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Working Paper

European traded gas hubs: TTF now a global gas benchmark

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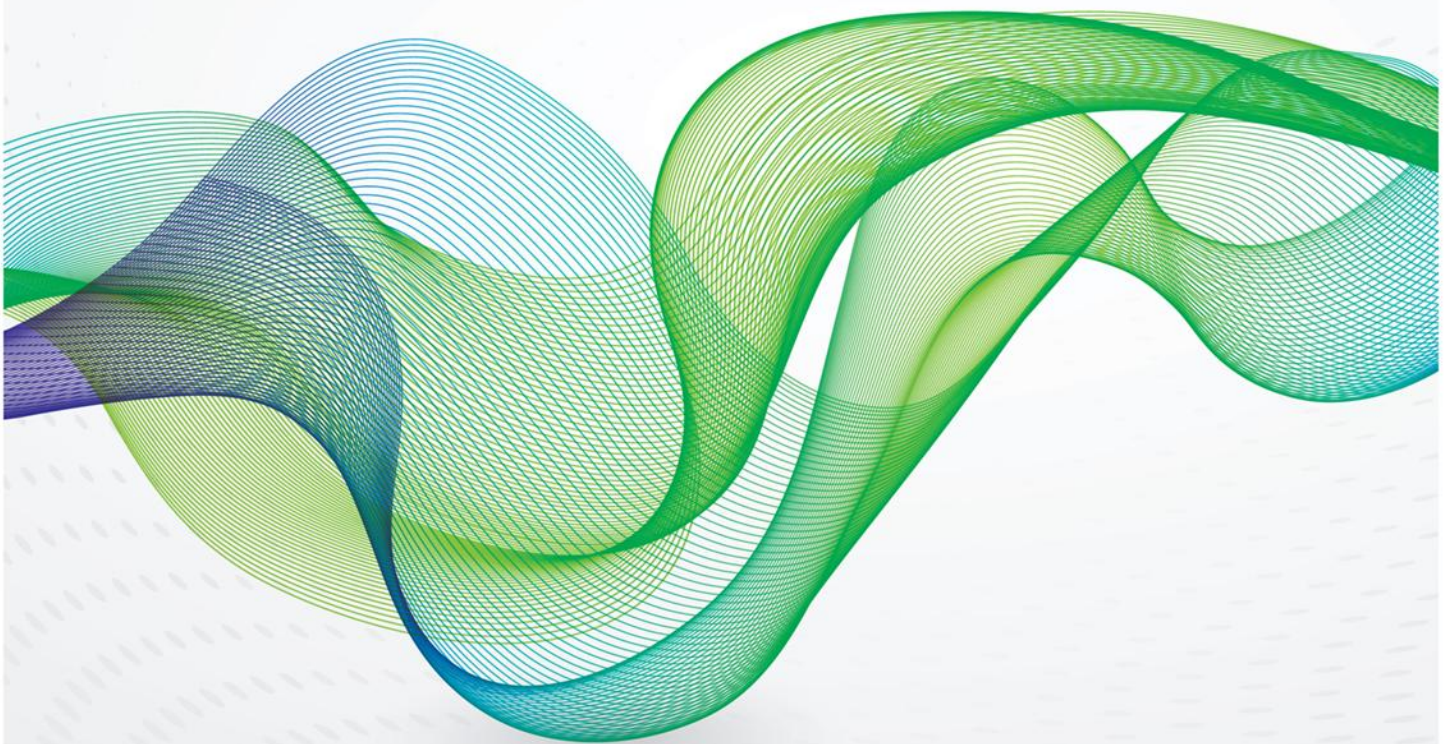
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June 2025

European traded gas hubs: TTF now a global gas benchmark





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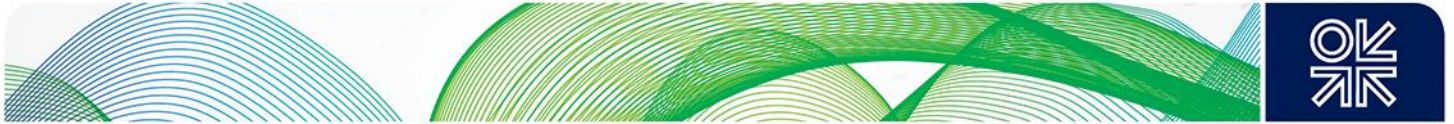


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Executive Summary

Last year, the author published a paper which showed that the trading at TTF and at most of Europe's hubs, had indeed 'rebalanced' after the very turbulent period from 2020 to 2022. It also concluded that TTF is a benchmark for the countries bordering the Netherlands, but also increasingly for all of Europe. It has even started to be referenced globally.

The main purpose of this paper has been first to analyse the results of the 2024 trading data for the European gas hubs, to give a fuller picture of the recovery and where the various hubs now stand and second, to establish whether the Dutch TTF can now credibly be designated a global gas benchmark.

The two primary traded gas hubs in Europe are the British NBP, the first to be established and now a mature regional hub for the British Isles, and the Dutch TTF which dwarfs all the other European hubs and is the only 'mature' global benchmark hub in Europe. There are other well-established hubs in northwest Europe and some very small 'nascent' balancing and spot trading hubs.

Despite the extreme trading conditions over the past few years and a decline in physical demand, European traded volumes increased year-on-year by 23 per cent in 2024.

Trading in most countries continued to trend away from OTC contracts towards exchange futures contracts. The exception in the 'main' hubs examined was the PSV which had a fall in exchange volumes and a rise in OTC trades.

The Dutch TTF hub had by far the largest traded volumes in all products across the whole curve and a year-on-year increase of 25 per cent in 2024. TTF volumes are now nearly five times greater than all of the other hubs reviewed put together and nearly ten times greater than the next most traded hub, the British NBP.

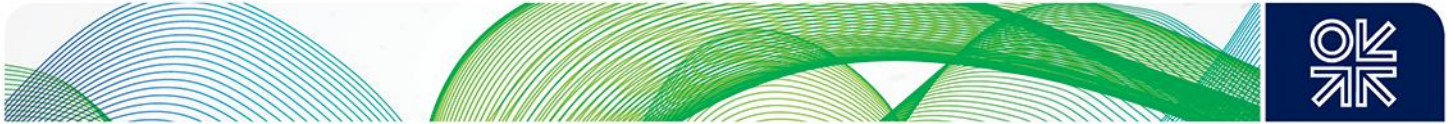
Only the Dutch TTF and the British NBP recorded exchange financial options trading and volumes were significantly higher than in 2023. In fact, 48 per cent more TTF options were traded than the total trades at all the Continental European hubs put together.

The most important metric is the traded gas hubs churn rate and the results for 2024 show that the Dutch TTF stands far ahead of all the others with a very impressive 20.3 times, well within the 'liquid' bracket.

The paper reviews the longer term trends at seven selected hubs since 2011, to determine whether or not the traded gas markets have stabilised after three very turbulent years in the energy markets. The Dutch TTF had a slowly rising trend from 2011 to 2014, rising more strongly from 2014 to 2020, levelling out until 2022, with a 'meteoric' almost linear growth from 2023. Other hubs followed mixed but similar growth patterns although the Belgian ZTP has experienced a long and steady decline over the whole period.

For most of the 2010s, the markets were well-correlated with increasing price convergence, with the possible exception of the Italian PSV. During the very turbulent trading of 2022, both correlation and convergence widened significantly at some of the hubs and included some large anomalies. In particular the NBP and Belgian hubs and the French TRF diverged to quite a large extent from the other five hubs for most of the period April to September 2022. Markets started to rebalance from as early as Q4 2022 and since about May 2023, the selected hubs became well correlated with price convergence now broadly similar to the period prior to April 2022, around the benchmark Dutch TTF hub.

Dutch TTF total traded volumes have grown to such an extent that they represent 82.9 per cent of total European traded gas volumes. The TTF churn rate calculated against the much greater physical consumption figure of the countries including and surrounding the Netherlands, whose shippers are known to be using TTF for their risk management, has risen considerably for the second year running' to 45.9 times, easily becoming for the first time a 'very liquid' benchmark hub. There is no doubt that this is a very mature and very liquid gas pricing benchmark.



When calculating the TTF churn against all of Europe's gas consumption, the result is a very impressive 20.3 times, well within the 'liquid' bracket. TTF is increasingly being used to price spot LNG cargoes, and is used in assessing the Platts LNG DES Northwest Europe Marker, when there are no actual reported trades, bids and offers. The assessment will then be based on a spread to the TTF futures price.

An ever increasing number of market participants from Europe to the Americas and to a lesser degree Asia, are trading TTF futures contracts. These participants comprise all sectors of the gas industry and gas market and beyond and include participants from investment banking, insurance, institutional investors and pure speculators.

The ICE exchange published an Insight in March 2025, stating that *"TTF's rise has been facilitated by broader participation from financial market players - hedgers, arbitragers, and speculators. This is a positive reflection of the evolution of the TTF secondary market, and a development which brings greater liquidity, helping to reduce bid offer spreads and trading costs for all market participants"*.

In conclusion it is clear that the benchmark Dutch TTF is far and away the leading European traded gas hub, used by many more market participants than any other hub; has a very high traded products score, with far greater total traded volumes than all the other hubs put together; has the highest Tradability Index score and finally, by far the greatest churn rate. TTF total traded volumes represent 82.9 per cent of total European traded gas volumes, and its churn rate calculated against the much greater physical consumption figure of the countries including and bordering the Netherlands, has risen considerably for the second year running and is now 45.9 times, easily becoming for the first time a 'very liquid' benchmark hub. The TTF churn against all Europe's gas consumption is a very impressive 20.3 times. TTF is being used to price spot LNG cargoes and has become an investment asset class in its own right.

Outside Europe, Henry Hub is the pricing benchmark for North America and is used to price physical gas contracts in the US and Mexico and some Canadian contracts. It is also used to price LNG cargoes destined for South America, Asia and Europe, as well as some spot LNG cargoes. It is extensively used for risk management of physical gas portfolios and is an investment asset class in its own right. Asia has started to liberalise its gas markets but has a long way to go. Increased short term and spot LNG trades in Asia, and the use of the JKM are helping the transition. The JKM, when compared to its main sphere of influence, had a churn of 0.99 times in 2024 (up from 0.69 in 2023). This is an illiquid market but is showing some signs of growth.

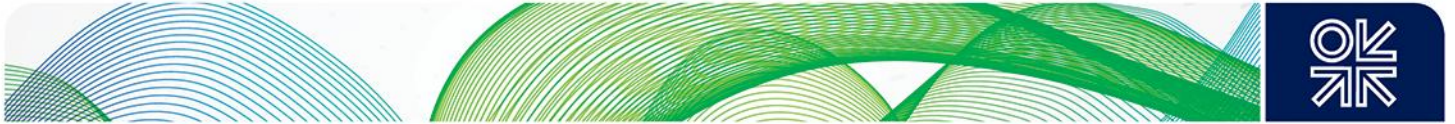


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1. Introduction

The author has been following the development of the European traded gas hubs over many years and has already published a number of papers and insights on the subject.¹ He is now also following the development of traded gas markets in Asia and the relative importance of global gas pricing benchmarks.

His paper published last year reviewed the turbulent period from 2020 to 2022, which saw the lowest ever northwest European gas prices at the end of May 2020, followed by successive strong rallies to the highest ever northwest European gas prices at the end of August 2022. It also analysed the trading results for 2023 and concluded that European gas markets had by and large rebalanced.

In particular, it showed that Europe's leading hub, the Dutch TTF, had not only rebalanced but indeed, had gone from strength to strength, being not only a reference hub for the Netherlands and the surrounding countries, but also further afield, across Europe and in the pricing of spot LNG cargoes.

This paper will review the trading data for 2024 to assess whether the markets have continued in a stable manner, and will focus on the Dutch TTF hub's increasing use as a benchmark across all of Europe and globally. TTF traded volumes alone continued to grow very strongly throughout 2024, which leads the author to believe that there must be an underlying reason for its strong performance, well beyond all the other hubs.

The purpose of this paper therefore is to analyse the results of the trading data in 2024 for the European traded gas hubs, to determine not only their trading activity and their relative ability to be used by shippers to risk manage their portfolios, but also to review whether the TTF has now definitely assumed the role of a global benchmark.

2. An overview of the European traded gas hubs

Map 1 shows all European gas hubs² operational at the end of 2024. The colour scheme indicates which hubs are categorised³ as 'Mature', 'Active', 'Poor' and 'Inactive'. There are two Mature hubs, the Dutch TTF and the British NBP, which has regained its 'mature' status, three 'active' hubs, the German THE, the French TRF and the Italian PSV; and three Poor hubs, the Austrian VTP, the Spanish PVB, and the Belgian ZTP. All remaining hubs are classed as Inactive.

Finally, there are also five 'nascent' hubs in Slovenia, Croatia, Serbia, Moldova and Ukraine. As with some of the emerging 'Inactive' hubs, the author does not include these hubs in the analysis as there are insufficient data available.

In Croatia, there is virtually no OTC trading and no exchange trading, although balancing trades are performed on a digital platform operated by the Transmission System Operator (TSO). In Slovenia, a virtual trading point was established in late 2015 to primarily enable balancing operations to conform with the EU directives;⁴ these are carried out on a web application. However, the author was unable to find any sources referring to actual trading at either hub, whether OTC or Exchange, balancing, spot, or curve trading.

Moldova, Serbia and Ukraine are cited in the EFET 2024 Review of Gas Hubs Assessments and the reports' associated press release where they are described as having been added, but their scores indicate still only basic hub design,⁵ reflecting part-implementation of EU rules, rather than genuine reform that will lead to wholesale trading.

¹ All of which are listed in the Bibliography and are available to download from the OIES website: <https://www.oxfordenergy.org/authors/patrick-heather/>

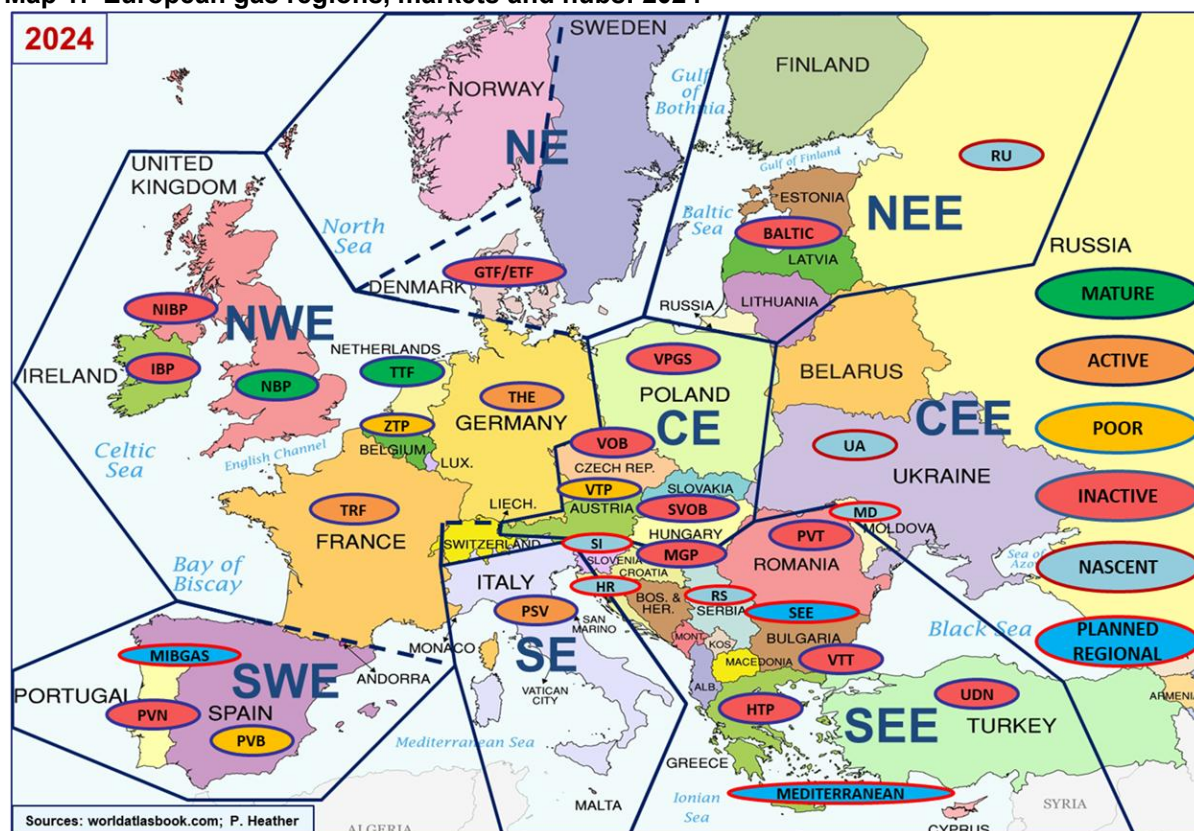
² Appendix 1 lists all of the European gas hubs, their names and year of inception.

³ As defined by the Author, following his 5 Key Elements analysis; see Chapter 3.1 of this Paper.

⁴ According to the European Federation for Energy Traders (EFET), "Slovenia has nudged ahead of Croatia in terms of market design, though Croatia is more widely traded" (EFET 2023 Press Release: <https://www.efet.org/files/documents/231106%20GC%20PR%20Hub%20Scores%202023.pdf>)

⁵ They have the two lowest scores of all the hubs at 5/20 for Moldova, and 3/20 for Serbia.

Map 1: European gas regions, markets and hubs: 2024



Ukraine has continued the process of liberalising its energy markets and does have some limited OTC gas trading, as well as some exchange trading on the UExx.⁶ This is remarkable given the substantial challenges the country currently faces but it must be said that there is wide support for creating a competitive gas market, including from the European Bank for Reconstruction and Development, USAid, the European Energy Committee and the Ukrainian Ministry of Energy.

The Greek gas hub showed strong growth in 2023, albeit from a very low first year start,⁷ to record a total of 9.03TWh traded on the HEnEx trading platform; however, the traded volumes almost halved in 2024, to just 5.06TWh and there were still no OTC trades reported.

Overall, there was a continued resurgence in gas trading across the European hubs,⁸ with increased traded volumes,⁹ despite a slight fall overall in the underlying physical volumes.¹⁰ Eight countries had higher total traded volumes compared to 2023,¹¹ and the remaining nine countries lower.¹² The increase in total trades against the fall in total physical volumes resulted in the gross churn for all of Europe rising to above 17 times, a 30 per cent increase on the previous year.¹³ However this is mainly due to the large increase in trading in the Netherlands and that country's associated increase in churn rate.¹⁴

⁶ Ukrainian Energy Exchange: <https://www.ueex.com.ua/enq/>

⁷ The Hellenic Energy Exchange gas platform finally went live in March 2022 and recorded 2.87TWh of spot trades.

⁸ The Author analysed the data for the hubs in 17 countries: Austria, Belgium, Britain, Bulgaria, Czech Republic, Denmark, France, Germany, Hungary, Italy, Netherlands, Poland, Portugal, Romania, Slovakia, and Spain.

⁹ 97,892TWh in 2024, compared to 79,727TWh in 2023, an increase of 23%.

¹⁰ 5,708TWh in 2024, compared to 6,032TWh in 2023, a decrease of 5% in the gross physical volumes.

¹¹ From highest to lowest increase: Portugal, Hungary, Slovakia, Romania, Italy, Britain, Netherlands, Austria.

¹² From least to most fall: Poland, France, Bulgaria, Germany, Denmark, Spain, Czech Republic, Greece.

¹³ The European gross churn in 2024 was 17.15, compared to 13.22 in 2023.

¹⁴ The gross market churn at TTF has more than doubled in two years from 63 times in 2022, to 137.5 times in 2024.



At a European level,¹⁵ total traded volumes increased in 2024 by 23 per cent over the previous year, with a rise of 13 per cent in OTC trading, and a rise of 27 per cent in exchange futures and options trading, mainly thanks to the 28 per cent increase at the Dutch TTF. There was however a fall of 10 per cent in exchange spot volumes across all Europe.

However there were some very wide variations from country to country. Apart from countries¹⁶ that did not report OTC trades,¹⁷ the rise in OTC trading varied from +10 per cent in the Netherlands and Germany, to +41 per cent in Slovakia. However in four countries OTC trades fell, from -18 per cent in the Czech Republic, to -100 per cent in Hungary (zero trades recorded in 2024, after a fall of 80 per cent in 2023).

All but three countries¹⁸ saw a decline in their exchange futures trading, from just -3 per cent in Romania, to -47 per cent in Germany; Austria had no statistically meaningful change;¹⁹ and nine countries²⁰ saw an increase in their gross churn rates, although in six of those the churn multiple is under 1. The Netherlands recorded the greatest absolute rise (+37.82), resulting in a gross churn of over 137 times.

More detail will be given in Chapter 3.2 but the Dutch TTF is once again forging even further ahead of all the other European hubs, in every criterion reviewed in the 5 Key Elements.

3. Review of the 5 Key Elements in 2023

Before we review the 5 Key Elements pertaining to European gas trading, it is useful to place European gas in the context of its global equivalents and the crude oil market. As described in the 2024 paper, this is currently more important following the exceptional turbulent period in energy trading following the crises of 2021 and 2022. The analysis last year showed that the markets seemed to have rebalanced but to what extent does that narrative remain intact in 2024?

Figure 1 shows the relevant global gas and Brent oil prices over a fifteen year period from January 2010 to December 2024, from which the extraordinary period of high and volatile energy prices of 2021 and 2022 can clearly be seen.

It also clearly shows how all of these energy prices collapsed from Q4 2022²¹ to reach an initial low in the summer²² of 2023, before slowly consolidating. During 2024, there was a gradual easing of Brent prices, slightly more of a fall in the average Japan LNG price, and a noticeable decline in TTF, NBP and JKM prices to the lowest point²³ since early 2021. The North American Henry Hub benchmark remained at, or just above, historically low levels throughout 2023 and 2024, although it and the three other benchmark hubs did tick up in Q4-2024.

¹⁵ The detailed breakdown of all the figures can be seen in the Churn Matrices tables in the Appendices.

¹⁶ Poland, Denmark, Bulgaria, Greece, and Portugal.

¹⁷ The author has now obtained OTC traded volumes for Romania, as reported by the BRM exchange as 'cleared' futures.

¹⁸ Britain (+41%), The Netherlands (+28%), and Italy (+8%).

¹⁹ From 171.43TWh in 2023, to 171.55TWh in 2024.

²⁰ Portugal, Britain, Netherlands, Italy, Romania, Hungary, Austria, Slovakia, and Poland.

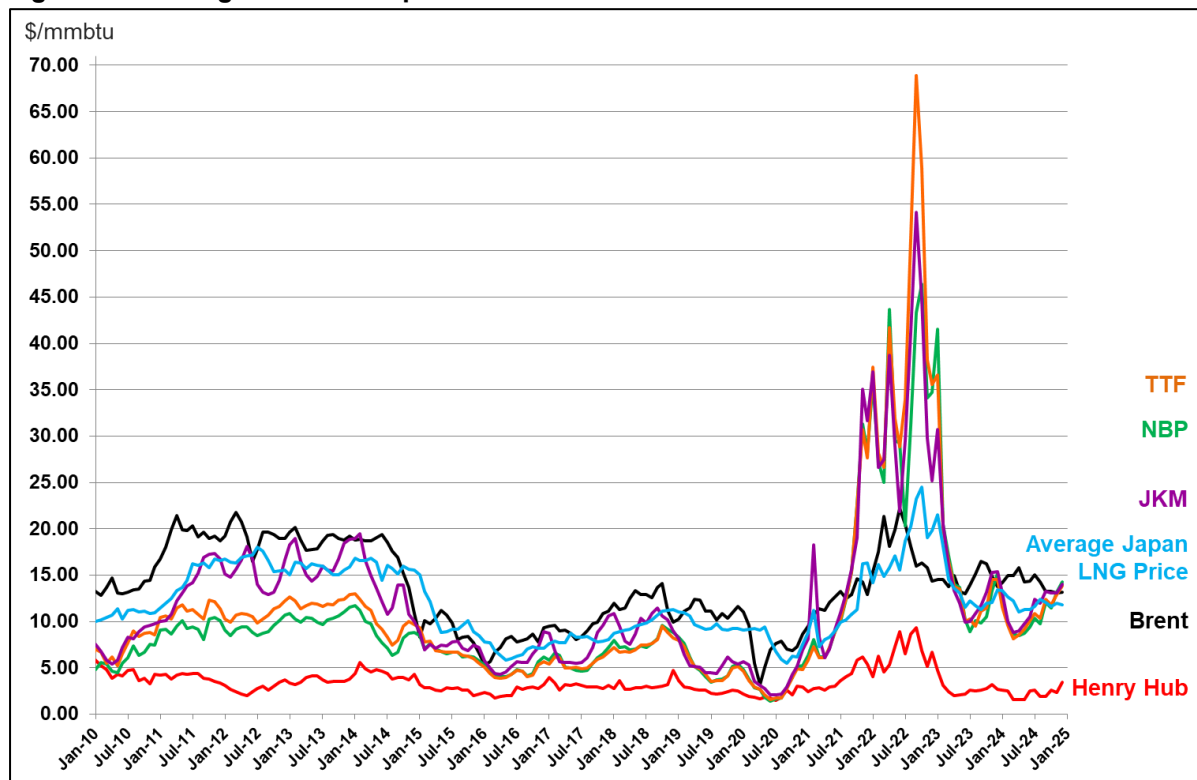
²¹ Brent prices started to fall from June 2022.

²² Henry Hub as early as April, Brent, JKM and Japan Average in June, NBP in July, and TTF in August.

²³ In March 2024.



Figure 1: Global gas and Brent prices: Jan 2010 – Dec 2024



Sources: S+P Global Platts, EIA, Argus, CME; M. Fulwood, P. Heather

Table 1 shows the price changes in the five reference energy contracts, between the average 2024 prices compared to the July 2021 prices, as well as the average 2024 price compared to the long term 15-year average.

It is clear that after the 2021 price surge and 2022 Russia/Ukraine war, all markets have rebalanced from early 2023 onwards and that they are, on average, mainly below the 15-year average.

Table 1: Global gas and Brent price changes (per cent)

\$/MMBtu	Brent	HH	NBP	TTF	JKM	Japan Ave
Ave 2024	14.21	2.27	10.72	10.76	11.58	11.96
Aug-21	12.45	4.04	12.37	12.48	12.97	10.20
Difference	14.1%	-43.9%	-13.3%	-13.8%	-10.7%	17.2%
\$/MMBtu	Brent	HH	NBP	TTF	JKM	Japan Ave
Ave 2024	14.21	2.27	10.72	10.76	11.58	11.96
15yr Ave	13.62	3.39	10.01	10.90	12.14	12.05
Difference	4.3%	-33.0%	7.0%	-1.3%	-4.6%	-0.8%

Sources: Taken from the data behind the global gas and Brent price figures

The author believes this confirms last year's findings that the traded gas markets had indeed rebalanced at a slightly higher level in December 2024 than the long term average, except for Henry Hub which continues to stay at historically low levels after correcting from the price spike.

The extreme gas market volatility and the exceptional and unprecedented high gas prices in 2021 and 2022, as well as significantly increased volumes in some of the emerging hubs led the author to rethink the methodologies used in his analysis of the 5 Key Elements.



3.1 A note on methodology

The author revised in 2022 the methodologies used in his analysis of the 5 Key Elements. The new methodologies are more precise and should help the reader better understand the variations in maturity and development across the now many traded gas hubs in Europe, including the emerging hubs.²⁴ These have continued to be applied in the 2024 analysis presented in this paper.

3.2 Results of the 5 Key Elements in 2024

Trading activity continued to increase in 2024, and attracted more participants, but only in some markets. Table 2 shows the number of 'active'²⁵ participants at each of the selected hubs; the more active participants there are, the more liquidity there will be in a market. The methodology recognises the importance of curve trading over spot, as it is this that is most often used to risk manage a participant's portfolio and to hedge physical contracts.

Table 2:²⁶ Key Element 1: Market participants: 2023

2024	OTC Active Traders*				
HUB	Hub Score^		S/P/M**	Q/S/Y***	Hub Score^
	2022	2023	2024	2024	2024
TTF	275	200	97	70	237
NBP	127	135	50	39	128
THE	187	90	57	22	101
TRF	116	75	45	21	87
PSV	96	68	32	17	66
ZTP	76	55	19	17	53
VTP	125	58	23	14	51
PVB	52	46	19	9	37
VOB	50	44	10	5	20
ZEE	13	13			

* The estimated number of traders who regularly trade.
 ** Spot / Prompt / Months contracts; *** Quarters / Seasons / Years contracts.
 ^ Hub score calculated as (1xS/P/M) + (2xQ/S/Y).

Sources: 2022: based on survey results from 3 market participants, with 1 broker input;
 2023: based on survey results from 5 market participants, with 1 broker input;
 2024: based on survey results from 4 market participants.

It must be stressed that the results are both somewhat subjective primarily regarding the OTC market, although two of the respondents gave an indication of participation in the exchange market as well. This is important as in most markets it is the anonymous exchange futures trading that is primarily used for hedging and risk management, whereas the OTC trading is most often used for the trading of (large) bilateral physical deals, or for balancing. Therefore these results need to be read in conjunction with the other metrics, but especially the actual traded volumes.

²⁴ For a detailed explanation, see Heather (2024), Chapter 3.1, p.5.

²⁵ The criterion used in the survey is how many traders trade at least once per week; the spot/prompt includes the Month Ahead contract.

²⁶ The methodologies used in this table are: (S/P/M): Green: ≥ 60 ; Amber: < 60 ; Red: < 25 ; Brown: < 10 ; (Q/S/Y): Green: ≥ 20 ; Amber: < 20 ; Red: < 10 ; Brown: < 5 ; (Hub): 1xSPM/2xQSY: Green: ≥ 100 ; Amber: < 100 ; Red: < 45 ; Brown: < 10 .



The results do indicate however that all the hubs remain in the same rankings as previously except for the Austrian VTP which has now fallen just behind ZTP.

Once again, the Dutch TTF is way ahead of all the other hubs with a calculated 'score' of 237, ahead of the British NBP with a score of 128. The German THE has increased its participation score to 101; and has the second greatest number of spot traders, which reflects that market's longstanding day-ahead balancing practice. As last year, only four hubs have 20 or more 'active' curve traders. TTF is by far the leading gas hub in Europe and attracts not only physical traders but also financial, institutional and speculative traders.

The next best hub is the French TRF with a score of 87 and an estimated 21 curve traders. France is once again ahead of Italy, which reflects the increase in the traded volumes at TRF, mainly due to the continued large volumes of LNG²⁷ imports.

Table 3:²⁸ Key Element 2: Traded products: 2024

Table of Key Elements - Traded Products - 2024																								
2024		HUB SCORE/56	OTC	SCORE / 28	CLEARING	WD DA	BOW W/E WDNW BOM	MA MONTHS	QUARTERS	SEASONS	YEARS (CAL + GAS)	EXCHANGE (% SHARE)	SCORE / 28	BALANCING TRADES	SPOT PROMPT	FUTURES MONTHS	FUTURES QUARTERS	FUTURES SEASONS	FUTURES YEARS	OPTIONS MONTHS				
Product evaluation based on absolute volumes*																								
TTF	49	Y	24	Y	Y	Y	Y	Y	Y	Y	ICE EEX CME	93 >6 <1	25	Y	Y	Y	Y	Y	Y	Y				
NBP	37	Y	19	Y	Y	Y	Y	Y	Y	Y	ICE EEX CME	>99 <1 0	18	Y	Y	Y	Y	Y	Y	Y				
THE	35	Y	20	Y	Y	Y	Y	Y	Y	Y	EEX ICE	>98 <2	15	N	Y	Y	Y	Y	Y	Y				
TRF	28	Y	15	Y	Y	Y	Y	Y	Y	Y	EEX ICE	>99 <1	13	N	Y	Y	Y	Y	Y	N				
PSV	27	Y	16	Y	Y	Y	Y	Y	Y	Y	GME ICE EEX	53 31 16	11	Y	Y	Y	Y	Y	Y	Y				
VTP	20	Y	10	Y	Y	Y	Y	Y	Y	Y	EEX ICE	>99 <1	10	N	Y	Y	Y	Y	Y	N				
PVB	15	Y	7	Y	Y	Y	Y	Y	Y	Y	MIB EEX	66 34	8	N	Y	Y	Y	Y	Y	N				
ZTP	14	Y	7	Y	Y	Y	Y	Y	Y	Y	EEX	100	7	Y	Y	Y	Y	Y	Y	N				
VOB	12	Y	7	Y	Y	Y	Y	Y	Y	Y	EEX	91 9	5	N	Y	Y	Y	Y	Y	N				
*KEY:		GREEN: =>600TWh			AMBER: <600TWh			BLUE: <250TWh			RED: <50TWh			GREEN: =>500TWh			AMBER: <500TWh			BLUE: <100TWh			RED: <30TWh	
GREY:		Hubs column based on OTC + Exchange 'score'/56; OTC column based on 'score'/28; Exchange column based on 'score'/28																						
No volumes		ICE=ICE or ICE/Endex			EEX=EEX			CME=CME Europe			MIB=MIBGAS			Y=AVAILABLE			N=NOT AVAILABLE							

Sources: OTC: LEBA, ICIS; Exchange: ICE, ICE-Endex, EEX, CME, GME; MIBGAS; P. Heather

A good measure of a hub's maturity is the types of products available to trade and their traded volumes, which are a good indication of whether a market is used for balancing or risk management. Table 3 shows all the traded products for each of the hubs, both OTC trading on the left and exchange trading on the right.

At a glance, it can be observed that in 2024, TTF is yet again top with a score of 49/56, the same as it has had for the last four years. Most of the individual product categories are shown as 'green', meaning that the OTC volume of that product is greater than 600TWh, and greater than 500TWh for the exchange volumes.

²⁷ See Heather (2024), Chapter 4 for a detailed explanation.

²⁸ The methodologies used in this table are: (Products): as per Key in table; (Hub score/56): Green ≥/42; Amber <42; Red <16; Brown <8.



All of the remaining hubs stay in the same colour band as they have been in since 2020; two hubs (TRF, PSV) have a slightly higher score in 2024 compared to the previous year, two hubs have a lower score (NBP, VTP), and four hubs remain the same (THE, PVB, ZTP, VOB).

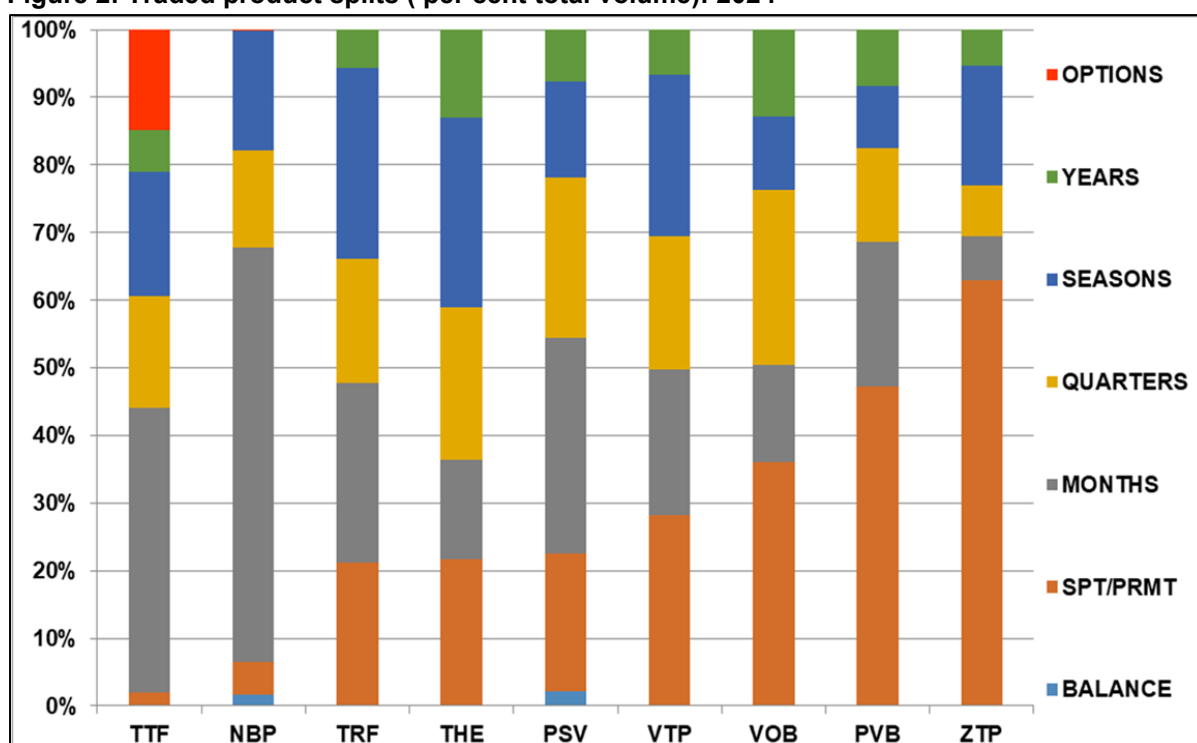
This year the top five hubs (TTF, NBP, THE, TRF, PSV) have a score higher than the mean, as they did in 2023, with the VTP just below that number. The Spanish, Belgian and Czech hubs are much lower.

There are some interesting product splits across the hubs, as shown in Figure 2, but it must be remembered that this figure shows the percentage split at each hub, not the actual volumes which need to be considered alongside the splits to be more meaningful.

Three of the hubs saw an increase in the proportion of spot/prompt trades compared to 2023: the Czech VOB from 33 per cent to 36 per cent; the Spanish PVB from 39 per cent to 47 per cent; and the Belgian ZTP from 60 per cent to 63 per cent. The Belgian hub is really focused on very short-term trading.

When comparing the Months trades, four hubs saw a decline in the percentage share, four saw an increase, and one stayed about the same. Of particular note is the NBP, whose share of the Months rose by 8.9 per cent to 61 per cent of total trades, by far the greatest of all the hubs, reflecting that particular contract's use in hedging both LTCs and LNG imports.

Figure 2: Traded product splits (per cent total volume): 2024



Sources: OTC: LEBA, ICIS; Exchange: ICE, ICE-Endex, EEX, CME, CEGH, GME; MIBGAS; P. Heather

Although the Dutch TTF saw a small decline in its proportion of Months trades, from 46 per cent in 2023 to 42 per cent in 2024, it should be remembered that it also recorded 14.9 per cent of Options trades, which are monthly contracts. TTF is still both the hub with the highest share of Months compared to the other Continental hubs, and the hub with the greatest outright actual traded volume of Months contracts.

Indeed, when looking at the actual volumes traded, the result could appear rather different. For example, whereas the French TRF and German THE recorded the highest percentages of Seasons²⁹, as shown in Figure 1, the absolute volumes traded in the Seasons at the TRF were just 448TWh (and

²⁹ 28.19% and 27.97% respectively, the highest percentages of all the hubs in this product.



down from 556TWh in 2023) and at the THE were 917TWh (down from 1024TWh in 2023). By contrast, the Dutch TTF recorded a much lower percentage³⁰ of Seasons trading, but the actual traded volume was 14,886TWh,³¹ some 16 times that of THE and 33 times that of TRF.

Similarly, when looking at the Quarters, the Czech VOB recorded the highest percentages, followed by the Italian PSV and German THE, with the TTF recording the 5th highest percentage, as also shown in Figure 1. The absolute traded volumes however paint a different picture: TTF traded a total of 13,472TWh, some 24 times that of PSV, 28 times that of THE and a massive 1225 times that of VOB.³²

In the Years, TTF traded 4,952TWh (an increase of 40 per cent over 2023), some 6.5 times more than all the other hubs put together, despite in percentage terms the German THE, the Czech VOB, the Spanish PVB, the Italian PSV and the Austrian VTP all recording higher splits than TTF.

Table 4:³³ Key Element 3: Traded volumes: 2024

2024		TOTAL TRADED VOLUMES* (TWh)						
HUB		2011	2021	2022	Δ% =>	2023	Δ% =>	2024
TTF		6295	53430	43135	+51	64980	+25	81110
NBP		18000	6640	6335	-2	6185	+34	8310
NCG	THE	880	3155	3305	+12	3710	-12	3280
GPL		310						
PSV		185	1155	940	+33	1275	+36	1735
TRF		PEG N 430	855	1415	+18	1675	-5	1590
VTP		CEGH 170	920	685	+0.5	690	+16	800
ZTP		n/a	235	560	-16	470	-19	380
PVB		n/a	170	260	+29	335	-15	285
VOB		n/a	95	90	+3	90	-11	80
ZEE		870	80	35	-86	5		

*rounded to nearest 5TWh; not the same data sources in all years.

Sources: 2008: converted from bcm in IEA 2009 Natural Gas Review, p.30;
 2011: LEBA, ICIS, ICE, ICE-Endex, EEX, Powernext, CEGH, GME; P. Heather
 2021-2023: LEBA, ICIS, ICE, ICE-Endex, EEX, CME, CEGH, GME; MIBGAS; P. Heather

Finally only two hubs in 2024,³⁴ the Dutch TTF and the British NBP recorded exchange financial options trading and the volumes were significantly higher than in 2023. The options contracts are listed on the ICE exchange and totalled 12,071TWh on TTF and 15.9TWh on NBP, representing 16.97 per cent, 0.26 per cent respectively of exchange trading.³⁵ In fact, there were 48 per cent more TTF options traded than the total trades at all the Continental European hubs put together.³⁶

³⁰ 18.35%, up from 16.18% in 2023.

³¹ A 41.58% increase on the 2023 Seasons trades of 10,514TWh.

³² 564TWh, 482TWh, and 11TWh respectively.

³³ The methodology used in this table is: (Volumes) Green: ≥ 5000 ; Amber: < 5000 ; Red: < 1000 ; Brown: < 100 TWh.

³⁴ Although the German THE traded options (just 0.029TWh) for the first time in 2023, none were recorded in 2024.

³⁵ Equivalent to 18.88% and 0.19% respectively of total exchange and OTC trading.

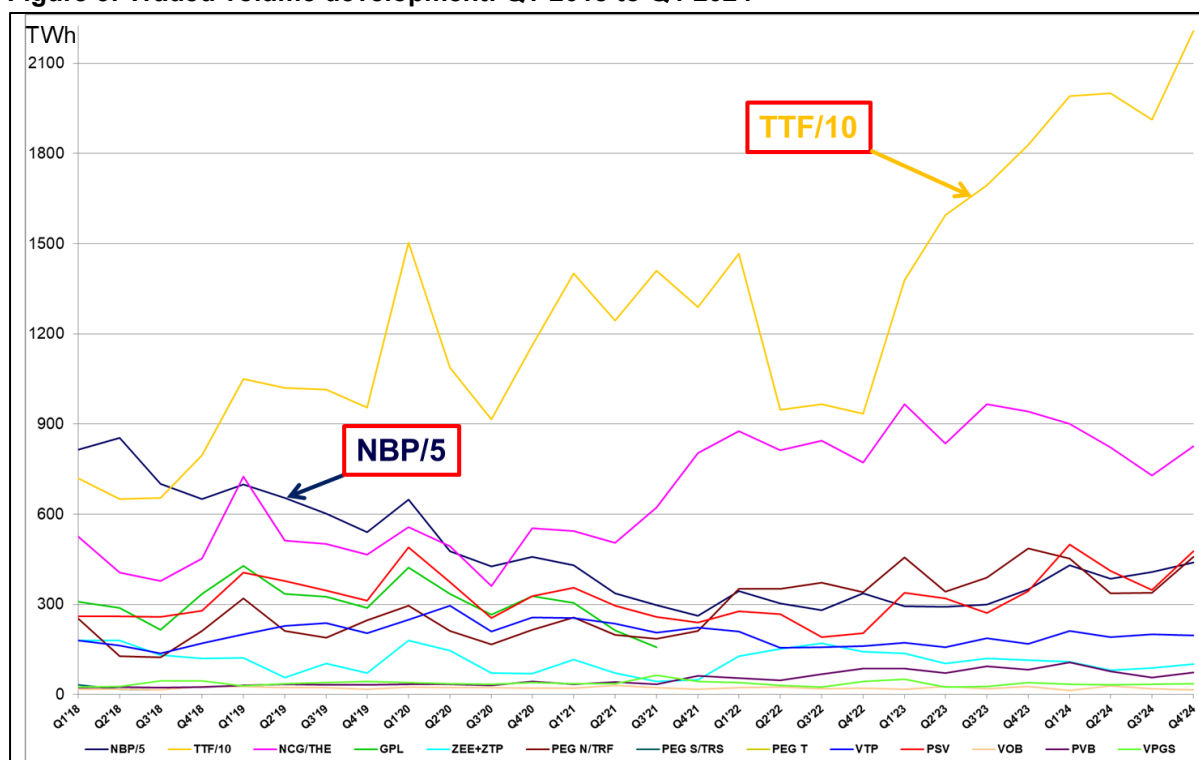
³⁶ 12,071TWh versus 8144TWh.



It is clear from the traded products table and the product splits that the Dutch TTF and the British NBP are both 'mature' hubs, ahead of all the other European hubs. They both have large volumes of Month Ahead trades, reflecting LTC (and spot LNG) hedging. However, it is the Dutch TTF that is *the* foremost risk management hub, with large volumes of curve products reflecting portfolio risk management, including a large volume of options traded.

High absolute traded volumes are usually indicative of a liquid market with a large number and varied range of participants. Depending on the size of the underlying physical market, this will likely also indicate a large churn rate. In Table 4, mature hubs are shown in green; the active hubs, with developing depth, liquidity and transparency in amber; the poor hubs, which cannot yet be considered as deep, transparent or liquid, in red; and the illiquid hubs in Brown.

Figure 3: Traded volume development: Q1-2018 to Q4-2024



Sources: OTC: LEBA, ICIS; Exchange: ICE, ICE-Exend, EEX, CME, GME, MIBGAS, TGE; P. Heather

Even from a summary glance at Table 4, it is evident that the Dutch TTF hub has by far the largest traded volumes, including as described above in all products across the whole curve. Despite having eased back in 2022, trading increased by 51 per cent in 2023, which was the largest increase of any hub that year and increased again by 25 per cent in 2024. This is in part due to increasing LNG imports into the Netherlands. The TTF volumes are now nearly five times greater than all of the other hubs listed here put together; they are nearly 10 times greater than the next most traded hub, the British NBP; just under 25 times greater than the German THE hub in Europe's largest gas consuming country; and nearly 47 times greater than the Italian PSV.

The Belgian ZTP hub had a phenomenal 138 per cent increase in its traded volumes in 2022 but, in 2023, the volumes eased back by 16 per cent, and a further 19 per cent in 2024, despite it now being the sole traded hub in Belgium. The German THE recorded an unexpected fall of 12 per cent, as did the Spanish PVB of 15 per cent.

Figure 3 clearly shows the wide variations between the European hubs with TTF firmly set at the top; the long gradual decline of NBP since 2016, although still the second largest hub in Europe and a total



traded volume greater than in each of the last three years;³⁷ the more or less steady performance of the German NCG through to 2021, with the GPL volumes adding to the increase in the merged THE volumes after October 2021; the slow rise in the Italian PSV through to 2020, since when it has struggled to maintain its position.

There was a slow but sure rise at the Austrian VTP, albeit from a much lower level, and topping out and easing back since 2020; a rather erratic performance of the French PEG Nord/TRF, before the increases seen in 2022 and 2023, although it too eased back a little in 2024, falling back below the Italian PSV.

Finally in this section on traded volumes, Table 5 shows the total traded volumes at the 'emerging' hubs although, as can be seen in the second column, some of these have actually been operational for quite some years. The author has previously commented³⁸ on the particular circumstances regarding the Polish VPGS and the Danish GTF/ETF hubs. At the VPGS in particular, although the total volumes there appear to be reasonably good, these are predominantly volumes traded between the incumbent supplier PGNiG and its distribution and retail subsidiaries; there were no OTC trades reported. Danish OTC (GTF) trades are primarily conducted by shippers adjusting or balancing their portfolios and none were recorded; at the exchange ETF there was no curve trading at all and again, the spot trading is primarily balancing operations, recording a 12 per cent fall year-on-year.

Table 5:³⁹ Traded volumes - emerging hubs: 2024

2024		EMERGING HUBS TRADED VOLUMES (TWh)					
HUB	Started	OTC			EXCHANGE		
		PRMT	CURVE	TOTAL	SPOT	CURVE	TOTAL
VPGS	2014	No activity reported			27.70	108.96	136.67
MGP	2010	No activity reported			49.49	0.03	49.52
GTF/ETF	2004/08	No activity reported			46.52	Nil	46.52
VTT	2020	No activity reported			15.66	26.28	41.94
PVT [*]	2020	0.55	4.89	5.44	19.16	5.77	24.94
SVOB	2016	n/a	n/a	14.21	no exchange trading		
Baltic-FI [*]	2012-20	No activity reported			7.29	0.09	7.37
HTP ^{**}	2018	No activity reported			5.06	n/a	5.06
PVN	2021	No activity reported			Only WD,DA,ID		0.63

^{*}total physical trades transacted on the Romanian Commodity Exchange (BRM) but not necessarily conducted at the PVT.
^{*}the Baltic-Finland market area, as defined by the GET Baltic exchange, being the sum of the LT/LV-EE/FI Market Areas.
^{**}HEEx's Gas Trading Platform finally went live 21st March 2022; prior to this, all trades were 'balancing trades' on the Desfa platform.

Sources: ICIS, EEX, TGE, CEEGEX, HUDEX, BGH, GET Baltic, BRM, MIBGAS, HEnEx; P. Heather

Four of the hubs in the table had increased volumes in 2024, including a strong 43 per cent rise at the Romanian PVT, which at 30.37TWh is almost equal to the volumes traded in 2022.⁴⁰ The newly-operational Portuguese PVN hub is still firmly at the bottom of the table but the very small volumes rose strongly again⁴¹ in its third year of trading. The Hungarian MGP saw the largest rise of 65 per cent, due mainly to a 57 per cent rise in spot trading.⁴² The Slovakian SVOB is the only emerging hub to only trade OTC and its volumes increased a further 41 per cent in 2024 (after a rise of 148 per cent 2023).

³⁷ The total NBP traded volumes at NBP in 2020 were still higher at 10,062TWh.

³⁸ In particular, see: Heather (2015), Chapter 5.5.2.3 "Poland", pp. 44-46; also Heather (2019), paras. 5-6, p.16; and Chapter on "Emerging Hubs", pp. 18-19.

³⁹ The methodology used in this table is: (Volumes) Green: ≥ 5000 ; Amber: < 5000 ; Red: < 1000 ; Brown: < 100 TWh.

⁴⁰ PVT traded volumes in 2022 were 30.79TWh.

⁴¹ PVN traded volumes in 2022 were just 0.06TWh, and 0,17TWh in 2023.

⁴² Exchange spot trading in 2023 was 29.66TWh.



Five of the emerging hubs' traded volumes were lower in 2024: the Polish VPGS, the Danish ETF,⁴³ the Bulgarian VTT and the Greek HTP. The Greek hub had shown strong growth in 2023,⁴⁴ but fell back again by 44 per cent in 2024 and despite the HEnEx exchange planning to introduce futures trading, this has still not happened and the only trades conducted are Within Day, Day Ahead, and D+1, D+2 and D+3.

The trend of the past few years, especially since 2021, persisted into 2024, regarding the move away from OTC trading towards more exchange trading.⁴⁵ Figure 4 shows the relative shares of both OTC and exchange volumes at all of the main hubs listed in Table 4 and shown in Table 5. The share of exchange trading now totally dominates and in 2024 attained a share of 84 per cent of total European trades. Some of the emerging hubs do not have any OTC trading at all,⁴⁶ nor has Poland for a few years now; Denmark used to trade OTC but had no trades in 2023 or 2024. The Hungarian MGP recorded a very small quantity of OTC trades in 2023⁴⁷ but none in 2024.

Figure 4: OTC / Exchange market shares: 2024

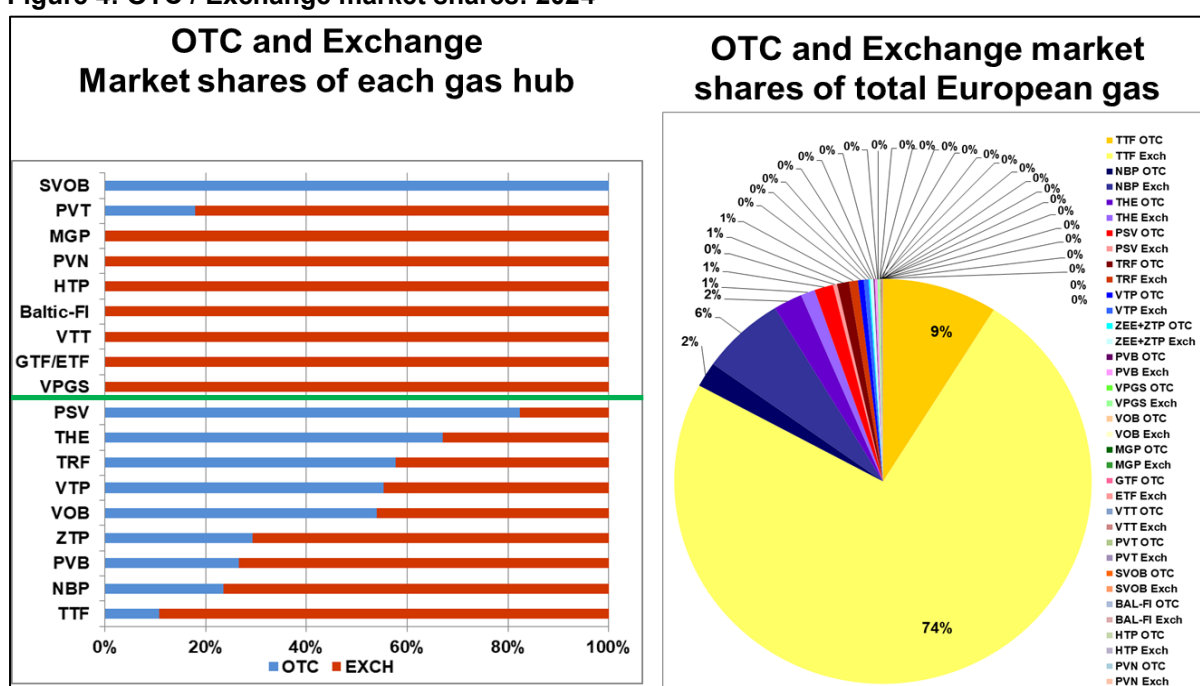




Table 6:⁵¹ Top 4 Hubs Total Traded, OTC, and Exchange volumes and shares: 2024

2024	TOP 5 HUBS TRADED VOLUMES AND OTC/EXCHANGE SHARES					
HUB	Total Volume TWh	Share %	OTC Volume TWh	Share %	EXCH Volume TWh	Share %
TTF	81,110	82.85	8,725	54.82	72,386	88.29
NBP	8,309	8.49	1,958	12.30	6,351	7.75
THE	3,279	3.35	2,198	13.81	1,081	1.32
PSV	1,734	1.77	1,428	8.97	306	0.37
TRF	1,588	1.62	916	5.75	673	0.82
Σ Europe	97,900	98.08	15,917	95.65	81,983	98.55

Sources: compiled by the Author from data behind other Tables and Figures; P. Heather

The top three hubs, TTF, NBP and THE together account for 95 per cent of total European gas trading, made up of a total 81 per cent of OTC trading and 97 per cent of exchange trading. When adding the PSV and TRF, the top five hubs account for 98.1 per cent of total European gas trading, made up of a total 95.7 per cent of OTC trading and 98.6 per cent of exchange trading. These data clearly show how much bigger the TTF is than its nearest rivals, with the fourth placed Italian PSV and fifth placed French TRF each only registering less than 2 per cent of total market share.

Moving on to Key Element 4, the author does not place much emphasis on the Tradability Index⁵² but has always included it in the analysis of the hubs because it is sometimes quoted in various reports. It is not very meaningful as it does not record the depth of a market, only the bid/offer spread and must therefore be read alongside the other metrics. Crucially, whatever the bid/offer spread, this metric alone cannot show whether each of the contracts traded or not, and in what volumes if any.

The results for 2024 are a good indication of that point. Despite several of the hubs increasing their TI score, that was not reflected in many of their traded volumes data. The German THE for example improved from a TI of 11/20 at the beginning of 2024 and ended the year with a TI of 17/20; however, the traded volumes at THE actually fell by 12 per cent. The other extreme is the Slovak SVOB where the TI seemed to erratically jump from a TI score of 1/20 to 5/20 in Q3 2024, but then collapsed to 0/20 in Q4 2024 and this despite the total annual volumes increasing by 41 per cent, with no apparent variation in the four quarterly totals.⁵³

Although this metric does not show the depth of a market, there is still no doubt from the results that the Dutch TTF is and has consistently been since 2012⁵⁴ far ahead of all the other hubs with a near 'perfect' score of 19/20, indicating that there are tight bid-offer spreads in all but one contract.⁵⁵

⁵¹ The methodology used in this table is: (Volumes Tw) Green: ≥ 5000 ; Amber: < 5000 ; Red: < 1000 ; Brown: < 100 TWh; (Shares %) Green: ≥ 25 ; Amber: < 25 ; Red: < 15 ; Brown: < 5 %.

⁵² This is calculated by ICIS for 13 European hubs plus the Turkish UDN. The methodology consists of assessing the "bid-offer spread typically available every day to all interested counterparties", on 10 different contracts and for two bid-offer points of ≤ 0.5 €/MWh and ≤ 0.3 €/MWh, and then attributing 1 point if available, giving a score out of a maximum 20 points.

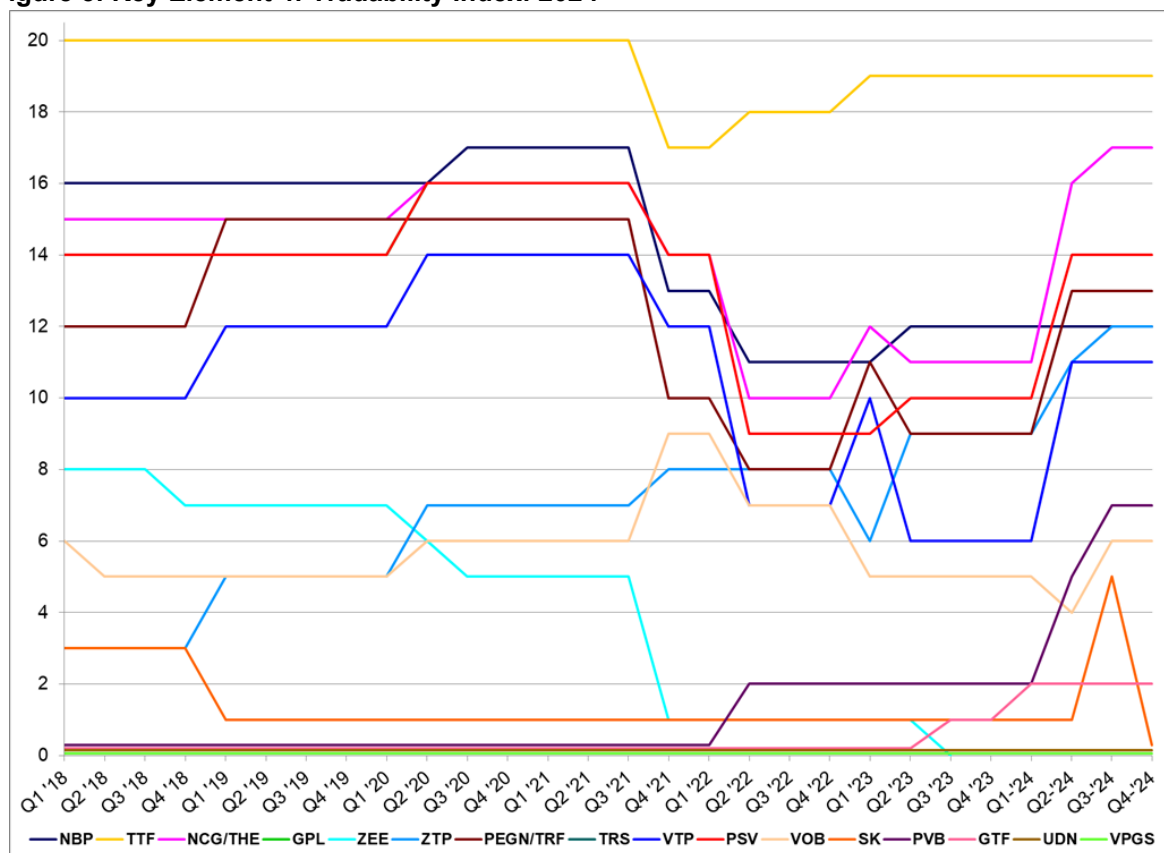
⁵³ SVOB total traded volumes for Q1: 2.941 TWh; Q2: 5.957 TWh; Q3: 2.621 TWh; and Q4: 2.696 TWh.

⁵⁴ From Q3-2015 to Q3-2021, it stood at 20/20; from Q3-2008 to Q4-2016, NBP TI was at 19/20.

⁵⁵ According to the ICIS European Gas Hub Report, Q4-2023, p.8, the only contract to not have a bid-offer spread of less than ≤ 0.3 €/MWh was the Balance of Month.



Figure 5: Key Element 4: Tradability Index: 2024



Sources: ICIS European Gas Hub Reports 2018-2024; P. Heather

Another important metric is Key Element 5, the traded gas hubs churn rate.⁵⁶ It is probably the most important factor in determining the success of a traded market. When looking at market liquidity, you simply cannot 'transfer' liquidity from a mature hub to a neighbouring hub that does not have the same characteristics, even if the 'headline' price of the spot marginal gas is closely correlated.

In this one metric all others are, necessarily, reflected. If there are many participants, trading many different products in large quantities, then the churn rate is likely to be high. The churn rate is used by traders as a 'snapshot' of a market's liquidity; some traders will not participate in markets with a churn of less than 10 and many financial players will only participate when the churn is above 12. In his analysis the author has determined that a hub is 'mature' when the churn rate is 10 times or more.

Since 2020 the author has calculated and shown both the net⁵⁷ market churn rates for the last three years and the gross⁵⁸ churn. Using a net churn methodology can be appropriate in the early stages of the development of a hub, as it is initially more focused on the Market Area (in most cases, national) balancing requirements. However, to judge the growing liquidity and maturity of a hub, as it trades further down the curve and attracts risk management volumes, the gross churn methodology is more accurate as it shows a given hub's ability to be a pricing benchmark beyond its own market area. This is because there are many reasons for the amount of trading done at a given hub: trading of actual physical gas or trading to hedge and manage risk, both for gas destined for consumption in that hub area; but also, trading in relation to quantities of gas destined for export to neighbouring market areas.

⁵⁶ For an explanation, see: Heather (July 2019), p 11.

⁵⁷ The net churn is the total traded volumes at a given hub, divided by its consumption, as defined and used by the EU.

⁵⁸ The gross churn is the total traded volumes at a given hub, divided by its physical demand or throughput.



Table 7 shows the net and gross churn rates for the 10 main hubs⁵⁹ studied in this paper. The results for 2024 show that there is only one ‘mature’ European benchmark hub, the Dutch TTF standing far ahead of all the others and one ‘mature’ regional Sterling marker price, the British NBP. The only other hub that got close to the author’s threshold of 5 times for ‘active’ hubs in 2024, is the Austrian VTP (and on a net churn basis its churn is 10.9 times). The German THE was marginally lower in 2024 and the French TRF hub remained at about the same level; both are firmly in the ‘poor’ category in both gross and net churn results. The Italian PSV improved to 2.6 on both the net and gross churn basis, the Czech VOB hovered at the 1 times mark; the remaining two hubs are under 1 times churn making them ‘illiquid’.

Table 7:⁶⁰ Key Element 5: Churn rates 2024

2024	TRADED GAS HUBS CHURN RATES					
	Net Churn* basis			Gross Churn** basis		
HUB	2022	2023	2024	2022	2023	2024
TTF	142.1	223.8	274.3	63.0	100.9	137.5
NBP	8.2	8.9	12.1	6.1	7.1	10.4
VTP	8.0	9.3	10.9	2.4	4.2	4.9
THE	3.9	4.6	4.0	2.4	3.6	3.5
TRF	3.4	4.7	4.7	2.4	3.2	3.2
PSV	1.3	2.0	2.6	1.2	1.9	2.6
VOB	1.1	1.3	1.1	0.3	1.1	1.0
ZEE+ZTP [^]	3.6	3.1	2.6	0.9	0.9	0.9
PVB	0.7	1.0	0.9	0.6	0.8	0.8

* Total traded volume / Consumption in hub area.
 ** Total traded volume / Demand in hub area (= Total Physical Throughput = Consumption + Exports).
[^] Physical volumes are for Belgium as a whole; 2023 and 2024 figures are for ZTP.

Sources: 2022-2024: LEBA, ICIS, ICE, ICE-Endex, PEGAS, EEX, CME, CEGH, GME; MIBGAS; P. Heather

The author has heard it said that it is not realistic to place such emphasis on the TTF churn, as the Netherlands has relatively low gas consumption. This is indeed true and, if using the EU definition of churn, using the physical consumption as the denominator, the churn is a staggering 274 times. The author agrees that this figure is meaningless. He further agrees that even using the physical demand as the denominator could be seen as unrealistic but, if you compare that demand figure to that of Germany, it is just under two thirds.⁶¹ That would imply that, if both countries’ traded gas markets were similarly ‘mature’, then the TTF gross churn would be about 1.58 times that of the German gross churn. In fact, the Dutch TTF gross churn is over 39 times greater than that of the German THE hub.

To try to achieve a more realistic indication of the TTF’s gross churn, and the real maturity, importance, and relevance of this hub as a benchmark, or reference price for physical contracts beyond its national borders, the author has since 2019 calculated the churn rates for the global benchmarks.⁶² In those

⁵⁹ With the two Belgian hubs together, using total physical data for Belgium as a whole, as it is very difficult to get accurate physical data for the ZEE area alone. The 2023 and 2024 figures are for ZTP alone.

⁶⁰ The methodology used in this table is: Green: ≥ 10 ; Amber: < 10 ; Red: < 5 ; Brown: < 1

⁶¹ Physical demand in the Netherlands in 2024 was 589.91TWh; for Germany it was 934.10TWh. Source: JODI Gas World.

⁶² See Chapter 7 for more detail.



calculations, the TTF's churn rate using the physical consumption data from the surrounding countries⁶³ comes out at an impressive, mature and indeed liquid, 45.9 times. There is no doubt in the author's mind that TTF is a reliable benchmark that can and does in practice, offer accurate price signals of the gas flowing in the (north-west) European gas grids, that is used by shippers from many European countries to price physical contracts and to hedge their portfolio exposures. He has also calculated the TTF's churn rate using the physical consumption data from all European countries, which will definitively show that TTF is the *de facto* benchmark hub for all of Europe.

4. A summary of traded gas hubs in 2024

Table 8:⁶⁴ Summary of the 5 Key Elements 2024

2024	5 KEY ELEMENTS					
HUB	Active Market Participants*	Traded Products**	Traded Volumes	Tradability Index (Q4)	Churn Rate***	Score /15****
TTF	237	49	81110	19	137.5	15
NBP	128	37	8310	12	10.4	12
THE	101	35	3280	17	3.5	10
TRF	87	28	1590	13	3.2	8
PSV	66	27	1735	14	2.6	8
VTP	53	20	800	11	4.9	7
ZTP	51	14	380	12	0.9	5
PVB	37	15	285	7	0.8	4
VOB	20	12	80	6	1.1	4

* Hub Score in the OTC Active Traders table.
 ** Score /56 derived from the OTC and Exchange product categories in the Traded Products Table.
 *** Gross churn basis.
 **** Score based on each of the Key Elements scoring zero for Brown; 1 point for Red; 2 points for Amber; 3 points for Green.

Source: Calculated from previous tables

Table 8 summarises the 5 Key Elements in 2024 for the nine main traded gas hubs in Europe. The combination of each of the Key Elements and their respective scores is what determines the overall rankings of the hubs, as can be easily observed by the colour coding, used in the table and in Map 1.

There are two Mature 'tier one' hubs, but only TTF scoring a maximum 15/15, with NBP scoring 12/15. All the 5 Key Elements at TTF are shown as green and all of those results are the best/highest of all the hubs.

NBP returned from an Active to a Mature hub in 2024, having been in the 'tier two' category in 2021-2023. That was mainly due to a fall in its Tradability Index score and a lower churn rate from 11.2 in 2020 to 7.1 in 2023. However, with the higher traded volumes in 2024 and the subsequent higher churn rate, the hub score improved once more.

There are three 'active' hubs, with the German THE improving its ranking from 8/15 to 10/15, while the French TRF and PSV both remained at 8/15.

⁶³ The countries used in the analysis are France, BeNeLux, Germany, Austria, and the Czech Republic.

⁶⁴ The methodologies used in this table are: (Tradability Index): Green: ≥ 18 ; Amber: ≥ 16 ; Red: < 16 ; Brown < 5 ; (Hub rankings): Green/Mature: 12-15 Orange/Active: 8-11 Amber/Poor: 4-7 Red/Inactive: 1-3.



The remaining four ‘poor’ hubs remain unchanged from 2023: the Austrian VTP at 7/15, the Belgian ZTP at 5/15, and the Spanish PVB and Czech VOB, both on 4/15.

Having examined each of the 5 Key Elements in detail it is clear that the Dutch TTF is far and away the leading European traded gas hub, used by many more market participants than any other hub, has a very high traded products score, with far greater total traded volumes than all the other put together. TTF also accounts for 82.9 per cent of all European gas trading, for 55 per cent of all OTC trading, and 88 per cent of all exchange trading. TTF also has the highest Tradability Index score, only missing one point on one of the ‘balance of month’ contracts, and finally, by far the greatest churn rate.

5. The 3 Main Indicators

There are 3 Main Indicators⁶⁵ that reveal the level of liberalisation and market development of traded gas hubs: the political will to create the necessary framework to get the process off the ground; the cultural attitudes to trading and change that drive success in a trading environment; and these in turn dictate the level of commercial acceptance needed to allow the market to grow organically.

These 3 Main Indicators are the basis of creating successful traded gas markets. They are somewhat subjective but are essential to allowing a traded gas market to develop. They do not however in themselves guarantee that a market will succeed and become mature. Indeed, Energy Traders Europe (ETE) themselves note in the 2024 press release that “*the scorecard is intended to measure progress in hub development, and is not intended as a proxy for broader market conditions*”.

ETE⁶⁶ has been publishing a Gas Hub Development Study since 2014 and this is a good proxy for evaluating the three Main Indicators across all countries, as it assesses five regulatory conditions, six TSO conditions and seven market conditions. Initially it surveyed the so-called ‘established’ hubs plus a few newly-formed but not yet necessarily trading ‘emerging’ hubs. In 2017 it added Ukraine; in 2018 it added Portugal and removed the Belgian ZEE.

ETE stopped assessing the so-called ‘established’ older northwest European hubs in 2019 and decided to focus on the ‘emerging’ hubs as well as adding Croatia and Slovenia to the countries surveyed, adding the Irish IBP in 2020. ETE refined the hub scoring criteria in order to better reflect the new hubs and their particular difficulties in establishing themselves and/or developing trading. In particular, it was decided to remove from the criteria the measure of volumes of trades in the longer term products, which was no longer useful since the study focussed on the less mature markets. It was replaced with an assessment of market interference. Where an authority imposes conditions or obligations which constitute a barrier to entry or trade, then a lower score is given.

No study was published in 2022. ETE added Moldova and Serbia in 2023, so that the study now covers 18 hubs, all ‘emerging’.

The results of the 2024 Study are given in Table 9, enhanced by a four colour coding.⁶⁷ The Table shows that these ‘emerging’ hubs have mostly been steadily improving with, in the last year compared to 2023, ten hubs improving further, five remaining the same, and one falling: the Romanian PVT.

⁶⁵ See Heather (2015) for a full description of the 3 Main Indicators. This Paper gives the situation in 2024.

⁶⁶ Previously The European Federation of Energy Traders (EFET).

⁶⁷ The methodology for the rankings is: Mature/Green: ≥ 18 ; Active/Orange: < 18 ; Poor/Amber: < 15 ; Inactive/Red: < 9 . However, this methodology was established when the Study covered the ‘established’ hubs so that this year the table only has countries/hubs in the bottom two categories.



Table 9: ETE Hub scores categorised as mature, active, poor and inactive: 2017–2024

HUB	Score 2017	Score 2018	Score 2019	Score 2020	Score 2021	Score 2023	Score 2024
MGP	12½	11½	12½	13½	14	14	15½
IBP	n/a	n/a	n/a	9½	12	14	14½
HTP	6½	8½	10	10½	12	13½	13½
Lithuania	n/a	n/a	n/a	8½	11	13	13½
Finland	n/a	n/a	n/a	9	11½	12½	13
Estonia	n/a	n/a	n/a	8½	11½	12½	13
Latvia	n/a	n/a	n/a	8	11½	12½	13
SVOB	8½	9½	10	10½	12	12	12
Portugal	n/a	4½	5½	5½	9½	9½	12
Ukraine	3½	3½	7	9	11	11	11½
VPGS	10	9½	9½	10	10½	11	10½
Slovenia	n/a	n/a	6	6½	9½	10	10
Croatia	n/a	n/a	7½	8	9½	9½	9½
Bulgaria	1	4½	5	7½	9	7½	9½
UDN	5½	6	9½	10½	11½	9	9
Romania	3	3	4½	6½	8½	8½	7½
Moldova	n/a	n/a	n/a	n/a	n/a	3½	5
Serbia	n/a	n/a	n/a	n/a	n/a	3½	3½

Source: 2024 ETE Review of Gas Hubs Assessments; P. Heather

The following comments are taken from the EFET Press Release⁶⁸ for the 2024 Study. The most notable progress was seen in Moldova, where transactions are now possible at the virtual trading point⁶⁹ and an exchange platform is in operation, though the market remains highly concentrated. There was dedication to market development in neighboring Ukraine, which relies on its market prices in spite of difficult conditions, and progress was also recorded for the Portuguese PVN hub, which is quickly catching up with the neighboring market ever since joining the MIBGAS platform.

Continued progress was also recorded for the Baltics and Finnish hubs, which have now been connected to the EEX exchange and are soon to offer products cleared by ECC clearing house. Bulgaria appears to have reversed last year's deterioration in score, but this is largely down to the increase in liquidity arising from imports of Russian gas. Finally, and similarly to the previous year, the most developed hub being evaluated in the study is Hungary, which is approaching the level which Energy Traders Europe regards as mature in terms of hub design.

However, ETE also say that many of the long-established markets remain in stagnation, including Poland, Slovakia and Turkey. These hubs continue to suffer from high market concentration levels and considerable market entry barriers that still need to be addressed.

6. Long term market trends

As well as reviewing the European traded gas hubs data for 2024, this paper also reviews the longer term trends to see whether or not the traded gas markets have continued on from the 'rebalancing' that was observed in 2023.

⁶⁸ <https://www.energytraderseurope.org/documents/2024-review-of-gas-hub-assessment/>

⁶⁹ This is actually carried out at the Romanian VTT hub, but by making buy/sell nominations through the Moldovan TSO.

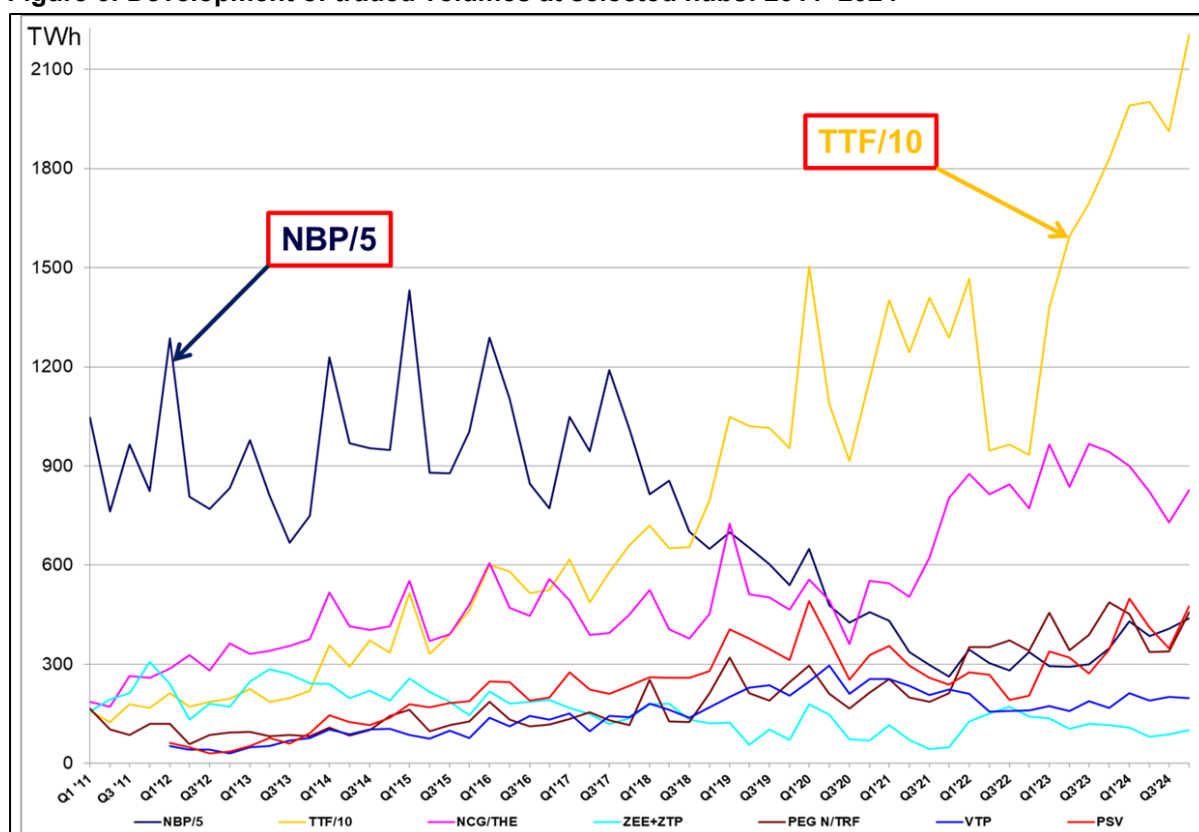


This chapter will therefore focus on the ‘established’ hubs (selected hubs)⁷⁰ and review the longer term traded volumes development, as well as the overall price correlation and convergence at the selected hubs. The review and analysis will enable a subjective judgement on whether the markets have indeed remained ‘rebalanced’.

6.1 Development of traded volumes in selected hubs

The recent development of traded volumes was shown in Figure 3, whereas Figure 6 shows the development over the past fourteen years starting in 2011. This shows more clearly how NBP was then the leading and dominant market, remaining steady until late 2017; since then it lost the participation of many Continental European shippers who used to risk manage their portfolios at the most liquid hub.

Figure 6: Development of traded volumes at selected hubs: 2011–2024



Sources : OTC: LEBA, ICIS; Exchange: ICE, ICE-Endex, EEX, CME, GME; P. Heather

As TTF overtook NBP in 2016, more and more of those shippers migrated their hedging and risk management trading over to the Dutch market, thereby foregoing the additional currency risk associated with NBP trading. NBP continued to lose volumes until the end of 2020, when it stabilised and traded volumes have held steady, even rising again since early 2023.

Although TTF overtook NBP in 2016, it was growing strongly from as far back as 2014. As with most of the hubs, it too recorded a sharp fall in traded volumes during 2020. After recovering during 2021, it had a second sharp fall throughout 2022 only to rebound even more sharply in every quarter of 2023, and again from Q3 2024, attaining new record highs to end the year 25 per cent up on the previous year's trading.

⁷⁰ British NBP, Dutch TTF, German NCG/THE, Belgian ZEE/ZTP, French TRF, Austrian VTP, and Italian PSV.



Of the remaining five hubs, the Belgian ZEE/ZTP hubs and the French TRF appeared to go against the trend in 2022, starting the year with three, albeit relatively small, successive quarterly rises; the French TRF hub has since had a 'seesaw' 9 quarters to the end of 2024, only to end 2024 back where it was in Q1 2023.

The long-term trend of the Belgian hubs is one of slow decline and, despite a small rally in 2020 and again in 2022, by the end of 2024 the volumes were lower than in 2011.

The German THE and Italian PSV broadly followed the same pattern as TTF, albeit at much lower volumes, up to Q1 2019. However since then, their paths diverged slightly: THE seesawed sideways until early 2021, before climbing to its highest levels in H1 2023. Since then it has retraced lower. PSV on the other hand continued to drift lower until late 2022, before edging higher through 2023 and finally dipping sharply until a late recovery in Q4 2024.

Finally, the Austrian VTP peaked in summer 2020 since when it declined through to summer 2022 stabilising thereafter through to the end of 2024.

6.2 Price convergence and correlations

Turning to the convergence of the main European hub prices and their correlation, some interesting points emerge. For most of the 2010s the markets were well correlated and had increasingly good price convergence, with the possible exception of the Italian PSV, which was typically well correlated but at slightly higher prices, mainly due to border capacity limitations.

However during the very turbulent trading of 2022, both correlation and convergence widened significantly at some of the hubs and, with the selected hubs in focus here, there were some large anomalies. In particular the NBP and Belgian hubs lost their otherwise good correlation, particularly in early Q2 2022 and again in August 2022, along with the French TRF. All three of those hubs diverged to quite a large extent from the other five hubs for most of April to September 2022 and to a lesser and gradually decreasing extent through to the end of the year.

These points can clearly be observed in Figure 7, which also shows how all the hubs continued to be well correlated during the price shock of H2 2021 with very good convergence. The main reasons for the disjointed markets in 2022 were the large volumes of additional LNG imports into France, Great Britain and Belgium and the lack of onward transportation and cross border capacity to ship the gas eastwards to where it was desperately needed.

Figure 7 does show though how the markets started to rebalance from as early as Q4 2022, albeit with some price divergence still through to about May 2023. After that point, the selected hubs became well correlated and had good price convergence, and certainly they are now broadly as correlated as prior to April 2022.

Indeed, from the summer of 2023 through to the end of 2024, all selected hubs were both well correlated and closely convergent, although there have still been, as there had been throughout the 2010s, slight anomalies from time to time.

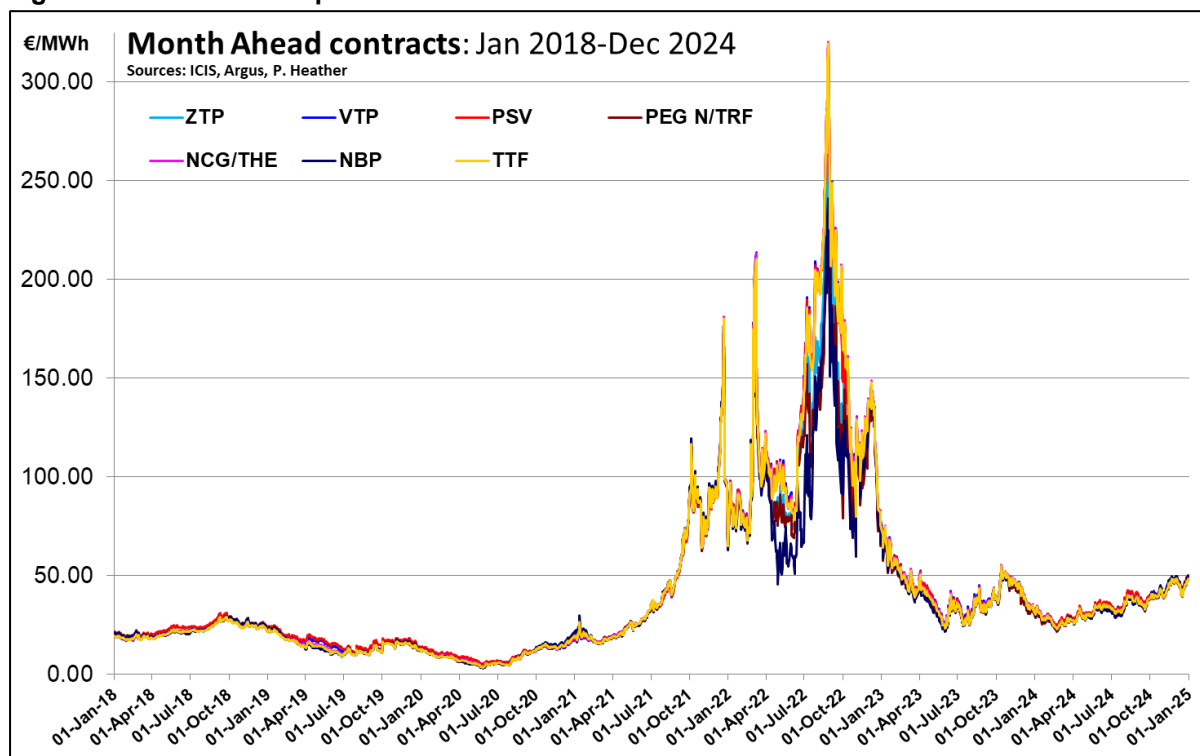
The actual correlation coefficients of some of the main 'pairs' of hubs show how the three large NWE LNG importers⁷¹ have very similar correlation patterns against the benchmark TTF, which although also an LNG importer was not as restricted in being able to export south and east.⁷²

⁷¹ Britain, France, and Belgium.

⁷² For more detail, see Heather (2024), Chapter 7.3, Figure 11, p.25.



Figure 7: Selected hubs price correlation: 2018 to 2024



Source: ICIS; P.Heather

Indeed, from the Summer of 2023 through to the end of 2024, all the selected hubs were both well correlated and closely convergent, although there have still been as there had been throughout the 2010s slight anomalies from time to time. These can be observed in the large scale graph of hub prices from January 2023 to December 2024 in Figure 8.

Generally speaking the graph shows that the six other selected hubs are very closely correlated since the beginning of 2023. The graph is constructed with the leading and benchmark TTF hub as first input (and therefore always visible), with the other hubs added in descending order of the 5 Key Elements score: NBP, THE, TRF, PSV, VTP and ZTP. Therefore, if any colour is visible above or below the bright gold line, it will show whether that hub is dearer or cheaper than the TTF.

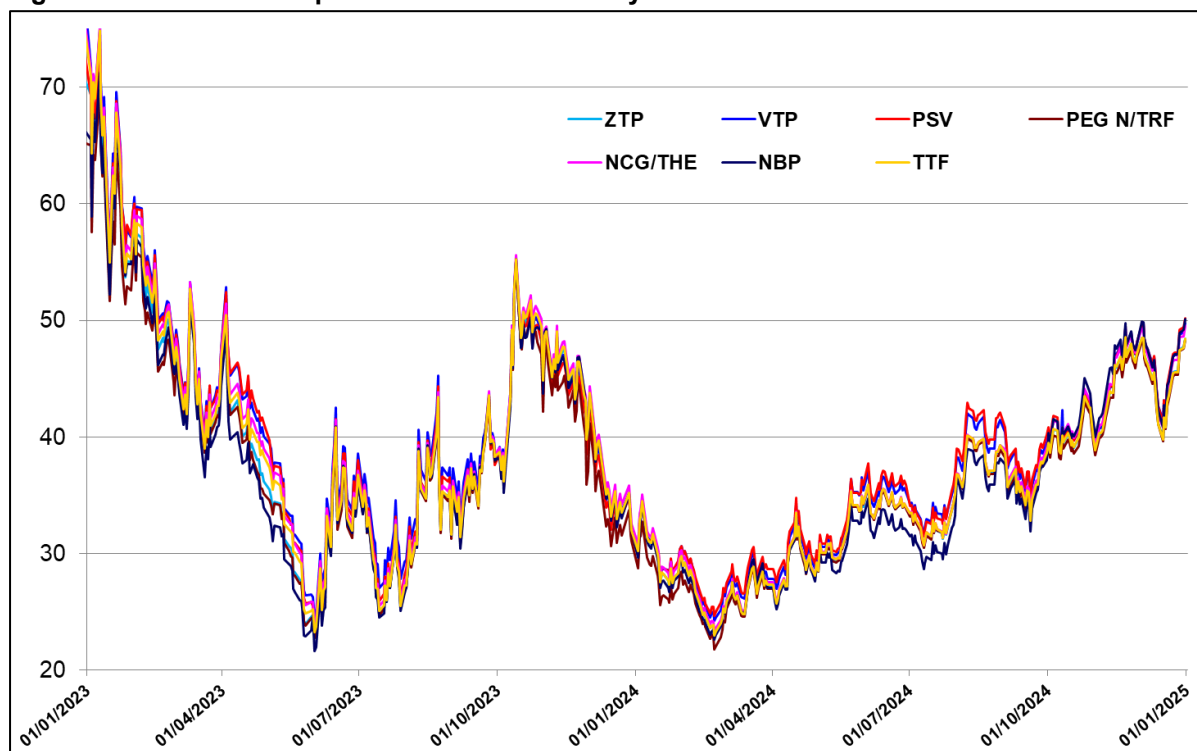
The results show strong correlation with no exceptions throughout the two-year period. Yet it does show that there were periods when there was more or less convergence, in particular during May and June 2023 and June, July and late August 2024 and to a lesser degree during January and February 2023.

During these periods and indeed throughout the whole timeframe, any divergence tended to be mostly NBP cheaper (especially during April to May 2023 and again from late May to late August 2024), and occasionally TRF and ZTP (in particular during April to May 2023); and VTP and PSV often dearer, and THE dearer, in particular during February to May 2023 (and to a lesser degree, between late October 2023 to February 2024).

However, by and large it can be observed that the main European hubs are once more very well correlated and mostly convergent around the benchmark Dutch TTF hub.



Figure 8: Selected hubs price correlation: January 2023 to December 2024



Source: ICIS EGHR Q1-2024; P.Heather

For the sake of clarity, the author has chosen not to show a graph with all thirteen principle European hubs, but can confirm that the correlation is just as good, as is the convergence, albeit with very minor occasional differences from, inter-alia, the PVB and GPL. Therefore, the data do show that the main European traded gas hubs have rebalanced, are trading, and are following very tightly the leading, benchmark, Dutch TTF hub.

6.3 Markets did rebalance and have stayed rebalanced

This chapter focused on the long-term market trends at the selected hubs with a view to determining whether the markets had ‘rebalanced’ or not. From the above analysis of the traded volumes development and the overall price correlation and convergence of the hubs, it is indeed apparent that the markets certainly did rebalance after the turbulent and extreme trading conditions of 2021 and 2022; the review of the 2024 data has confirmed that they have continued to be in balance.

7. TTF is a global gas price benchmark

The author has been following the development of gas trading activity in the Asia-Pacific region for a number of years and since 2019, has developed a methodology to try to compare the churn rates⁷³ of the main representative gas markets around the world. This year he has added a new TTF churn denominator: that of all European gas consumption, in order to evaluate whether TTF can now be considered a truly global benchmark.

As the data and analysis of this paper have shown, the Dutch TTF is truly *the* leading pricing benchmark for North-West Europe and indeed for many other European countries. It is also increasingly being used to price spot LNG cargoes. It has become an investment asset class⁷⁴ in its own right and as the data

⁷³ Note that these are calculated using consumption as the denominator and so for TTF and NBP the results are different to the gross churn rates in Table 3. For JKM, the denominator is LNG imports.

⁷⁴ Part of the Futures asset class of investments.



and analysis presented below will show, TTF is now a global benchmark too. Not only have the TTF total traded volumes grown to such an extent that they represent 82.9 per cent of total European traded gas volumes, but its churn rate calculated against the much greater physical consumption figure of the countries including and surrounding the Netherlands and whose shippers are known to be using TTF for their risk management, has now grown to nearly 46 times.

This section looks at TTF in the global context, alongside NBP, the other European benchmark and against the US Henry Hub (HH). Finally, they are compared to the nascent LNG pricing benchmark JKM⁷⁵ using the ICE and CME exchange-traded JKM options and futures contracts as the numerator and the LNG imports into China, Japan, Korea and Taiwan as the denominator.

Henry Hub is *the* pricing benchmark for North America,⁷⁶ with most of the other Market Centers (or hubs) being priced by differential against it. HH is used to price physical gas contracts in the US Mexico and, directly or indirectly, some of the Canadian contracts.⁷⁷ It is also used to price many contracted LNG cargoes destined for South America, Asia and Europe, as well as some spot LNG cargoes.⁷⁸ It is extensively used for risk management of physical gas portfolios and is an investment asset class in its own right.

The British NBP was the North West European (NWE) benchmark hub for over a decade but has since lost that mantle to TTF. It remains *the* Sterling pricing benchmark for the British Isles and is also used to price most LNG cargoes destined for the British Isles.

Finally and although not strictly a 'hub', JKM has become the pricing benchmark for some LNG cargoes delivered into Asia, although it has also been used to price some LNG cargoes to other parts of the world. Futures and options contracts based on the S&P Global Platts marker price have increased considerably over the past few years.

For the purposes of calculating churn rates, the relevant denominators used are the gas consumption in the US, Canada and Mexico for HH; the gas consumption in France, Germany, Austria, Czech Republic, and Benelux for TTF; the gas consumption in the UK and Republic of Ireland for NBP; and LNG imports into China, Japan, Korea, and Taiwan for JKM.

Table 10 shows the results of this global comparison and uses a similar colour coding⁷⁹ to the author's European hubs analyses. It shows which benchmarks are illiquid, mature, liquid and very liquid. The results clearly show that HH remains the gas benchmark with the highest churn, at an impressive 73 times (up from 59.6 times last year) when compared to US consumption alone. This is the second year that the HH churn has risen to above pre-pandemic levels.⁸⁰ and shows that this market also has rebalanced after the volatile energy markets of 2021 and 2022. There is no doubt that this hub is a very mature and very liquid gas pricing benchmark and remains so even after Mexican consumption⁸¹ is added (the churn is a little lower at 70.1 times) and after including Canadian consumption⁸² (the churn is a little lower still at 61.2 times). Total Canadian consumption is included in the calculation, even though not all Canadian gas contracts are priced against HH, because the main Canadian reference hubs, Alberta and Dawn, trade at a varying basis differential to HH.

⁷⁵ Japan Korea Marker, a price marker published daily by S&P Global Platts.

⁷⁶ It is the most used benchmark in the US and Mexico, although less so in Canada where AECO ('Alberta') is the main pricing hub; see: <https://www.capp.ca/wp-content/uploads/2024/03/Natural-Gas-Market-Fundamentals.pdf>, slide 3. The Alberta Energy Company (AECO), located in Alberta Canada, is one of the largest gas distribution hubs in North America; it's the most widely used Canadian benchmark for natural gas and is quoted in CAD/Gigajoules.

⁷⁷ The author has seen differing estimates of this from several publications, varying from just 30%, to 60%.

⁷⁸ An ever-increasing number of spot LNG cargoes are being priced against TTF.

⁷⁹ Dark Green/Very Liquid: ≥ 40 ; Mid Green/Liquid: $15 < 40$; Light Green/Mature: $10 < 15$; Amber/Poor: $5 < 10$; Red/Illiquid: < 5 . The calorific value conversion factors are those stated by the IEA for each country.

⁸⁰ The HH churn in 2018 was 53.9, 2019 was 45.5, 2020 was 57.0, 2021 was 50.1, 2022 was 49.7, and in 2023 was 59.6.

⁸¹ All of Mexico's gas is priced against HH.

⁸² Although realistically, HH is only used to price a proportion of Canadian contracts, the remainder being against Canadian hubs, especially Alberta..



TTF, when compared to the consumption in the five countries of its main sphere of influence, has risen considerably for the second year running⁸³ and is now 45.9 times, easily becoming for the first time a 'very liquid' benchmark hub. There is no doubt that this is a very mature and very liquid gas pricing benchmark. When calculating the TTF churn against all of Europe's gas consumption, the result is a very impressive 20.3 times, well within the 'liquid' bracket.

Table 10: Global Gas Benchmarks Churn Ratios - 2024⁸⁴

Global Benchmark churn rates 2024 (HH, TTF, NBP: trading/consumption; JKM: trading/LNG imports)				
Hub	Country/Region	Churn		Classification
		2023	2024	
HH	United States	59.6	73.0	VERY LIQUID
	US + Mexico	56.9	70.1	
	US + Mexico + Canada	50.1	61.2	
TTF	FR-DE-AT-CZ-BeNeLux	35.1	45.9	VERY LIQUID
	All Europe	16.2	20.3	LIQUID
NBP	Britain	8.9	12.1	MATURE
	UK-IE	8.3	11.2	
	Asia: No hubs yet but increasing spot trading			ILLIQUID
JKM	CN-JP-KR-TW	0.69	0.99	

Sources: JODI, ICE, CME, LEBA, ICIS, ICE, ICE-Endex, EEX; P. Heather

TTF is increasingly being used to price spot LNG cargoes, as well as in assessing the Platts LNG DES Northwest Europe Marker,⁸⁵ when there are no actual reported trades or reported bids and offers. This would then be an assessment by Platts, based on a spread to the TTF futures price.

The spot (current/next month) LNG marker is most often based on bids and offers and only occasionally will there be an actual trade. When actual trades are reported, they are most often for delivery in the next few days or weeks, although increasingly, they can be for delivery up to two months forward. Interestingly here, many of the bids and offers (for Atlantic Basin cargoes) are based against the TTF futures price.

Even when looking at the Platts APAC⁸⁶ market, which is more active than the NWE, many of the quoted bids and offers are priced against TTF (as well as outright fixed prices and, to a lesser extent, to the JKM price). This shows that even LNG cargoes for delivery in the Asia-Pacific region are being priced against TTF.

⁸³ In 2022 the TTF churn was 22.6 times, in 2023 was 35.1 times.

⁸⁴ All the data behind this table can be seen in Appendices: "Global gas hubs: Net market churns: 2023, 2024".

⁸⁵ As published in the The Platts LNG Daily, a respected news publication on the global LNG activity and trading. It reports on the latest LNG news stories, as well as a daily listing of various global LNG prices and trades.

⁸⁶ Asia-Pacific.



Forward delivery LNG markers are mostly calculated from the spot price, using the forward curve of the TTF futures market. Importantly, as there is currently no futures market so as to enable hedging, or any form of risk management, LNG traders will most often hedge their exposure through the TTF futures market; this is especially true of cargoes into Europe but also some in Asia.

The above are substantiated by comments received by the author regarding the ever-increasing number of market participants trading the TTF futures contracts. They are no longer only from northwest Europe, but from all over Europe and increasingly from around the world, especially the Americas and, to a lesser degree, from Asia also. He has also had it confirmed that these participants are from all sectors of the gas industry and gas market and beyond: from investment banking, insurance, institutional investors and pure speculators.

The ICE exchange stated in an Insight⁸⁷ they published in March 2025 that: *“TTF also serves as a pricing indicator to determine the destination of a given cargo and to hedge its price risk, while contract tenders around the world are priced relative to the benchmark. Importantly, TTF’s rise has been facilitated by broader participation from financial market players - hedgers, arbitragers, and speculators. This is a positive reflection of the evolution of the TTF secondary market, and a development which brings greater liquidity, helping to reduce bid offer spreads and trading costs for all market participants”*.

This confirms the author’s analysis and conclusion that the TTF contract has now become a credible global gas benchmark.

NBP, when compared to the consumption across the UK and Republic of Ireland, has a churn of 11.2 times (up from 8.3 last year); this has brought it back into the ‘mature’ category for both its British and British Isles churns. It is a regional Sterling gas pricing benchmark.

There is no doubt that the Asian JKM marker price is gaining support from the LNG industry, with producers, aggregators and buyers using it more each year. There are two exchanges offering JKM futures and options derivative contracts,⁸⁸ the ICE and CME. Despite the turbulent global energy markets of 2021 and 2022 causing traded volumes to fall, they rose again in 2023 set against slightly lower LNG imports and rose significantly in 2024, set against a similar level of imports; the churn therefore increased by 43 per cent, albeit still being under 1 times.

Asia has started to liberalise its gas markets but has a long way to go. Increased short term and spot LNG trades in Asia, and the use of the JKM are helping the transition. The JKM, when compared to its main sphere of influence, has a churn of 0.99 times in 2024 (up from 0.69 in 2023). This is an illiquid market but is clearly showing some signs of growth.

8. Summary and Conclusion

The main purpose of this paper has been to analyse the results of the trading data in 2024 for the European traded gas hubs, in order to be able to assess whether the traded gas markets have stabilised after having rebalanced since the three very turbulent years in the energy markets.

The secondary purpose has been to establish whether the Dutch TTF can now credibly be called a global gas benchmark.

The detail of the tumultuous years and the gas market’s recovery was explored in detail in last year’s paper; this paper adds the 2024 data to give a fuller picture of the recovery and where the various hubs now stand.

Map 1 showed all the European gas hubs that were operational at the end of 2024, including the very small ‘nascent’ balancing and spot trading hubs; to the ‘inactive’ hubs that might have a little more spot and prompt trading but often very little or no curve trading; to the medium ‘poor’ hubs in Belgium, Czech Republic and Spain that trade more products but still in relatively low volumes; to the larger ‘active’ hubs

⁸⁷ See paragraph 8 of: <https://www.ice.com/insights/energy/the-globalization-of-natural-gas-gains-momentum>

⁸⁸ JKM derivatives trading was launched in 2012.



in Italy, France, and Germany that trade reasonable volumes and also in more types of products, to the 'mature' regional British NBP hub. But these are all dwarfed by the only 'mature' global benchmark hub in Europe, the Dutch TTF.

8.1 Review of the 5 Key Elements in 2023

Despite the extreme trading conditions over the past few years, trading across all the European hubs remained relatively buoyant and very much in line with the underlying physical volumes in each country. However, in 2024 trading continued to pick up significantly, set against a small fall in physical volumes. When comparing the 2023/24 year-on-year difference, Europe as a whole had a 23 per cent rise in traded volumes, whilst physical demand fell by only 1 per cent. Eight countries had higher traded volumes and nine lower, whilst seven countries had higher physical demand and ten lower.

The composition of the trading continued the trend away from OTC contracts towards exchange futures contracts, in most countries. The exception in the 'main' hubs examined was the PSV where its exchange volumes fell and OTC trades increased.

The Dutch TTF hub has by far the largest the traded volumes, including in all products across the whole curve. With a year-on-year increase of 25 per cent in 2024, TTF volumes are now nearly five times greater than all of the other hubs listed here put together, nearly 10 times greater than the next most traded hub, the British NBP; just under 25 times greater than the German THE hub, in Europe's largest gas consuming country; and nearly 47 times greater than the Italian PSV.

The Belgian ZTP hub volumes dropped by 19 per cent in 2024, despite it now being the sole traded hub in Belgium. The German THE recorded an unexpected fall of 12 per cent, the Spanish PVB 15 per cent.

Only the Dutch TTF and the British NBP recorded exchange financial options trading and the volumes significantly higher in 2024 than in 2023. The options contracts are listed on the ICE exchange and totalled 12,071TWh on TTF, and 15.9TWh on NBP, representing 16.97 per cent, 0.26 per cent respectively of exchange trading. In fact, there were 48 per cent more TTF options traded than the total trades at all of the Continental European hubs put together.

The most important metric is the traded gas hubs' churn rate as, in this one metric all others are, necessarily, reflected. If there are many participants, trading many different products in large quantities, then the churn rate is likely to be high. The net and gross churn rates for the 10 main hubs were studied in this paper and the results for 2024 show that there is only one European benchmark hub, the Dutch TTF, standing far ahead of all the others and the only hub that can also be considered as a global reference hub, plus one regional Sterling marker price, the British NBP.

The hub rankings were unchanged as were the scores, apart from the German THE rising from 8/15 to 10/15, and the British NBP rising from 11/15 to 12/15.

8.2 The long term trends

This paper reviewed the longer term trends at seven selected hubs, namely the British NBP, the Dutch TTF, the Belgian ZTP, the German THE, the Austrian VTP, the French TRF and the Italian PSV to determine whether or not the traded gas markets have stabilised after having rebalanced following the three very turbulent years in the energy markets. This comprised looking at the development of traded volumes since 2011, price correlation, and price convergence.

The fourteen year period showing the trading development at the seven major European hubs revealed that the Dutch TTF has had four 'phases', rising slowly from 2011 to 2014, rising more strongly from 2014 to 2020, retracing slightly in 2020-21 and then trading sideways until 2022, before the last phase from 2023 to date with a 'meteoric' almost linear growth.

The NBP was the most traded hub for many years but peaked in 2016 when it was overtaken by TTF and was thereafter in a slow decline until 2022, from when it started to recover to its position today as Europe's second largest hub in traded volumes, some 2.5 times greater than the next best hub, the German THE.



The THE has had a long slow erratic rise over the whole period, with some of the latter rises in volumes thanks to the merger of the GPL and NCG hubs into the new THE. The French TRF is now slightly ahead of the Italian PSV, which it overtook in 2022, and both hubs have had a slow and erratic rise over the years.

The Austrian VTP slowly increased its volumes over the years until 2020, since when it declined a little before drifting sideways. The story of the Belgian ZTP is one of a long slow decline over the whole period.

Turning to the convergence of the main European hub prices and their correlation, some interesting points emerge. For most of the 2010s, the markets were well correlated and increasingly had good price convergence, with the possible exception of the Italian PSV, which was typically well correlated but at slightly higher prices, mainly due to border capacity limitations.

However during the very turbulent trading of 2022, both correlation and convergence widened significantly at some of the hubs and, with the selected hubs in focus here, there were some large anomalies. In particular the NBP and Belgian hubs lost their otherwise good correlation, particularly in early Q2 2022 and again in August 2022, along with the French TRF. All three of those hubs diverged to quite a large extent from the other five hubs for most of April to September 2022 and to a lesser and gradually decreasing extent through to the end of the year.

The markets started to rebalance from as early as Q4 2022, albeit with some price divergence still, through to about May 2023. After that point, the selected hubs became well correlated and had good price convergence, now broadly as good as prior to April 2022.

The results show the strong correlation, with no exceptions throughout the 2023-2024 period. However, it does show that there were periods when the convergence was more or less good, in particular during May and June 2023, and June, July, and late August 2024; and to a lesser degree during January and February 2023.

During these periods, and indeed throughout the whole timeframe, any divergences tended to be mostly NBP cheaper (especially during April to May 2023, and again from late May to late August 2024), and occasionally TRF and ZTP (in particular during April to May 2023); and VTP and PSV often dearer, and THE dearer, in particular during February to May 2023 (and to a lesser degree, between late October 2023 to February 2024).

However, by and large it can be observed that the main European hubs are once more very well correlated and mostly well converged, around the benchmark Dutch TTF hub.

8.3 TTF is a global gas price benchmark

As the data and analysis in this paper have shown, the Dutch TTF is truly *the* leading pricing benchmark for northwest Europe and indeed for many other European countries; it is also increasingly being used to price spot LNG cargoes. It has become an investment asset class in its own right and, as the data and analysis presented in this paper show, TTF is now a global benchmark too.

Not only have the TTF total traded volumes grown to such an extent that they represent 82.9 per cent of total European traded gas volumes, but its churn rate calculated against the much greater physical consumption figure of the countries including and surrounding the Netherlands, whose shippers are known to be using TTF for their risk management, has risen considerably for the second year running. It is now 45.9 times, easily becoming for the first time a 'very liquid' benchmark hub. There is no doubt that this is a very mature and very liquid gas pricing benchmark.

When calculating the TTF churn against all of Europe's gas consumption, the result is a very impressive 20.3 times, well within the 'liquid' bracket.

TTF is increasingly being used to price spot LNG cargoes, as well as in assessing the Platts LNG DES Northwest Europe Marker, when there are no actual reported trades or reported bids and offers; this would then be an assessment by Platts, based on a spread to the TTF futures price.



The author has received various comments from industry participants regarding the ever-increasing number of market participants trading the TTF futures contracts and that they are no longer only from northwest Europe, but from all over Europe and increasingly from around the world, especially the Americas and, to a lesser degree, from Asia also.

He has also had it confirmed that these participants are from all sectors of the gas industry and gas market and beyond: from banking, investment banking, insurance companies, various institutional traders and pure speculators.

The ICE exchange published an Insight in March 2025, stating that *“Importantly, TTF’s rise has been facilitated by broader participation from financial market players - hedgers, arbitragers, and speculators. This is a positive reflection of the evolution of the TTF secondary market, and a development which brings greater liquidity, helping to reduce bid offer spreads and trading costs for all market participants”*.

This confirms the author’s analysis and conclusion that the TTF contract has now become a credible global gas benchmark.

8.4 Final Conclusion

This paper set out to analyse the results of the trading data in 2024 for the European traded gas hubs, determine whether the traded gas markets have stabilised after having rebalanced since the three very turbulent years in the energy markets.

The secondary purpose has been to establish whether the Dutch TTF can now credibly be called a global gas benchmark.

Having reviewed each of the 5 Key Elements in detail, as well as several complimentary analyses, it is clear that the benchmark Dutch TTF is far and away the leading European traded gas hub, used by many more market participants than any other hub, has a very high traded products score, with far greater total traded volumes than all the other put together; it also has the highest Tradability Index score and finally, by far the greatest churn rate.

From the analysis of the traded volumes development, and the overall price correlation and convergence of the hubs, it is indeed apparent that the markets certainly did rebalance after the turbulent and extreme trading conditions of 2021 and 2022; the review of the 2024 data has confirmed that they have continued to be in balance.

On a global scale, Henry Hub is the pricing benchmark for North America, with most of the other Market Centers (or hubs) being priced by differential against it. HH is used to price physical gas contracts in the US and Mexico and, directly or indirectly, some of the Canadian contracts; it is also used to price many contracted LNG cargoes destined for South America, Asia and Europe, as well as some spot LNG cargoes. It is extensively used for risk management of physical gas portfolios and is an investment asset class in its own right.

Asia has started to liberalise its gas markets but has a long way to go. Increased short term and spot LNG trades in Asia, and the use of the JKM are helping the transition. The JKM, when compared to its main sphere of influence, has a churn of 0.99 times in 2024 (up from 0.69 in 2023). This is an illiquid market but is clearly showing some signs of growth.

The Dutch TTF is truly the leading pricing benchmark for North-West Europe and indeed for many other European countries; it is also increasingly being used to price spot LNG cargoes. It has become an investment asset class in its own right.

The TTF total traded volumes represent 82.9 per cent of total European traded gas volumes, and its churn rate calculated against the much greater physical consumption figure of the countries including and surrounding the Netherlands, and whose shippers are known to be using TTF for their risk management, has risen considerably for the second year running and is now 45.9 times, easily becoming for the first time a ‘very liquid’ benchmark hub.

The TTF churn against all of Europe’s gas consumption is a very impressive 20.3 times, well within the ‘liquid’ bracket.



There has been an ever-increasing number of varied market participants trading the TTF futures contract, from banking, investment banking, insurance companies, various institutional traders and pure speculators, as confirmed by the ICE exchange statement.

Considering all the data and analysis presented in this paper, the final conclusion must be that TTF is now a global benchmark.



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Appendices

The European traded gas hubs in 2024

NBP	- National Balancing Point; GB; 1996
(ZEE) ZTP	- Zeebrugge Hub; BE; 2000 to September 2023
	- Zeebrugge Trading Point; BE; 2012
PSV	- Punto di Scambio Virtuale; IT; 2003
TTF	- Title Transfer Facility; NL; 2003
(AOC) PVB	- Almacenamiento Operativo Comercial /Punto Virtual de Balance; ES; 2004/2015
GTF and ETF	- Gas Transfer Facility and Exchange Transfer Facility; DK; 2004 and 2008
(PEGs) TRF	- Points d'Échange de Gaz (Nord, Ouest, Est, Sud, TIGF) / PEG Nord (merger of PEGs N,O,E); FR ; 2004/2009
	- Trading Region South (merger of PEGs S, TIGF); FR; 2015
	- Trading Region France (merger of PEG N, TRS); FR; 2018
(CEGH) VTP	- (Central European Gas Hub; AT; 2005) Virtual Trading Point; AT; 2013
(GPL/NCG)THE	- Gaspool and NetConnect Germany; DE; 2009 to September 2021
	- Trading Hub Europe; DE; 2021
MGP	- Magyar Gázkiegymelési Ponton; HU; 2010
UDN	- Ulusal Dengeleme Noktası; TR; 2011
VOB	- Virtuální Obchodní Bod; CZ; 2011
VPGS	- Virtual Point Gaz-System; PL; 2014
NIBP	- Northern Ireland Balancing Point; NI; 2015
SVOB	- Slovenskom Virtuálnom Obchodnom Bode; SK; 2016
IBP	- Irish Balancing Point; IE; 2017
HTP	- Hellenic Trading Point; GR; 2018
PVT	- Punctul Virtual de Tranzactionare; RO; 2020
VTT	- Virtualna Türgovska Tochka; BG; 2020
PVN	- Ponto Virtual de Negociação; PT; 2021
Slovenia, Croatia, Moldova, and Serbia - nascent hubs with little or no trading	

Churn rates: 2022 to 2024 – Top 7 Hubs

Volumes in TWh	Σ OTC (less cleared)	Σ Exch. Fut/Opt	Σ Exch. spot	Σ Traded	Σ NET Physical	Net market churn	Σ GROSS Physical	Gross market churn
TTF 2022	7,217.58	34,463.24	1453.15	43,133.97	303.50	142.1	684.38	63.03
TTF 2023	7,912.94	55,681.50	1387.09	64,981.53	290.41	223.8	644.34	100.85
TTF 2024	8,724.59	71,145.38	1240.06	81,110.03	295.72	274.3	589.91	137.50
Δ Holland	10%	28%	-11%	24.8%			-8.4%	36.3%
NBP 2022	1,884.26	4,322.59	127.12	6,333.98	775.58	8.2	1,034.14	6.12
NBP 2023	1,641.69	4,415.92	125.97	6,183.58	692.36	8.9	866.85	7.13
NBP 2024	1,958.35	6,210.05	140.66	8,309.06	684.15	12.1	802.22	10.36
Δ Britain	19%	41%	12%	34.4%			-7.5%	45.2%
VTP 2022	263.72	228.11	194.56	686.39	86.15	8.0	288.93	2.38
VTP 2023	340.04	171.43	176.68	688.15	74.35	9.3	162.23	4.24
VTP 2024	442.99	171.55	186.66	801.20	73.65	10.9	163.41	4.90
Δ Austria	30%	0%	6%	16.4%			0.7%	15.6%
THE 2022	1,562.72	734.28	1009.65	3,306.65	845.38	3.9	1,373.52	2.41
THE 2023	1,999.32	882.06	829.20	3,710.59	812.99	4.6	1,028.20	3.61
THE 2024	2,197.86	469.08	611.82	3,278.76	821.66	4.0	934.10	3.51
Δ Germany	10%	-47%	-26%	-11.6%			-9.2%	-2.7%
TRF 2022	865.39	258.92	292.52	1,416.84	419.52	3.4	592.91	2.39
TRF 2023	817.95	506.10	351.25	1,675.29	356.44	4.7	525.53	3.19
TRF 2024	915.52	377.93	295.03	1,588.49	338.86	4.7	504.36	3.15
Δ France	12%	-25%	-16%	-5.2%			-4.0%	-1.2%
PSV 2022	719.61	121.33	121.31	962.25	725.42	1.3	774.02	1.24
PSV 2023	1039.99	110.03	126.40	1,276.42	653.12	2.0	679.48	1.88
PSV 2024	1427.99	118.62	187.72	1,734.33	656.40	2.6	662.82	2.62
Δ Italy	37%	8%	49%	35.9%			-2.5%	39.3%
VOB 2022	37.44	16.40	35.52	89.36	80.90	1.1	277.26	0.32
VOB 2023	51.15	17.02	23.90	92.06	72.64	1.3	83.53	1.10
VOB 2024	42.04	15.28	20.55	77.88	72.51	1.1	76.09	1.02
Δ Czech	-18%	-10%	-14%	-15.4%			-8.9%	-7.1%



Churn rates: 2022 to 2024 – the remaining hubs, all under 1.0 gross churn

Volumes in TWh	Σ OTC (less cleared)	Σ Exch. Fut/Opt	Σ Exch. spot	Σ Traded	Σ NET Physical	Net market churn	Σ GROSS Physical	Gross market churn
ZEE+ZTP/L'22	269.70	52.84	269.90	592.44	164.18	3.6	635.32	0.93
ZEE+ZTP/L'23	155.56	46.39	274.16	476.11	153.97	3.1	539.52	0.88
ZTP/L'24	111.34	31.50	236.99	379.84	147.25	2.6	437.24	0.87
Δ Belgium	-28%	-32%	-14%	-20.2%			-19.0%	-1.6%
PVB 2022	63.42	90.56	104.43	258.41	365.78	0.7	433.42	0.60
PVB 2023	99.62	108.55	126.14	334.31	327.02	1.0	401.29	0.83
PVB 2024	76.29	87.33	124.36	287.97	314.31	0.9	347.37	0.83
Δ Spain	-23%	-20%	-1%	-13.9%			-13.4%	-0.5%
VPGS 2022	0.00	116.58	21.94	138.53	191.32	0.7	198.32	0.70
VPGS 2023	0.00	122.86	20.75	143.62	197.90	0.7	205.90	0.70
VPGS 2024	0.00	108.96	27.70	136.67	187.55	0.7	188.99	0.72
Δ Poland	n/a	-11%	34%	-4.8%			-8.2%	3.7%
GTF/ETF 2022	17.99	0.04	17.58	35.60	20.11	1.8	46.67	0.76
GTF/ETF 2023	0.00	0.00	52.78	52.78	17.87	3.0	114.80	0.46
GTF/ETF 2024	0.00	0.00	46.52	46.52	18.05	2.6	120.58	0.39
Δ Denmark	n/a	n/a	-12%	-11.9%			5.0%	-16.1%
MGP 2022	1.27	0.00	26.01	27.28	100.78	0.3	117.44	0.23
MGP 2023	0.25	0.05	29.66	29.96	89.72	0.3	112.01	0.27
MGP 2024	0.00	0.03	49.49	49.52	90.30	0.5	138.41	0.36
Δ Hungary	-100%	n/a	67%	65.3%			23.6%	33.8%
VIT 2022	0.00	9.98	4.03	14.01	29.22	0.5	162.38	0.09
VIT 2023	0.00	30.51	14.98	45.50	27.19	1.7	169.47	0.27
VIT 2024	0.00	26.28	15.66	41.94	29.35	1.4	200.40	0.21
Δ Bulgaria	n/a	-14%	5%	-7.8%			18.2%	-22.1%
PVT 2022	0.00	15.73	16.59	32.32	104.46	0.3	114.00	0.28
PVT 2023	0.00	5.97	11.80	17.77	97.85	0.2	120.14	0.15
PVT 2024	5.44	5.77	19.16	30.37	101.60	0.3	124.78	0.24
Δ Romania	n/a	-3%	62%	70.9%			3.9%	64.6%
SVOB 2022	4.05	n/a	n/a	4.05	56.61	0.1	262.87	0.02
SVOB 2023	10.05	n/a	n/a	10.05	45.75	0.2	157.83	0.06
SVOB 2024	14.21	n/a	n/a	14.21	47.24	0.3	193.35	0.07
Δ Slovakia	41%	n/a	n/a	41.5%			22.5%	15.5%
HTP 2023	0.00	0.00	9.03	9.03	51.09	0.2	171.57	0.05
HTP 2024	0.00	0.00	5.06	5.06	67.29	0.1	183.24	0.03
Δ Greece	n/a	n/a	-44%	-43.9%			6.8%	-47.5%
PVN 2023	0.00	0.00	0.17	0.17	59.20	0.0	49.09	0.00
PVN 2024	0.00	0.00	0.63	0.63	53.40	0.0	41.03	0.02
Δ Portugal	n/a	n/a	272%	271.7%			-16.4%	344.8%
Σ Europe 2023	14,068.55	62,098.41	3,559.96	79,726.91	4,019.84	19.8	6,031.78	13.22
Σ Europe 2024	15,916.63	78,767.76	3,208.09	97,892.49	3,999.28	24.5	5,708.30	17.15
Δ Europe	13%	27%	-10%	23%	-1%		-5%	30%
			81,983.23					
Baltic-FI				7.37				
Europe Total				97,899.86				



Global gas hubs: Net market churns: 2023, 2024

Volumes in TWh	Benchmark Hub	Σ Traded Volumes	Σ NET Physical / Asia Net LNG Imports	Net market churn
Britain 2023	NBP	6,184.53	692.36	8.9
Britain 2024	NBP	8,309.06	684.15	12.1
Δ Britain		34.4%	-1.2%	36.0%
UK + IE 2023	NBP	6,184.53	745.52	8.3
UK + IE 2024	NBP	8,309.06	739.70	11.2
Δ UK + IE		34.4%	4.5%	35.4%
Holland 2023	TTF	64,981.53	290.41	223.8
Holland 2024	TTF	81,110.03	295.72	274.3
Δ Holland		24.8%	1.8%	22.6%
NW Europe 2023	TTF	64,981.53	1,850.15	35.1
NW Europe 2024	TTF	81,110.03	1,765.96	45.9
Δ NW Europe		24.8%	-4.6%	30.8%
United States 2023	HH	537,109.00	9,004.67	59.6
United States 2024	HH	721,471.26	9,876.89	73.0
Δ United States		34.3%	9.7%	22.5%
US + Mexico 2023	HH	537,109.00	9,439.00	56.9
US + Mexico 2024	HH	721,471.26	10,294.68	70.1
Δ US + Mexico		34.3%	9.1%	23.2%
US + MX + CA 2023	HH	537,109.00	10,724.31	50.1
US + MX + CA 2024	HH	721,471.26	11,784.32	61.2
Δ US + MX + CA		34.3%	9.9%	22.2%
NW Asia 2023	JKM	2,042.92	2,948.59	0.69
NW Asia 2024	JKM	2,917.45	2,950.22	0.99
Δ Asia	JKM	42.8%	0.1%	42.7%