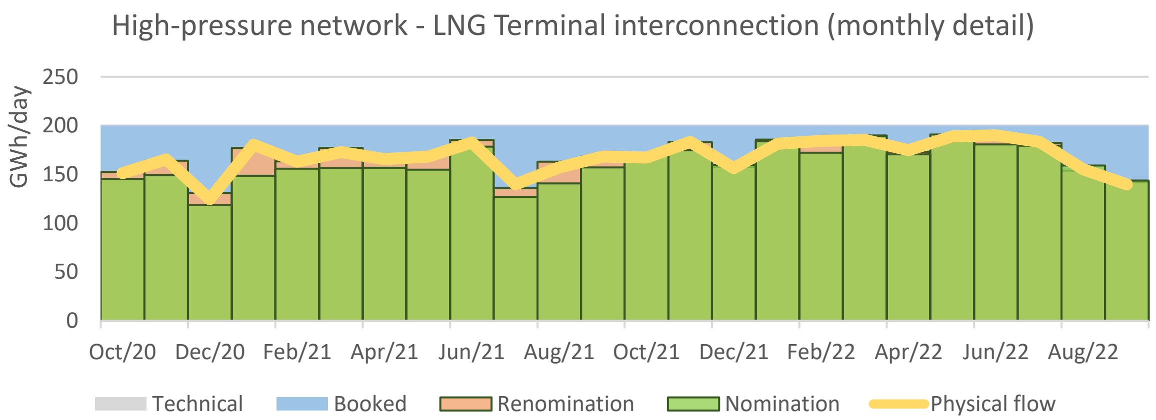

Figure 10: Monthly average of LNG Regasification between October 2020 and September 2022. Renomination quantities to superior values displayed in orange.

4.3 Calculation of the probability of interruption for 2023/24

By analysing the history of occurrences of capacity utilisation increase due to renomination, it was possible to calculate the frequency of interruptible capacity reduction experienced, determining the distribution of this capacity reduction, PR(d), expected on gas day d, as shown in Figure 11.

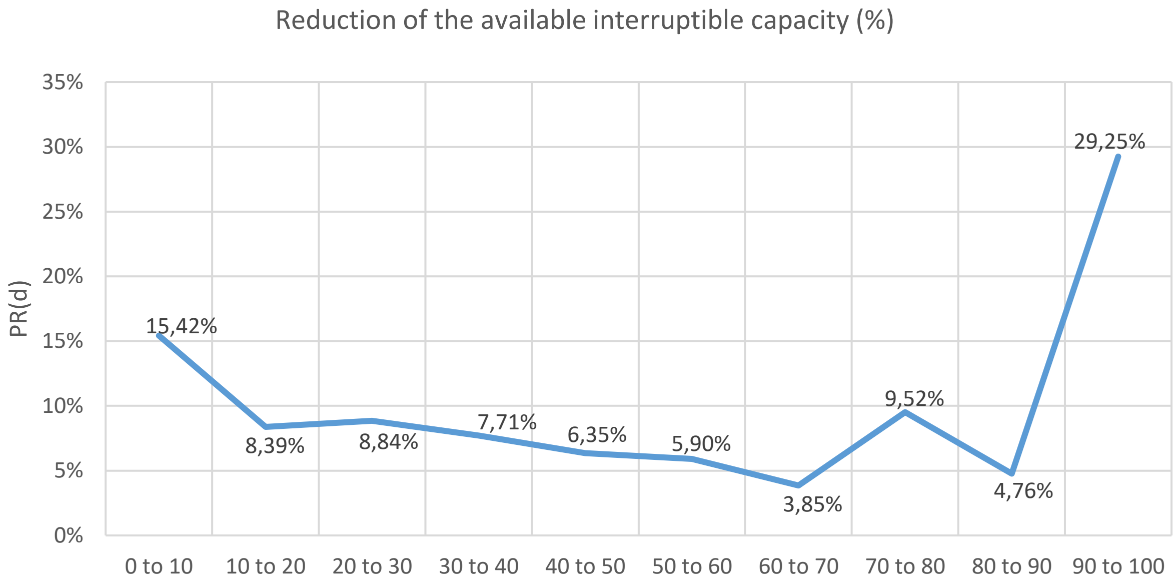

Figure 11: Reduction of interruptible capacity expected for each gas day PR(d).

As already mentioned in 2.1.2, it is assumed that the probability of contracting interruptible capacity, PC(d), presents the same distribution as the reduction in available interruptible capacity, determined for PR(d), with the former competing with the latter in the reduction of this capacity, but in opposite directions.

The expected number of interruptions for each set of interruptible capacity reduction hypothesis by contracting, PC(d), and by renomination, PR(d), for each available interruptible capacity interval, is shown in the matrix in Table 8, by multiplying the second by the third terms of equation (3).

Table 8: Interruptions expected for each set of hypothesis of reduction of interruptible capacity, contracted, PC(d), and renominated, PR(d)

		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
		PR(d)									
	PC(d)	15,42%	8,39%	8,84%	7,71%	6,35%	5,90%	3,85%	9,52%	4,76%	29,25%
90 to 100	29,25%	4,510%	2,454%	2,587%	2,255%	1,857%	1,725%	1,128%	2,786%	1,393%	8,557%
80 to 90	4,76%		0,400%	0,421%	0,367%	0,302%	0,281%	0,184%	0,454%	0,227%	1,393%
70 to 80	9,52%			0,842%	0,734%	0,605%	0,561%	0,367%	0,907%	0,454%	2,786%
60 to 70	3,85%				0,297%	0,245%	0,227%	0,149%	0,367%	0,184%	1,128%
50 to 60	5,90%					0,374%	0,348%	0,227%	0,561%	0,281%	1,725%
40 to 50	6,35%						0,374%	0,245%	0,605%	0,302%	1,857%
30 to 40	7,71%							0,297%	0,734%	0,367%	2,255%
20 to 30	8,84%								0,842%	0,421%	2,587%
10 to 20	8,39%									0,400%	2,454%
0 to 10	15,42%										4,510%

No interruption:
PC(d) x PR(d) = 0

Example: if in a given time when there is interruptible capacity available, a level of contracting of this capacity occurs in the interval of up to 10% (an event which has a probability of occurrence PC(d) = 15.4%), the reduction of interruptible capacity up to 90% cannot have any impact. Only when the level of reduction in the capacity level is in the 90 to 100% range (independent event with probability of occurrence PR(d) = 29.25%) will an interruption occur, with a 4.510% probability. The same interpretation should be made for each contracting interval, but for this purpose, the accumulation of probabilities along the intervals of successively reduced capacities should be taken into account.

For each interval of available interruptible capacity, the quotient between the interruptible capacity hypothesis ($CAP_{av.int}$) and contracted interruptible capacity (CAP) is the interrupted contracted interruptible capacity. The matrix in Table 9 shows the contracted interruptible capacities likely to be interrupted for each combination of the variables mentioned, $CAP_{av.int}$ and CAP. With the definition of this variable, it will be possible to quantify the quantity affected by each expected interruption record, from Table 8.

Table 9: Interruption of contracted interruptible capacity for each set of hypothesis of interrupted capacity ($CAP_{av.int}$) and contracted interruptible capacity (CAP): $CAP_{av.int} / CAP$.

		Interrupted Capacity [C]									
	Contracted Interruptible Capacity [L]	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
90 to 100	95%	0%	11%	21%	32%	42%	53%	63%	74%	84%	95%
80 to 90	85%		0%	12%	24%	35%	47%	59%	71%	82%	94%
70 to 80	75%			0%	13%	27%	40%	53%	67%	80%	93%
60 to 70	65%				0%	15%	31%	46%	62%	77%	92%
50 to 60	55%					0%	18%	36%	55%	73%	91%
40 to 50	45%						0%	22%	44%	67%	89%
30 to 40	35%							0%	29%	57%	86%
20 to 30	25%								0%	40%	80%
10 to 20	15%									0%	67%
0 to 10	5%										0%

Exemplo: Each entry in the table results from the application of the following expression: Max{L+C-100%;0}/L - where "C" and "L" correspond to each value in the "interrupted capacity" column and to each value in the "contracted interruptible capacity" line, respectively. Applying the example described, "C" = 25%, "L" = 85%, and so the contracted interruptible capacity interrupted will be Max{85%+25%-100%;0}/85% = 12%.

Considering as reference the days where the use of firm capacity increases in renomination processes, the probability of interruption will be obtained through the product of the probability of an interruption occurrence (PC(d) x PR(d)), from Table 8, by the contracted interruptible capacity affected, i.e., interrupted ($CAP_{av.int}/\ CAP$), against the available interruptible capacity (Table 9). The result of this operation is shown in Table 10.

Table 10: Product between the probability of occurrence of an interruption, PC(d) x PR (d) in Table 8, by the interrupted contracted interruptible capacity, $CAP_{av.int}/\ CAP$ from Table 9.

		0 to 10	10 to 20	20 to 30	30 to 40	40 to 50	50 to 60	60 to 70	70 to 80	80 to 90	90 to 100
		Interrupted Capacity									
	Interrupted contracted interruptible capacity	5%	15%	25%	35%	45%	55%	65%	75%	85%	95%
90 to 100	95%		0,258%	0,545%	0,712%	0,782%	0,908%	0,712%	2,053%	1,173%	8,106%
80 to 90	85%			0,050%	0,086%	0,107%	0,132%	0,108%	0,320%	0,187%	1,311%
70 to 80	75%				0,098%	0,161%	0,225%	0,196%	0,605%	0,363%	2,600%
60 to 70	65%					0,038%	0,070%	0,069%	0,226%	0,141%	1,041%
50 to 60	55%						0,063%	0,083%	0,306%	0,204%	1,568%
40 to 50	45%							0,054%	0,269%	0,202%	1,651%
30 to 40	35%								0,210%	0,210%	1,933%
20 to 30	25%									0,168%	2,070%
10 to 20	15%										1,636%
0 to 10	5%										
							Σ [PC(d) x PR(d) x $CAP_{av,int}$/CAP] =				34,007%

By applying the sum to the set of probability distributions calculated in the matrix in Table 10, it is possible to calculate the probability of interruption, considering the days of increase in firm capacity due to renomination processes as a reference. Since the probabilities calculated so far were determined in the scope of the ratio of firm capacity increases in renomination processes, R, it is necessary to transpose this reality to the referential of the considered period, applying the last term of equation (3). The R value calculated for the period under consideration is 60.41%, resulting in a calculated PRO of:

$$PRO = \Sigma \left[PC(d) \times PR(d) \times \frac{CAP_{av.int}}{CAP}\right] \times R = \mathbf{20.544\%}\,.$$

5 Conclusions

Considering the application of an ex-ante discount when determining tariffs for interruptible capacity in the 2023/24 gas year, the transmission system operator submits a reasoned proposal for the parameters set out in the Tariff Regulations for the gas sector. These parameters are: (i) the probability of interruption of interruptible capacity (Pro); (ii) adjustment factor to the estimated economic value of the type of product (A).

In the study regarding the determination of the probability, a common methodology was applied both to VIP Ibérico and to the high-pressure network and LNG Terminal interconnection. This option was based on the fact that, in both cases, the offer of interruptible capacity and the respective interruption results from the nomination behaviour and subsequent renomination, regarding the specificities in the use of the infrastructures in each point. This approach incorporates quantitative elements of the use of the respective points during a historically relevant period, considering for this purpose the biennium with the highest level of contracting.

Apropos of the high-pressure network and LNG Terminal interconnection, Table 6 presents the data relative to the period when interruptible capacity was offered, properly describing it by the global quantities of contracted capacity through overnomination and the respective quantities of interrupted capacity.

As can be easily seen, a decrease of interrupted capacity, from 8.2% to 1.5%, was registered in the last year. On the other hand, this evolution is inconsistent with the results obtained through the applied methodology, where an increase of the interruption probability was determined, from 15.3% to 20.6%. Given the current conjuncture of the energy sector and bearing in mind the foreseen uncertainty for the future, in our understanding a correlation between the determined probability and the historical data obtained within a still brief period of time is untenable. Therefore, and considering the divergent evolution of both analysis, based on theoretical probability and on the frequence of interruption occurrences, the transmission system operator assumes a more conservative approach, proposing the maintenance of the the ex-ante discount recommended last year and currently in effect.

Regarding factor 'A', a unit value (A=1) was considered appropriate to each of the standard capacity products for interruptible capacity at any of the interconnection points concerned, considering as well that there is a neutral variation in the economic value of each product against the respective probability values determined by the methodology.

The following table shows the transmission system operator's proposal for these parameters, offering a comparison with the recommended values for the gas year 2022/23:

Table 10: Probability of capacity interruption and ex-ante discount proposal for 2023/24.

Interconnection points with High-Pressure Network	Product	Probability 2022/23	Probability 2023/24	Proposal to 2023/24
VIP Ibérico (Spain - Portugal)	Daily Within - Day	4.646 %	4.646 %	4.646 %
VIP Ibérico (Portugal - Spain)	Daily Within - Day	4.646 %	4.646 %	4.646 %
Interconnection with LNG Terminal (Regasification)	Within - Day	15.261 %	20.554 %	15.261 %

Appendix A - Analysis of Regasification Interruptible Capacity in 2021/22

During the gas year 2021/22, 10.05 TWh of interruptible capacity on the high-pressure network/LNG Terminal interconnection (Regasification) was offered, which corresponds to around 14% of the total firm capacity available to the market. The next figure presents the monthly distribution of interruptible capacity with reference to the firm capacity available.

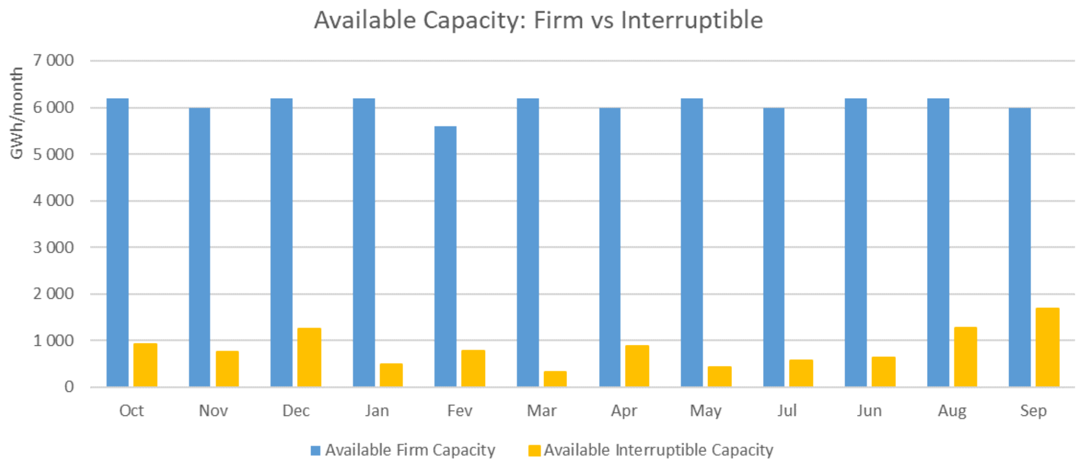

Figure A1: Monthly available capacities: firm and interruptible.

Analysing the above graph, it can be easily concluded that the difference between these two quantities is quite significant, corresponding the available interruptible capacity to around 88 GWh during the period between October 2021 to September 2022, which results in less than 1% of the available firm capacity. Regarding the contracting of the available interruptible capacity, the distribution was the following:

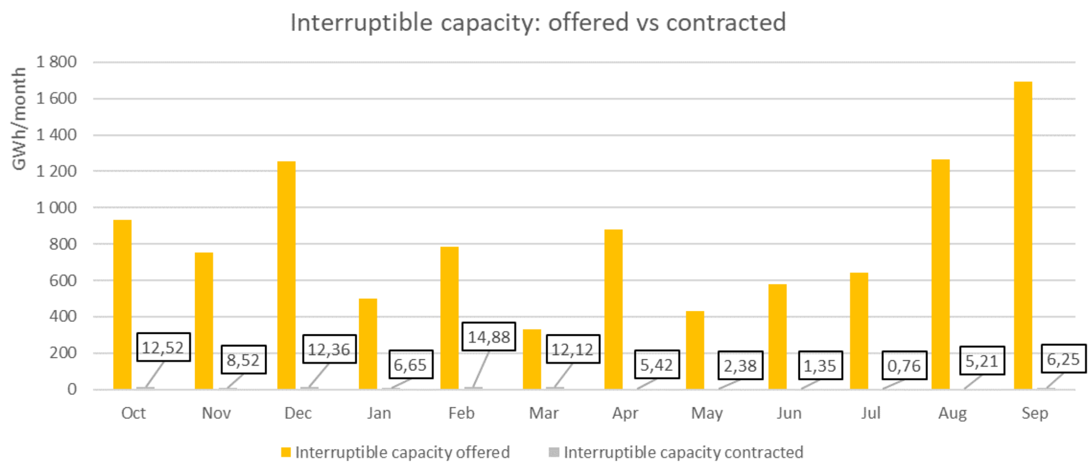

Figure A2: Monthly distribution of interruptible capacity: offered and contracted.

For the gas year under the scope of this analysis, a total of 88.4 GWh of interruptible capacity was contracted, from which 52.1 GWh were confirmed, resulting on an effective utilization of around 59%. From this numbers we can easily conclude that there was a reduction of this product comparing to the verified contracted values.

This reduction might occur in two different ways: either there is a reduction by renomination, when the market agent renominates to an inferior value or the market agent, which had contracted firm capacity, renominated to a superior value, resulting in interruptible capacity interruption. The overall values for the gas year of 2021/22 are presented in the next table:

Interruptible Capacity Contracted [kWh]	88 412 733
Confirmed Quantities [kWh]	52 150 528
Reduction by renomination [kWh]	34 924 348
Reduction by interruption [kWh]	1 337 857

The analysis of the data relative to interruptible regasification capacity for the gas year 2021/22, according to the model stated by the Article 16 of Tariff Network Code, results in the following graph:

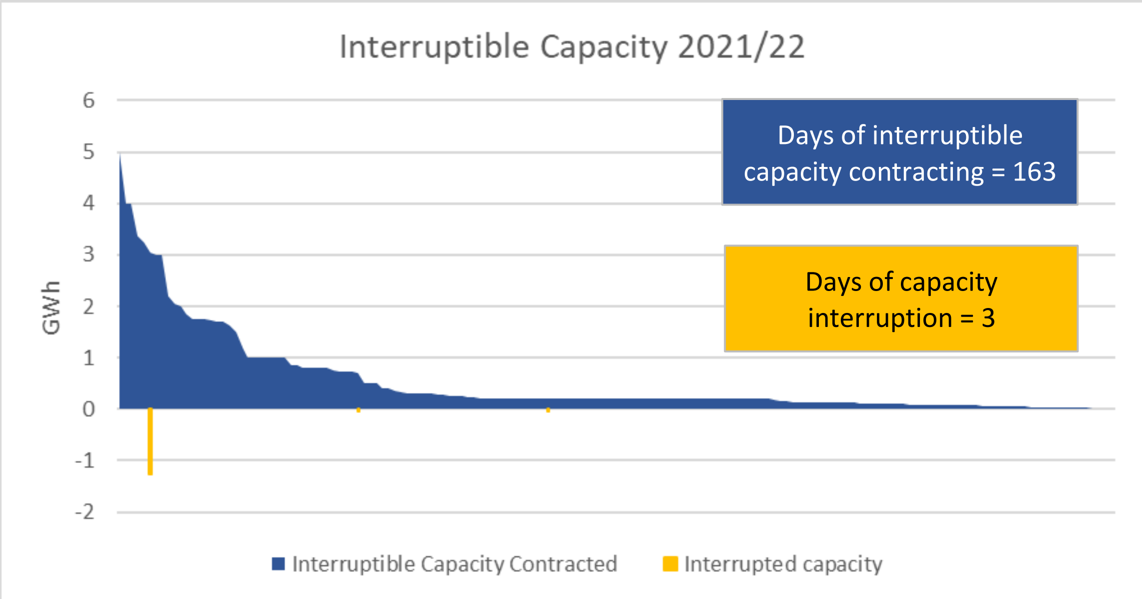

Figure A3: Analysis to the occurrence of interruptible capacity interruption.

Rate of interruption occurrence:

Days of interruptible capacity contracting	163
Days of interruptible capacity interruption	3
Expected number of interruptions N	3/163 = 0.0184

Affected capacities:

Average contracted capacity [GWh/d]	0.542
Average interrupted capacity [GWh/d]	0.446
CAP av. Int / CAP	0.446/0.542 = 82.3%

Assuming the period under analysis corresponds to the gas day, which comprehends 24h:

Interruption duration:

Dint [h]	24
D [h]	24
D Int / D	24/24 = 1

Thus, applying formula (2),

$$\mathrm{Pro} = \frac{\mathrm{N} \times \mathrm{D}_{\mathrm{int}}}{\mathrm{D}} \times \frac{\mathrm{CAP}_{\mathrm{av.\,int}}}{\mathrm{CAP}} \qquad (2)$$

the calculated probability of interruption is:

$$Pro = \frac{0.0184 * 24}{24} \times \frac{0.446}{0.542} = 0.0184 * 82.3\% = 1.5\%.$$