



## European traded gas hubs: an updated analysis on liquidity, maturity and barriers to market integration

### Chapter 1. Introduction

This OIES Energy Insight provides an update on the maturity and development of European traded gas hubs, including both longer-term established hubs and recently emerging ones, both from a liquidity and price perspective, in order to come to an overall assessment of the policy goal of achieving a Single Energy Market for natural gas in Europe.

The update considers whether the natural gas market in Europe is working well and functioning in line with policy makers' ambitions; whether it is providing the competitive and correct price signals to market players, and whether wholesale traders can buy gas at the same price throughout Europe, as they could in a truly interconnected European market for energy.

The present short contribution complements substantial research work undertaken in the last few years by the OIES, which has been following the development of European gas hubs since 2010.

Publications by Patrick Heather for the OIES have documented the trading liquidity at various hubs and have assessed their stages of development, through a compelling mix of both quantitative and subjective measures: the five Key Elements (number of market participants; traded products; traded volumes; tradability Index; churn rate) and the three Main Indicators (political will, cultural attitude, commercial acceptance).

Another parallel and complementary stream of research by Beatrice Petrovich has assessed the maturity of gas wholesale markets by studying the hub price dynamics, and three factors in particular: first, the frequency of the price signal for traded gas; second, the convergence of the price signal between the exchange and OTC market; third, the degree of price correlation between different markets, which is a metric to assess the cross-border trading efficiency and integration of European hubs.

The present Energy Insight offers an update on both hub liquidity development and hub price metrics to the end of 2016.

## Chapter 2. Liquidity analysis and the 5 Key Elements/3 Main Indicators

### The liquidity metrics

There has been continued progress in the development of the European gas hubs since the publication of the last OIES research<sup>1</sup>, which used data up to the end of 2014; this paper will bring the reader up to date with developments in 2015 and 2016. Although the European gas markets have evolved further in the past two years, there are still some very important hurdles to overcome before we can have efficient, successful and mature gas markets that can provide a reliable price reference for contracted gas supplies. The three main areas of concern are liquidity and transparency; physical connectivity; political willingness and cultural attitudes.

In order to evaluate the path to liberalisation and market development of the traded gas hubs across Europe, we will analyse the results of 3 Main Indicators; as far as these can be assessed. These are the political will in each of the Member States; the cultural attitudes to trading and change; which then dictate the level of commercial acceptance. The EFET Gas Hub Development Study is a good proxy for evaluating the three Main Indicators and its latest publication is reviewed in the second part of this Chapter.

In order to evaluate the depth, liquidity and transparency of the traded gas hubs across Europe, we will analyse 5 Key Elements, as far as these are available, the minimum necessary to permit a rigorous analysis of the depth, liquidity and transparency of a traded market. To focus on just one or two would certainly give a false account of the status of a traded market and distort any conclusion on a hub's development made therefrom.

The results, which appear below, will permit the evaluation of the respective hubs' maturity and their ability to provide a reliable price reference for contracted gas supplies. This is becoming increasingly pertinent, especially as the pricing of more and more, long term gas contracts has moved to hub indexation and market participants look to financially risk manage their physical gas portfolios effectively and efficiently.

What is clear is that during 2016 the Dutch TTF finally surpassed the British NBP as the dominant European gas hub, not only in terms of total traded volumes but also in several of the other metrics that are analysed in this paper. It is not only the €-denominated benchmark hub but has now become the leading European gas hub.

### The 5 Key Elements

The evaluation of the maturity of the selected hubs is based on evaluation of the following five key elements which will help in judging whether the criteria of depth, liquidity and transparency of these hubs are being met and to what degree. The five Key Elements are:

- a. Market participants: The number of active participants is an important indicator as to the development of that hub;
- b. Traded products: An important consideration when comparing traded markets to determine whether they are used for balancing or for risk management and so can produce a benchmark hub;
- c. Traded volumes: This element is associated with market activity and development and is a clear sign of a hub's relative importance;
- d. Tradability index: ICIS assessment for determining liquidity. In itself it is not an indicator of depth, liquidity and transparency;
- e. Churn rates: The multiple of traded volume to actual physical throughput. The most important Key Element and a measure of a gas hub's commercial success.

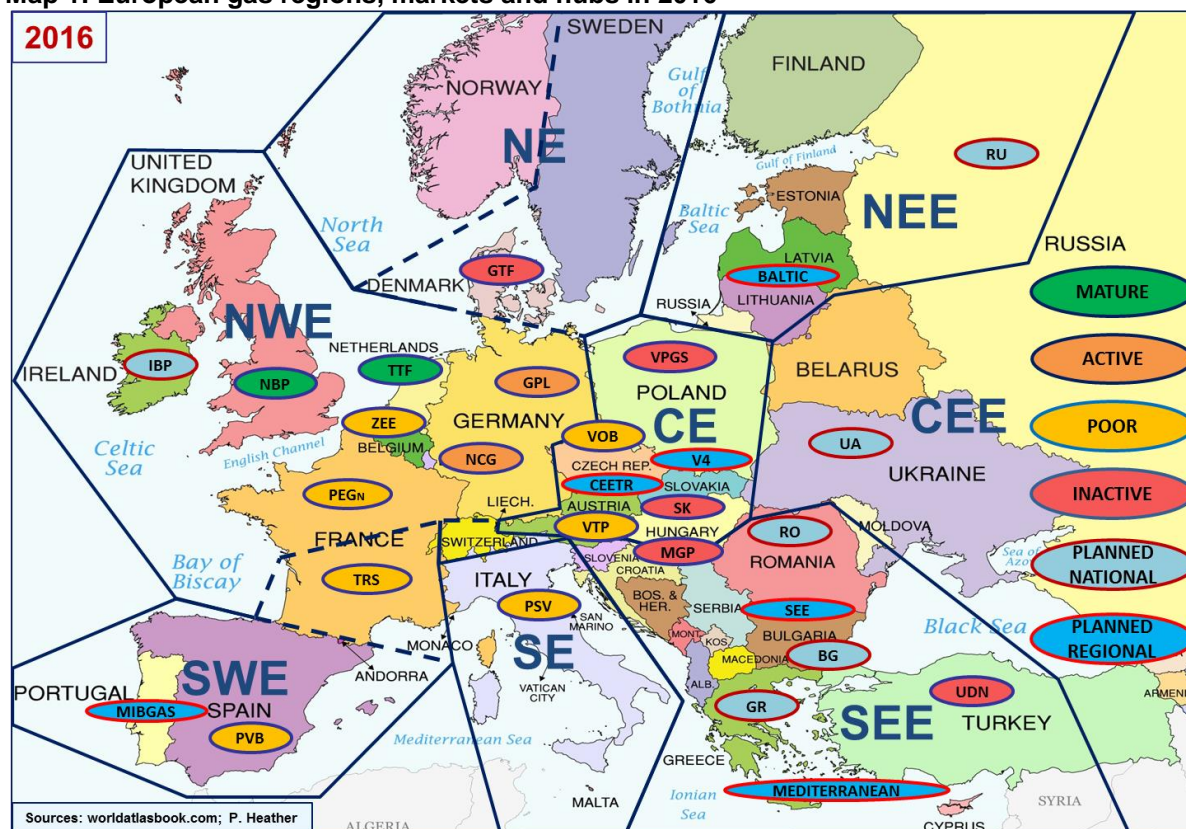
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<sup>1</sup> Heather (2015).

The detailed explanations as to the importance of the five Key Elements and the 3 Main Indicators and their impact on determining the level of hub maturity and development can be found in previous OIES papers, especially Heather (2015), Chapter 6. The detailed methodologies used in the tables to arrive at the 'rankings' of the hubs are described in the annex to that paper.

Map 1 shows the location of European hubs and the various levels of gas hub development, using a colour code based on the results of the analysis in this paper. The most developed part of Europe in terms of liberalised gas hubs is the North-West. This is also the part with the greatest disparity between the 'mature', 'poor' and emerging 'planned' hubs: Mature hubs are dark green; Active hubs orange; Poor hubs amber; and Illiquid hubs red. The colours used in Tables 1 to 6 are slightly different and will be explained with each Table.

**Map 1: European gas regions, markets and hubs in 2016**



### Key Element 1: Market participants

The number of companies trading at a gas hub is an important indicator as to the development of that market; it not only shows the willingness for traders to 'get involved' but also echoes how easy it is to participate. The important criteria are the number of independent participants and how many of them can be considered to be active: the more who regularly trade, the more liquidity there will be. If possible, the types of participants trading at a given hub should also be noted.

Only active traders should be considered because it is only they who will improve liquidity and competition to trade. This will usually create a 'tighter' bid/offer spread, and will reduce the chances of market manipulation. This will also generally mean that there will be greater depth to the market, meaning that there will be several buyers and sellers behind the posted bid and offer prices.

In Table 1 mature hubs are shown in green; the active hubs, with developing depth, liquidity and transparency in amber; and the poor hubs, which cannot yet be considered as deep, transparent or liquid, in red.



**Table 1: Market participants: 2005-2016**

HUB	Market Participants*			Active**		
	2005	2011	2014	2014	2015	2016
TTF	37	60	c.130	30	45	>40
NBP	c.80	c.160	c.200	40	45	>40
NCG+GPL	n/a	n/a	c.95	25	>25	30
PSV	n/a	112	118	12	15	18
ZEE+ZTP	53	78	82	15	15	15
CEGH/VTP	n/a	40	53	10	15	15
PEG Nord	23	36	55	10	10	15
PEG TRS				5	5	<10
VOB	n/a	n/a	16	<10	<10	<10
PVB	n/a	n/a	70	<5	<10	<10

\*the number of companies registered to trade at each of the hubs, or registered as Shippers;  
 \*\* the estimated number of participants who regularly trade.

Sources: 2005: E-Control; 2011: Heather (2012), Powernext;  
 2014, 2015, 2016: AEEG, CEGH, CNMC, GTS, Huberator, ICE, Ofgem, Parliamentary Wholesale Gas Market Report, Powernext, and from discussions with market participants and brokers

With respect to the number of active market participants, NBP and TTF numbers have stabilised in 2016 but are still at the top of the table and ahead of the German hubs and far ahead of all the other hubs. These two hubs are also those with a good number of financial players.

The German hubs and the Italian PSV both saw a 20% rise in active participants in 2016, particularly impressive for the PSV which only a few years ago was in the 'poor' category. The Spanish PVB is also slowly improving but can only record under 10 active participants.

These results show that in 2016, on Key Element 1, NBP, TTF and the two German hubs were mature; that the PSV, Belgian hubs, VTP and PEG Nord were active with developing depth, transparency and liquidity; and that the TRS, VOB and PVB cannot yet be considered as deep, transparent or liquid.

### Key Element 2: Traded products

An important consideration when comparing traded markets and in evaluating their relative success is to look at the products available to trade (Table 2) and to note where along the traded curve the volumes are being effected. This is important as only risk management hubs are likely to become benchmark hubs providing market prices and only benchmark hubs are likely to be able to provide risk management products – a virtuous circle but one that can be seen in other commodities across the world: liquidity attracts liquidity which in turn makes a market successful, increases its churn rate and allows it to develop into a 'mature' market able to provide reference prices.

**Table 2: European Gas Hubs: Traded Products in 2016**

2016																			
Product valuation based on absolute volumes*	OTC	CLEARING	WD DA	BOW W/E WDNW BOM	IMA MONTHS	QUARTERS	SEASONS	CAL YEAR	GAS YEAR	INDEX	EXCHANGE (% SHARE)	BALANCING TRADES	SPOT PROMPT	FUTURES MONTHS	FUTURES QUARTERS	FUTURES SEASONS	FUTURES YEARS	OPTIONS MONTHS	
TTF	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	ICE 82 PGS 17 CME 1	N	Y	Y	Y	Y	Y	Y	
NBP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	ICE 99 PGS 0 CME 0	Y	Y	Y	Y	Y	Y	Y	
NCG	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	PGS 99 ICE 0	N	Y	Y	Y	Y	Y	N	
GASPOOL	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	PGS 99 ICE 1	N	Y	Y	Y	Y	Y	N	
PSV	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	GME 66 PGS 30 ICE 3	Y	Y	Y	Y	Y	Y	N	
PEG NORD	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	PGS 100	N	Y	Y	Y	Y	Y	N	
ZEE + ZTP	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	ICE 93 PGS 7	Y	Y	Y	Y	Y	Y	N	
VTP	Y	N	Y	Y	Y	Y	Y	Y	Y	Y	CGH 100	N	Y	Y	Y	Y	Y	N	
PEG TRS	Y	N	Y	Y	Y	Y	Y	N	N	N	PGS 100	N	Y	Y	N	N	N	N	
PVB	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	MIB 100	N	Y	Y	N	N	N	N	
VOB	Y	Y	Y	Y	Y	N	N	N	N	N	CGH 100	N	Y	Y	N	N	N	N	
<b>*KEY:</b>	GREEN: =>600TWh		AMBER: <600tTWh		BLUE: <250TWh		RED: <50TWh		GREEN: =>500TWh		AMBER: <500TWh		BLUE: <100TWh		RED: <30TWh				
<b>GREY:</b>	Hubs column based on OTC + Exchange 'score'/64; OTC column based on 'score'/36; Exchange column based on 'score'/28																		
<b>No volumes</b>	ICE=ICE/Endex		PGS=PEGAS		CME=CME Europe		CGH=CEGH		MIB=MIBGAS		Y=AVAILABLE		N=NOT AVAILABLE						

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

The traded products table shows the different types of products that are available to trade, in both the OTC and Exchange markets. The 'popularity' of the different products in each of the hubs is shown by four colour codes, according to absolute traded volumes (the methodology is listed in the 'Key' row near the bottom of the table). The table is divided between the OTC market to the left and the exchange market to the right.

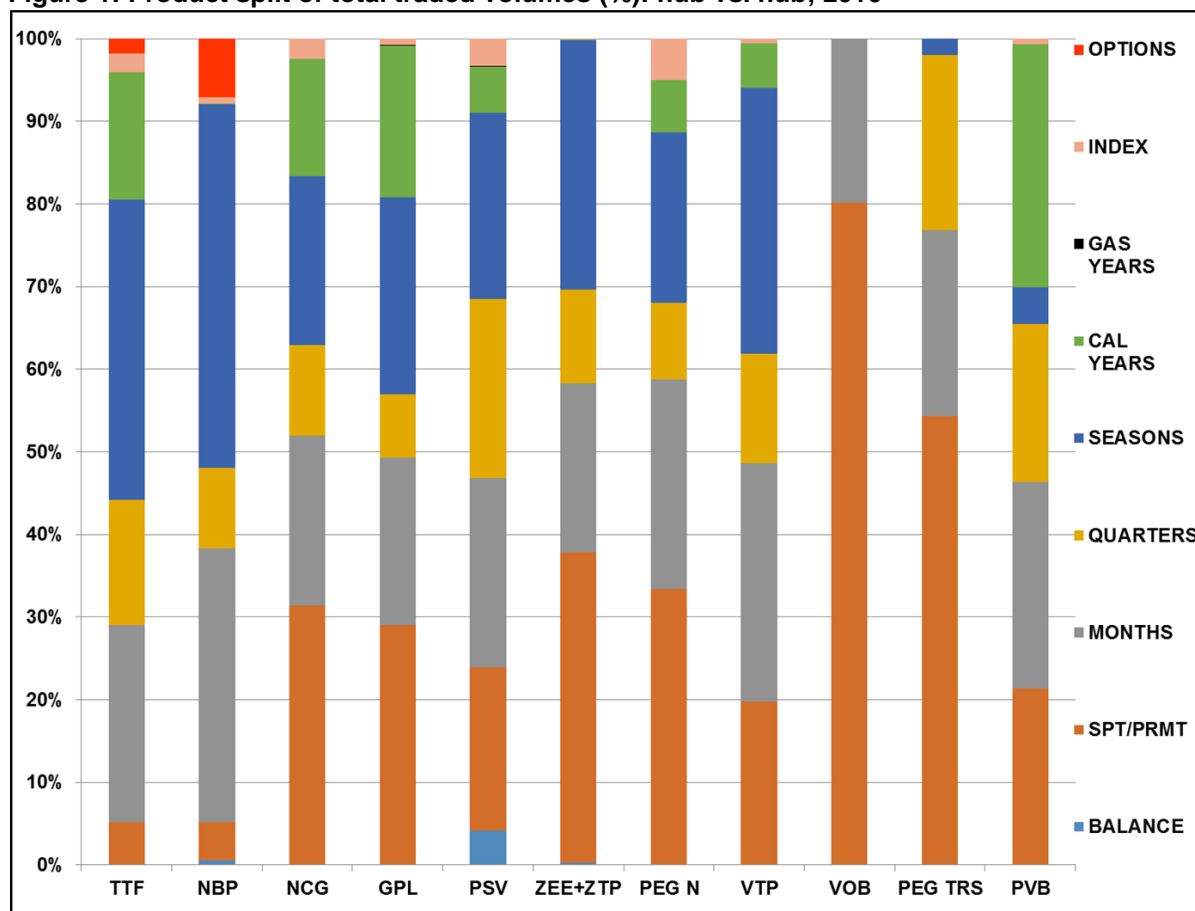
The relative hub versus hub detailed product splits for the total traded volumes are shown in Figure 1. This additional information will give a better understanding of what products along the curve are traded at each of the European hubs and how each of the hubs relates to the others. However, the splits are all percentages of each hub's total traded volume and not absolute volumes.

Although it is possible to trade all along the curve in the OTC market in each of the European gas hubs, in reality only the NBP and TTF trade in any quantity<sup>2</sup> beyond the Month Ahead contract, although some of the other hubs are noticeably improving<sup>3</sup>. When looking at the percentage splits, it is the TTF that is slightly ahead of the NBP, with an impressive 71% of the total trading being done in the Quarters, Seasons and Years (with NBP ranked second at 62%), both an improvement on the 2014 data.

<sup>2</sup> In absolute volumes.

<sup>3</sup> In percentage terms.

**Figure 1: Product split of total traded volumes (%): hub vs. hub; 2016**



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

In absolute volumes, the German hubs follow (although in percentage terms they are 51% at GPL and 48% at NCG) but it is the emerging Spanish PVB which is third in percentage terms of curve trading with 54% (albeit with very low absolute volumes), followed by the Italian PSV with 53% (in growing absolute volumes; see Table 3).

The Belgian market is almost exclusively OTC with a small amount of spot exchange trading. Overall, it has reasonable liquidity. The spot/prompt and first month part of the curve accounts for 58% of the total traded volume; the remaining 42% is in the near to mid curve, mainly traded in spreads against the NBP but with a limited amount of spreads against TTF and NCG.

The two French hubs are very different from each other and need to be analysed separately. Both have seen slightly increasing traded volumes in 2016 but PEG Nord is the more active. The spot/prompt and first month part of the curve accounts for 59% of the total traded volume (both OTC and exchange combined) and is quite liquid. The remainder of the curve rarely trades except in spreads (OTC and exchange) against the southern TRS, TTF and NCG; curve trading has mixed liquidity with some reasonably good volumes in the front Seasons.

However, it must be noted that, although the percentages of spot/prompt may be quite high for both the Belgian and French hubs, their absolute traded volumes fall short of the PSV, German hubs, and far short of the British NBP and Dutch hub (as shown in Table 3).

Finally, let us look at options traded products. These products are favoured by financial participants, especially banks and hedge funds and are usually only traded in mature markets that have good

liquidity and transparency. Only NBP and TTF recorded exchange options volumes (as well as a small quantity of OTC). The NBP exchange options accounted for 12.5% of its total exchange volumes and the TTF 6% of the total exchange traded volumes. However, adding the OTC volumes and then looking at the share of all traded volume, the NBP options accounted for a reasonable 7.1% and TTF for just 1.7%. These figures are all an improvement on the 2014 data.

With respect to the number of traded products it is clear from the tables that TTF and NBP have the greatest volume and percentage of curve trading, NBP having by far the greatest percentage of options trading and TTF in second place. The German hubs are next in absolute volumes (especially NCG) and also in the types of product traded (especially GPL). PSV has improved significantly since 2014 and now has the 5<sup>th</sup> highest traded volumes but also shows that those volumes are starting to be traded along the curve, mostly OTC. The Belgian hubs trade more than PEG Nord along both the spot/prompt and the curve, although they have far less exchange trading overall. PEG Nord does have some near to mid curve OTC trading, especially in spreads against adjoining hubs, and the Powernext PEG Nord spot contract does have very good volumes. Out of the remaining hubs, VTP has a growing amount of OTC curve trading in the Quarters and Seasons.

These results show that in 2016, on Key Element 2, TTF and NBP were mature; that the German hubs, PSV, PEG Nord and the Belgian hubs were active, with developing depth, transparency and liquidity; and that the VTP, TRS, PVB and VOB cannot yet be considered as deep, transparent or liquid.

### Key Element 3: Traded volumes

Traded volumes openly tell the tale of market activity; whatever the number of participants, whatever the types of product available, the volumes tell a very important story in the analysis of the development of a market, in this case the traded gas hubs. The traded volumes, compared to the overall size of the underlying market, determine the churn rate (see below), which is probably the most important factor in determining the success of a traded market. Generally speaking, markets with very high absolute traded volumes also have a large churn rate, have a large and varied range of participants and are usually free from price manipulation.

Table 3 shows the total traded volumes at each of the hubs in 2008, 2011, and 2014 and the progression from 2014 to 2016. In this table, mature hubs are shown in green; the active hubs, with developing depth, liquidity and transparency in amber; and the poor hubs, which cannot yet be considered as deep, transparent or liquid, in red.

Both TTF and NBP have by far the greatest traded volumes, and have done so for over 5 years; the big change since 2014 is that TTF has now overtaken NBP in Q2-2016 (see Figure 2), after an increase of 26% from 2014 to 2015 and a further 30% advance from 2015; during these two years NBP remained fairly flat. Another big increase over the past two years was recorded by the PSV (+69%), which has now overtaken the Belgian hubs and is getting closer to GPL.

NCG has risen nearly 20% over the past two years and GPL 11% and the two German hubs remain in third and fourth position but have only a fraction of the traded volumes of the top two hubs. The Belgian hubs seem to be recording a slow decline as they have lost some 10% over the last 5 years. The French PEG Nord has recovered a little, having previously lost ground in the early part of the decade but is being caught up by the Austrian VTP which has seen a steady increase in its volumes over the past five years. The traded volumes quarterly development over these past five years is shown in Figure 2.

The 'bottom' three hubs in absolute volumes are those which have seen some of the highest growth rates; the Czech VOB has had very rapid growth, tripling in size in just three years; the French TRS has grown 18% in the same time, after a short hiatus following the merger of the previous PEG Sud and TIGF hubs; and, finally, the emerging Spanish PVB has 'taken off' since its inception in late 2015 (taking over from the previous AOC balancing mechanism), increasing its traded volumes by over 200% but, of course, from a very low base.

**Table 3: Total Traded volumes: 2008-2016**

HUB	TOTAL TRADED VOLUMES* (TWh)						
	2008	2011	2014	Δ% =>	2015	Δ% =>	2016
TTF	560	6295	13555	+26	17080	+30	22230
NBP	10620	18000	20505	+2	20955	-4	20045
NCG	360	880	1750	+2	1790	+16	2080
GPL		310	1000	-5	950	+17	1110
PSV	160	185	525	+37	720	+23	885
ZEE+ZTP	500	870	850	-5	805	-3	780
PEG Nord	185	430	435	+15	500	+10	550
CEGH/VTP	165	170	400	-15	340	+56	530
VOB	n/a	n/a	35	+129	80	+31	105
PEG TRS	n/a	SUD 40	80	TRS -27	65	+54	100
		TIGF 5	5				
PVB	n/a	n/a	n/a	-	<10	+200	30

\*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.

2015, 2016: LEBA, ICIS, ICE, ICE-Endex, PEGAS, CME, CEGH, GME; MIBGAS; P. Heather

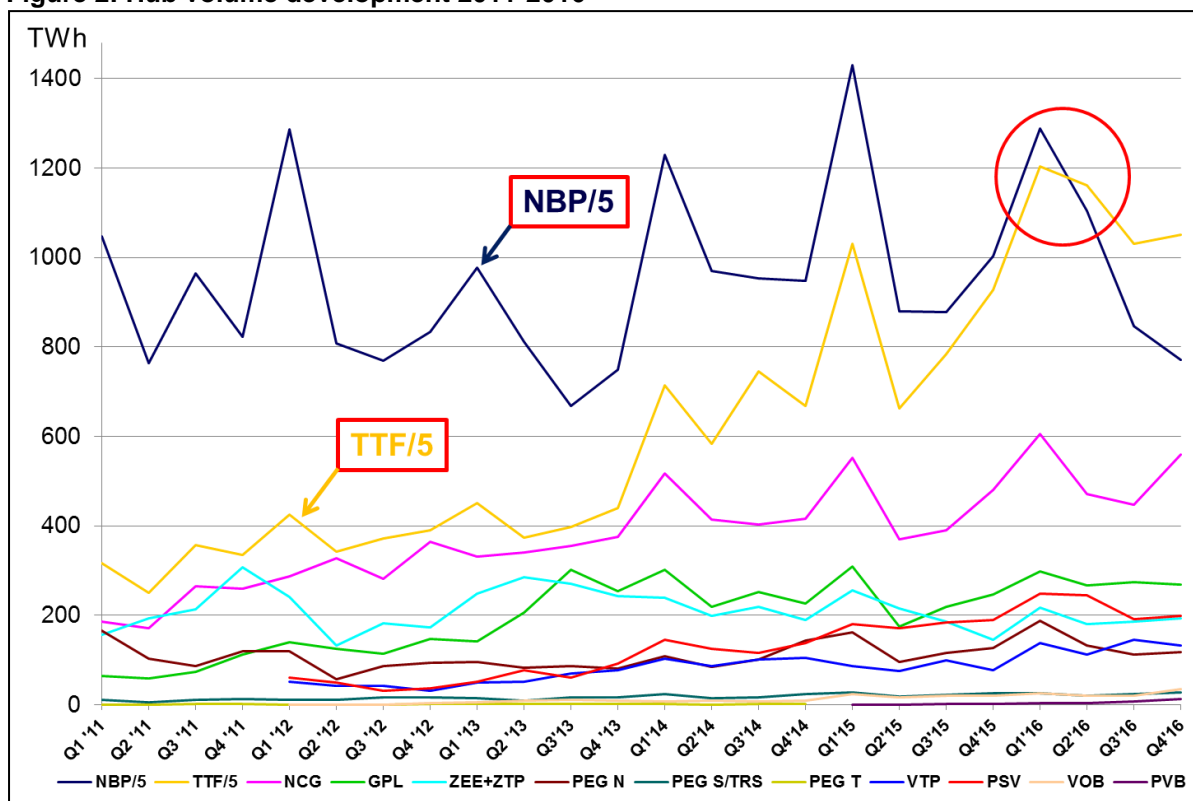
The situation in 2016 is that TTF has now overtaken (by 11%) the NBP but those two hubs together simply dwarf all the others in the amount of volume traded: out of a total of 48,445TWh traded across all the hubs, TTF and NBP together accounted for over 87%.

Taken on its own, TTF is 7 times larger than the two German hubs combined, 25 times larger than PSV, over 28 times larger than ZEE; and about 41 times larger than both PEG Nord and VTP.

These results show that in 2016, on Key Element 3, TTF and NBP were mature; that the German hubs were active, with developing depth, transparency and liquidity; and that all the other hubs cannot yet be considered as deep, transparent or liquid.



**Figure 2: Hub volume development 2011-2016**



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

#### Key Element 4: Tradability Index

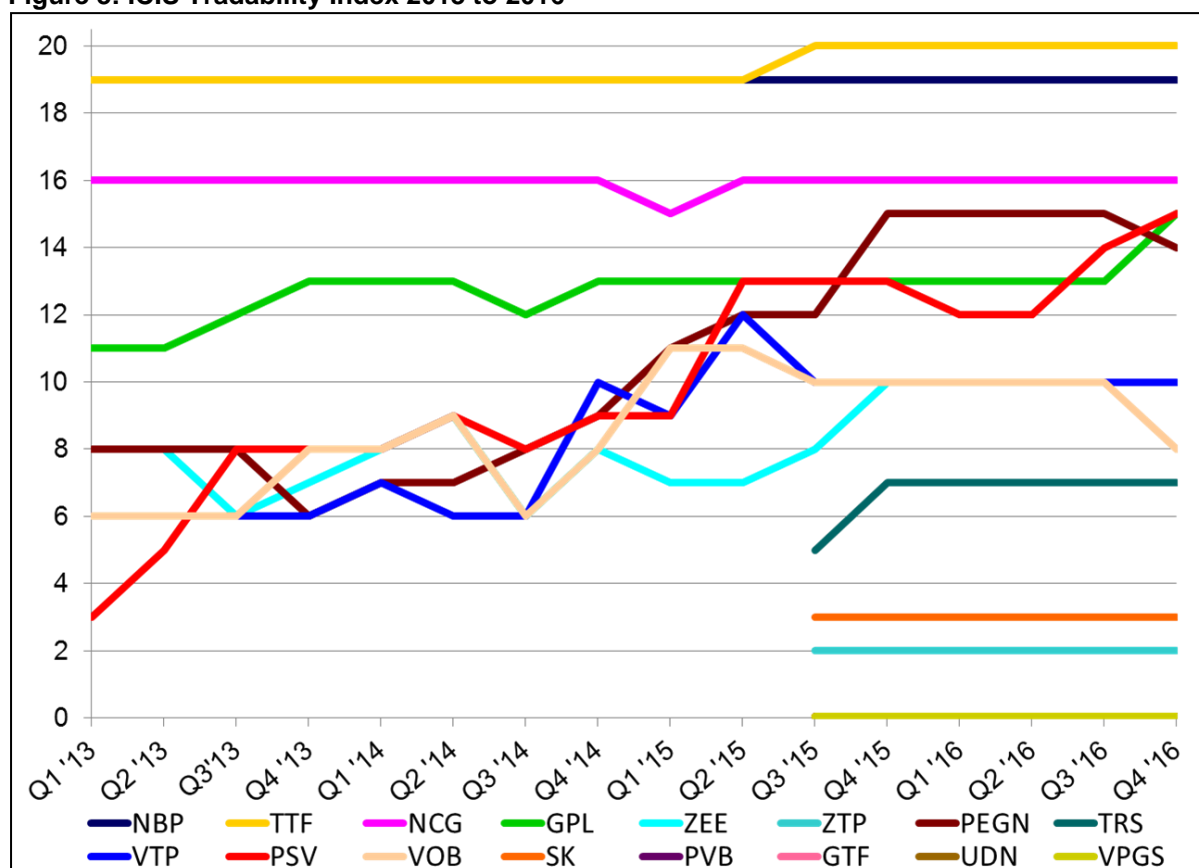
The ICIS Tradability Index is not in itself an indication of a deep, liquid and transparent market but it can assist the analysis of the development of a traded hub, in conjunction with other metrics. This is because it only looks at the bid/offer spread without evaluating the depth of the market at the quoted prices; therefore, although it is good if a market has a tight bid/offer spread, this is less significant if only a small volume can be traded at the advertised price/s. However, it should be included here also to complement the other key elements that help to determine the depth, liquidity and transparency of the hubs in question.

For the result to have any indication, it is necessary to look firstly at the progression of the Index over time, then secondly at the actual number. In practice, a result below 16/20 is not very meaningful, whereas a result of 18/20 or above does indicate that most of the criteria for arriving at that score have been met and so, by extension, that the hub in question does have reasonable liquidity.

By looking at Figure 3, it can be seen that, since 2014, TTF has stepped up to the maximum score of 20/20 and that NBP has remained at a very credible 19/20; these two hubs are 'mature' so this is not surprising. NCG has remained at 16/20 (bar a temporary blip to 15/20 in Q1-15).

All the remaining hubs were below the 16/20 threshold, meaning that their results are not very meaningful. However, we can still observe that there are three hubs that are clearly 'mid-market', whereas the remainder are all at or below 10/20.

**Figure 3: ICIS Tradability Index 2013 to 2016**



Sources: ICIS European Gas Hub Reports; P. Heather

The mid-market hubs were GPL, which remained at 13/20 (bar a temporary blip down to 12/20 in Q3-14), until it rose to 15/20 in Q4-16; PSV which had a steady climb from a poor 9/20 to 15/20, reflecting the progress seen in other metrics; and PEG Nord which also continued to improve its score in the past two years from a poor 9/20 to 15/20 but has slipped back in Q4-16 to 14/20.

These results show that in 2016, on Key Element 4, TTF and NBP were mature; that NCG was an active hub with developing depth, liquidity and transparency; and that all other hubs were poor hubs, and cannot be considered as deep, transparent or liquid.

### Key Element 5: Churn rates

Probably the most important measure of a gas hub's commercial success is the churn ratio, which is the multiple of traded volume to actual physical throughput: a measure of the number of times a 'parcel' of gas is traded and re-traded between its initial sale by the producer and the final purchase by the consumer. The churn rates are an excellent measure of a hub's real liquidity and success and are a parameter used in most commodity and also financial markets.

Commodity markets are deemed to have reached maturity when the churn is in excess of 10 times. 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 times.

**Table 4: Churn rates: 2008-2016**

(Mature hubs are shown in green; active hubs in amber; and the poor hubs in red.)

HUB	TRADED GAS HUBS CHURN RATES*				
	2008	2011	2014	2015	2016
TTF	3.3	13.9	36.0	45.9	57.1
NBP	14.4	19.8	26.2	26.2	22.1
CEGH/VTP	2.4	2.2	4.8	3.9	5.7
ZEE+ZTP	5.1	4.1	4.9	4.3	4.1
NCG	0.4	1.8	4.2	3.9	4.0
GPL		0.8	3.0	2.5	2.5
PEG Nord	FRANCE 0.4	FRANCE 1.0	1.6	1.7	1.7
PSV	0.2	0.2	0.8	1.0	1.2
VOB	n/a	n/a	0.4	1.0	1.1
PEG TRS	n/a	n/a	SUD 1.0	0.6	0.6
			TIGF 0.1		
PVB	n/a	n/a	n/a	<0.1	0.1

\*Calculated on a Net Market Churn basis; not the same methodology in all years.

Sources: 2008: Heather (2010), Table 6, p.19; Komlev presentation 2011; calculated from BP and IEA; 2011, 2014: LEBA; ICE ; ICE-Endex ; EEX ; Powernext ; CEGH; GME; P. Heather  
2015, 2016: LEBA, ICIS, ICE, ICE-Endex, PEGAS, CME, CEGH, GME; MIBGAS; P. Heather

Table 4 shows the hubs' net<sup>4</sup> market churn rates from 2008 to 2016. The results show that TTF has continued to improve its score to over 57 times from just under 14 times five years ago; NBP comfortably remains in second place, although a little lower, at just over 22 times. These two hubs are the only ones to register a churn rate above 10.

The hub in third position and the only other one to register a churn above 5, is the Austrian VTP, at 5.7 times. All the other hubs register a very poor churn rate of under 5 times: ZEE and the two German hubs have lost ground since 2014, PEG Nord has barely changed at 1.7 times, PSV and VOB have improved but to only 1.2 and 1.1 times respectively, TRS and PVB do not record a 'churn', as they are both under 1.

These results show that in 2016, on Key Element 5, TTF and NBP were mature; that VTP was an active hub with developing depth, liquidity and transparency; and that all other hubs were poor hubs, and cannot be considered as deep, transparent or liquid.

<sup>4</sup> See Heather (2015) for an explanation of the different methodologies used to calculate the churn.

### Summary of the 5 key elements, in 2014

The results from each of the 5 Key Element tables have been recorded in a summary table (Table 5). A simple scoring methodology has been used to derive the final ordering of the hubs, to reflect their level of development: mature, active, poor and inactive as indicated in the map of the European gas regions, markets and hubs (Map 1). The points system is indicated at the bottom of the table and, adding up each of the constituent Key Elements will give a hub score out of 15. A hub is classified as being 'mature' if the score is 12-15; 'active' if the score is 8-11; 'poor' if the score is 5-7; and 'inactive' if the score is 1-4.

**Table 5: Summary of the 5 key elements, in 2016**

2016	5 KEY ELEMENTS					
HUB	Active Market Participants	Traded Products*	Traded Volumes	Tradability Index (Q4)	Churn Rate	Score /15**
TTF	>40	53	22230	20	57.1	15
NBP	>40	47	20045	19	22.1	15
NCG	30	29	2080	16	4.0	10
GPL	30	23	1110	15	2.5	9
PSV	18	23	885	15	1.2	7
ZEE+ZTP	15	17	780	10	4.1	7
PEG Nord	15	18	550	14	1.7	7
VTP	15	14	530	10	5.7	7
VOB	<10	6	105	8	1.1	5
PEG TRS	<10	13	100	7	0.6	5
PVB	<10	9	30	0	0.1	5

\* Score /64 derived from the OTC and Exchange product categories in the Traded Products Table.  
 \*\* Score based on each of the Key Elements scoring zero for Grey; 1 point for Red; 2 points for Amber; 3 points for Green.

Source: Calculated from previous tables

These results show that in 2016, taking all 5 key elements into account, the NBP and the TTF are the only hubs that can be considered as mature, deep, transparent and liquid. NCG and GPL are active hubs with developing depth, transparency and liquidity; all the other hubs cannot be considered as deep, transparent or liquid.

### The 3 Main Indicators<sup>5</sup>

The three Main Indicators are most certainly inter-dependent in enabling the move towards fully liberalised gas markets across the entire EU. There must be the political will to get the process off the ground; there must be the cultural attitude to want to succeed in a trading environment; and there has to be the right commercial appetite to see all the changes followed through.

The EFET Gas Hub Development Study is a good proxy for evaluating the three Main Indicators across all countries, including those that do not yet have an operational traded gas hub, as it assesses 5 regulatory conditions, 6 TSO conditions and 6 market conditions.

The results<sup>6</sup> of the 2016 Study are given in Table 6, enhanced by a four colour coding<sup>7</sup>.

<sup>5</sup> See Heather (2015) for a full description of the 3 Main Indicators. The present paper will give the summary update for 2016.



**Table 6: EFET Hub Scores categorised as mature, active, poor and inactive; 2014-2016**

HUB	Score 2014	Score 2015	Score 2016
NBP	20	20	20
TTF	19	19½	19½
NCG	15½	19	19
GPL	16	19	19
PEGs	16	16½	18½
ZTP	16	17½	18
ZEE	17	17	17
PSV	10½	15	15
GTF	9	11	14
VTP	13	13	13½
AOC/PVB	7	7	13½
VOB	8	8½	9½
VPGS	4½	5½	9½
MGP	5	6½	9
SK	3½	7	8
GR	4½	5½	5½
UDN	5½	5	4
RO	2½	1½	2
BG	1½	1	1½

Source: 2016 EFET Review of Gas Hubs Assessments; P. Heather

The order of the hubs in the top half of the table is almost identical to that in Table 5, except that EFET does not distinguish between the three PEGs, that the NBP and TTF rankings are reversed and that the French, Belgian and Italian hubs are reversed.

EFET gives the Danish hub a relatively good mid-market score (even though there is very little trading<sup>8</sup>), ahead of the VTP, PVB and VOB. Interestingly, the Polish VPGS just makes it as a poor hub with a score of 9½, which is echoed in the impressive increase in traded volumes<sup>9</sup> carried out on the POLPX since 2014. The Hungarian MGP also scrapes into this category.

Finally, the remaining 5 hubs studied have very low scores, classifying them as inactive; indeed, the three South East European hubs in Romania, Bulgaria and Greece are still only at the 'planned' stage. EFET has not so far studied the IBP (planned Irish hub).

<sup>6</sup> Note that EFET revised their methodology slightly for the 2016 study and recalculated the scores for the previous 2 years.

<sup>7</sup> Methodology: Mature/Green: =>18; Active/Orange: <18; Poor/Amber: <15; Inactive/Red: <9.

<sup>8</sup> This may be about to change following the addition of this hub on the PEGAS platform since November 2016.

<sup>9</sup> There has been very little OTC trading but the TGE Exchange (POLPX) has been offering products at the Polish VPGS hub since 2013, both spot (WD and DA) and curve (Months, Quarters, Seasons and Years). The annual traded volumes (TWh) have been: 2013: Spot: 0.425/Curve: 1.968; 2014: Spot: 5.390/Curve: 105.076; 2015: Spot: 13.925/Curve: 92.634; 2016: Spot: 24.595/Curve: 89.874.

## Chapter 3. Price analysis and remaining barriers to trade gas across borders

### The price metrics

If we want to assess the maturity of wholesale gas markets the natural complement of the liquidity analysis presented above is the study of hub price dynamics, and in particular the assessment of: the frequency of the price signal for traded gas; the convergence of the price signal between the exchange and OTC market and, last but not least, the degree of price correlation among different markets.

Frequent (i.e. daily) price signals are a prerequisite for a well-functioning traded commodity market, as they provide price transparency which is vital for its core activities: physical balancing, financial risk management, and, more generally, an efficient allocation of the commodity across different locations and market participants. Convergence between the exchange and OTC market price signals is important because OTC and organized exchange prices should not significantly differ, when referred to the same delivery framework and hub in a well-functioning market.

The third price-based indicator for hub maturity is the degree of price correlation between adjacent markets. Price correlation is considered as one possible, although not an exhaustive, metric to assess the efficiency of cross-border trading and the degree of integration between European hubs<sup>10</sup>. More specifically, high correlation scores between the price time series of two adjacent markets suggest a breakdown of structural barriers to flowing gas across borders and, consequently, that arbitrage forces succeed in bringing prices back in line with each other very rapidly after a demand/supply shock occurs. If we can demonstrate that good correlation between prices at different hubs exists, this should resolve any suspicion of manipulation at local level and indicates the possibility of freely trading the commodity across borders, as envisaged by the Gas Target Model<sup>11</sup>. Where price correlation is poor, this indicates that the commodity cannot move freely across borders/interconnectors. The occurrence of a period of low correlation (or price de-linkage) can be explained either by insufficient capacity to transport gas across borders (physical congestion) or by the fact that transmission capacity is there but is not optimally used (non-physical congestion).

To sum up, while gas trading volumes and liquidity are important indicators of the maturity of gas markets at a local level, the maturity of the gas market at European level is better assessed by looking at the degree of price correlation between neighbouring hubs<sup>12</sup>.

### Price signals in 2016

By visual inspection it is apparent that if we focus on the day ahead contract which is, by and large, the most frequently traded across all the hubs, starting from 2016 we could rely on the existence of a continuous daily price signal, either on the exchange or on the OTC market, for most of the trading gas hubs in Europe (**Figure 4**). In 2016, OTC trading started at the Slovak virtual trading hub<sup>13</sup>: this

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<sup>10</sup> For a discussion on the relevance and shortcomings of price correlation metrics, please refer to Petrovich (2014) P. 9-10 and Petrovich (2013) P. 8-10.

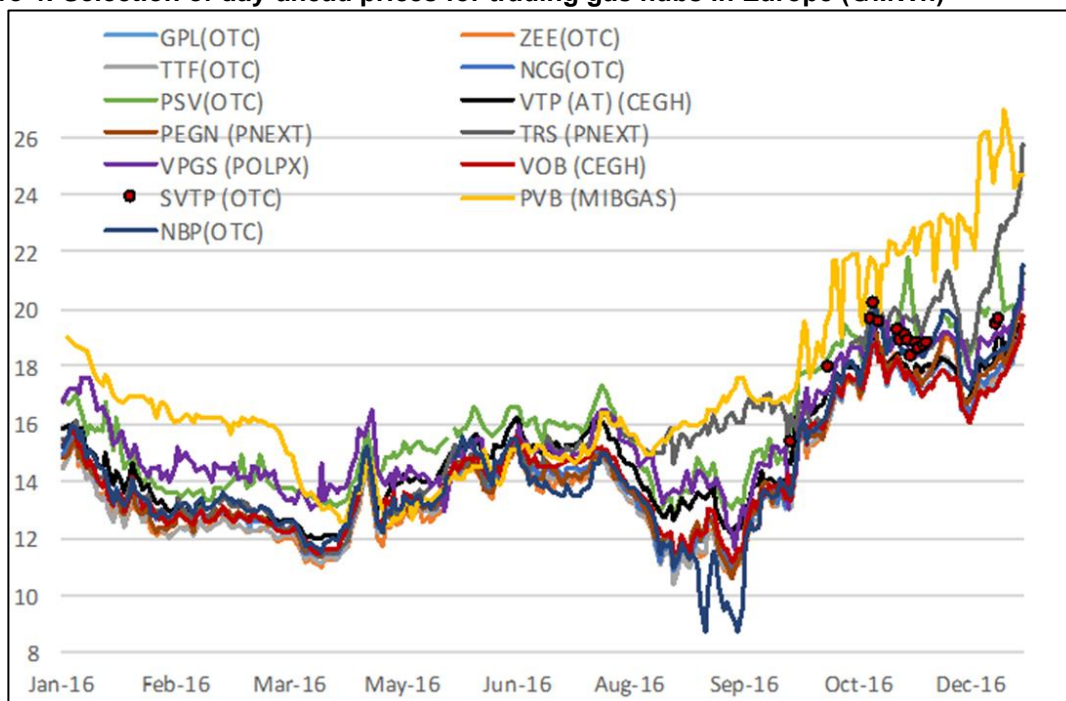
<sup>11</sup> The Gas Target Model is a conceptual model for the single European gas market originally developed by CEER in 2011, and updated in 2015, for details: ACER, European Gas Target Model –review and update, <http://www.acer.europa.eu/Events/Presentation-of-ACER-Gas-Target-Model-/Documents/European%20Gas%20Target%20Model%20Review%20and%20Update.pdf>

<sup>12</sup> Strong price correlation means that prices in two markets react to the same supply/demand changes, in the same way and at the same time, therefore producing parallel price movements (i.e. constant price spreads). For details on the definition and methodology for measuring price correlation, refer to Petrovich (2013, 2014).

<sup>13</sup> Based on our sources (trades data provided by ICAP, Marex Spectron, Tullett Prebon), we could not compute a continuous OTC short-term price time series for the Slovak hub. However, this could be simply because other brokers who are active in this market, such as 42 Financial, GFI, Griffin Markets or Tradition (source: Trayport Market Matrix), hold a majority market share. LEBA volume report includes the Slovak hub volumes in the “Other gas” category. No Slovak gas products are currently traded on an exchange as of 2016, to the best of our knowledge, leaving Slovakia without an exchange price signal for market traded gas.

could be the next market to join the club. In other European regions, such as the Baltics and South East Europe, traded gas prices are not yet quoted on any kind of consistent basis. In Hungary there is still an immature traded market for gas, the MGP, with virtually no OTC trading and a very small amount of trading on the CEEGEX exchange platform<sup>14</sup>; in Romania the state-owned OPCOM exchange publishes a daily price reference, but hardly trades; in Denmark gas trading is still marginal, but the situation is likely to change soon, as is signalled by the fact that the PEGAS exchange launched spot and future products for the Danish gas hub in November 2016<sup>15</sup>.

**Figure 4: Selection of day-ahead prices for trading gas hubs in Europe (€/MWh)<sup>16</sup>**



Notes: SVTP = Slovakian virtual trading point; PNEXT = Powernext;

Sources: Tankard Parties (i.e. ICAP, Marex Spectron, Tullett Prebon) for OTC prices; CEGH, Powernext, POLPX, MIBGAS for exchange prices; oanda.com and Datastream for exchange rates

More liquid hubs constantly feature a daily day ahead price signal both in the OTC and exchange market and they are virtually identical, signalling price efficiency. In 2016 the MIBGAS exchange in Spain started to provide a price signal on a consistent basis, as Spanish gas exchange trading increased. Spanish OTC trades, occurring since 2014 and increasing in 2015 and 2016<sup>17</sup>, are concluded at prices which are consistent with MIBGAS prices (**Figure 5**).

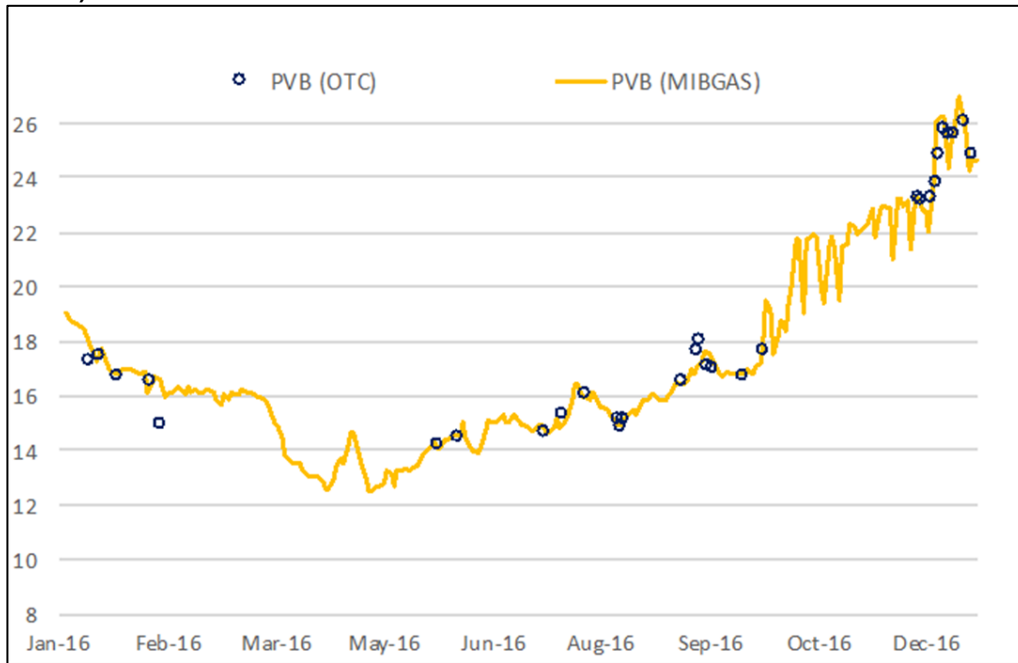
<sup>14</sup> In January 2016 only 0.05 TWh were traded spot at CEEGEX (source: <https://www.ceegex.hu/en/kommunikacio/Aktualitasok/Lists/actualities/DispForm.aspx?ID=35>); in October 2016 CEEGEX launched within-day products( source: <https://www.ceegex.hu/en/kommunikacio/Aktualitasok/Lists/actualities/DispForm.aspx?ID=60>)

<sup>15</sup> Source: EEX press release dated November 24, 2016 “PEGAS: Successful Launch of Danish ETF Contracts” available at: <https://www.eex.com/en/about/newsroom/news-detail/pegas--successful-launch-of-danish-etf-contracts/61278>.

<sup>16</sup> The most representative market outlet is chosen for each hub, which could be OTC or exchange. ZTP hub is not included although it has a rather frequent daily day ahead price signal on the OTC market. The daily OTC prices are volume-weighted average daily prices, computed from data on single OTC trades as provided by three main brokering houses (the Tankard Parties: ICAP, Marex Spectron, Tullett Prebon), which in 2016 represented about 70% of total European OTC trading. For further details see: Petrovich (2013, 2014).

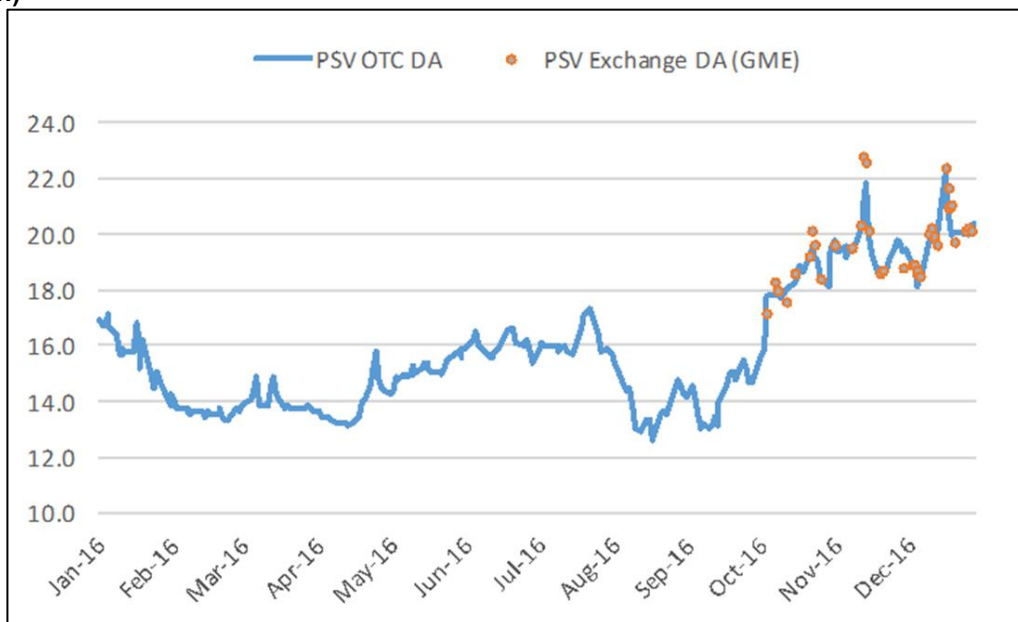
<sup>17</sup> Data in the OTC trades sample (based on Tankard Parties data) that we use to derive daily OTC day ahead prices are still too few to provide a consistent and robust day ahead price signal.

**Figure 5: Daily OTC and exchange day ahead gas prices for delivery at the Spanish PVB in 2016 (€/MWh)**



Sources: Tankard Parties for OTC prices, MIBGAS

**Figure 6: Daily OTC and exchange day ahead gas prices for delivery at the Italian PSV in 2016 (€/MWh)**



Sources: GME MGP-GAS, Tankard parties

Some other emerging hubs still lack a daily spot price signal either on the OTC or on the exchange market. At the Polish hub, for instance, OTC trading is still marginal<sup>18</sup>, but the gas exchange POLPX

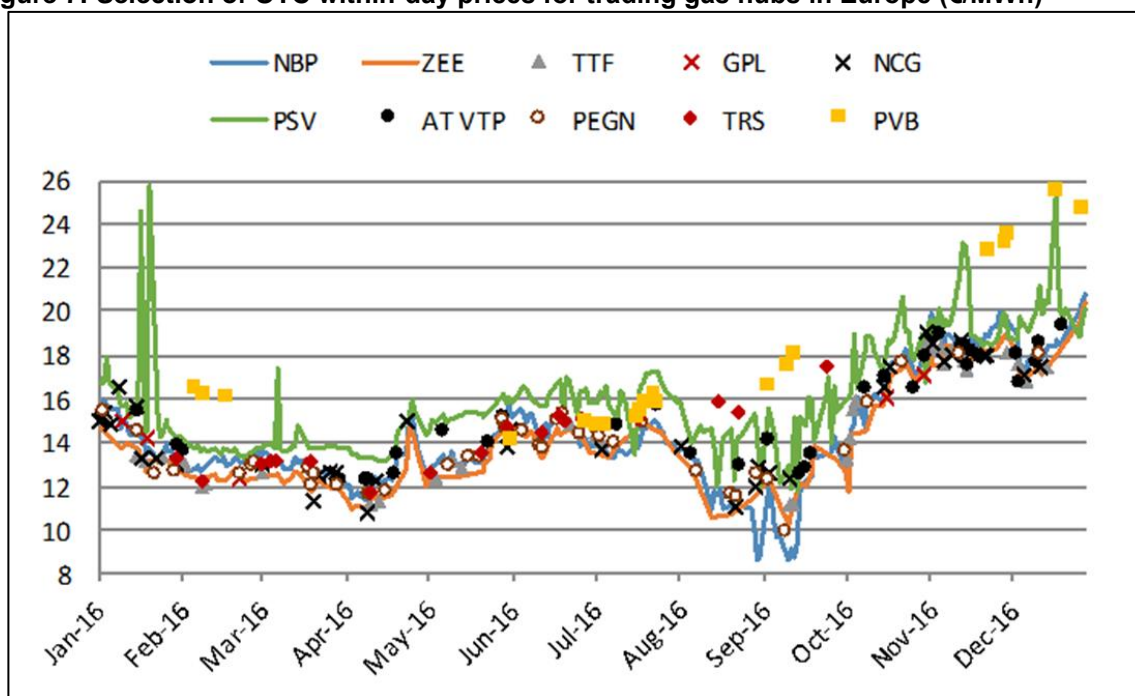
<sup>18</sup> According to ICIS Heren data, in Poland there were only 96 OTC trades reported during 2016 and 5 traded during Q1 2017. LEBA volume report includes Polish hub's volumes in the "Other gas" category, but they represent a small share of it.



has offered a daily day ahead price signal since 2013. In contrast, at the Italian PSV, until very recently, a daily spot price signal was only offered by the OTC market. Day ahead liquidity on the GME exchange was virtually zero before October 2016, when a new market-based balancing regime was implemented.<sup>19</sup> This led to more liquidity on the exchange platform managed by the state-owned Italian market operator (Gestore dei Mercati Energetici, GME). The day ahead product offered on the GME market venue started to be traded and offered a price signal for some days, which was substantially in line with the Italian OTC price (**Figure 6**).

As curve trading concentrates at few hubs (as shown by the analysis in Table 2 and Figure 1), reliable price signals for maturities beyond the month ahead cannot be found in all European gas markets covered in this study: the “balancing” hubs are, in fact, only fit to provide price discovery on shorter maturities. Interestingly enough, the only markets showing a robust daily within-day price signal are NBP, ZEE and the Italian PSV (**Figure 7**). In fact, generally speaking, Continental Europe still lacks within-day trading, and, hence, lacks consistent within-day price signals: despite the ambition of the European Network Code on Balancing (reg. EU 312/0214), shippers in many European countries still balance largely at the day ahead stage.

**Figure 7: Selection of OTC within-day prices for trading gas hubs in Europe (€/MWh)<sup>20</sup>**



Source: Tankard Parties for OTC prices; oanda.com for exchange rates

### Price correlation scores in 2016

The assessment of price correlation between markets focuses on day ahead gas price quotations<sup>21</sup>, since the day ahead product is, by and large, the most frequently traded spot product on the exchanges as well as on the OTC market. In addition, the short-term horizon is typically the horizon

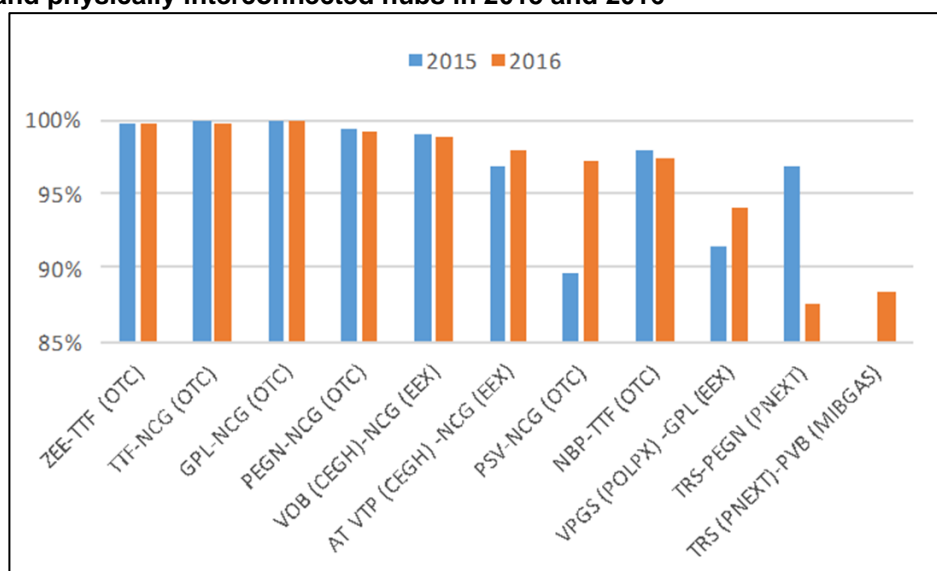
<sup>19</sup> A new market balancing regime was in place starting from the 1<sup>st</sup> of October 2016 (resolution 312/2016/R) implementing the European Gas Balancing Network Code (reg. EU 312/0214).

<sup>20</sup> The most representative market outlet, which could be OTC or exchange, is chosen for each hub.

<sup>21</sup> Please note that OTC correlation scores are based on volume-weighted average daily prices. For some hubs, looking at average daily prices may underestimate the strength of price correlation and might not show optimal use of interconnections, as arbitrage across the markets connected by very flexible transmission capacity can occur over the day and the prices at the close of the day, that are usually adopted as indexes in supply contracts, may diverge from quotes during the rest of the day, not being strictly driven by arbitrage opportunities. For a discussion: Petrovich (2013, 2014).

over which we would expect to see evidence of the strongest drivers of price differences between hubs (e.g. due to weather variations or local supply/demand issues). Consequently, observing structurally correlated day ahead prices suggests that the prices for the far-curve, if the liquidity develops over the curve, may be well correlated too. Day ahead price scores for adjacent hubs in 2016 remained relatively stable compared to 2015 (Figure 8).

**Figure 8: Cross correlation scores between day ahead daily prices for selected pairs of adjacent and physically interconnected hubs in 2015 and 2016**



Notes: 100% = perfect positive correlation, 0% = absence of any linear relationship; PNEXT = Powernext

Sources: Tankard Parties for OTC prices, CEGH, Powernext, POLPX, MIBGAS, oanda.com and Datastream for exchange rates

In North West Europe (TTF, NCG, Gaspool, ZEE, PEGN), price alignment and price level convergence continues to be strong: this region behaves as if it is a single-price area, i.e. a fully integrated trans-national market for gas. Interestingly, the younger and relatively scarcely liquid Czech hub shows prices very closely correlated to this interconnected price area (as reflected in the high correlation score between VOB and the neighbouring NCG). This, suggests a good level of market openness and the absence of barriers to cross border trade in this market region.

On the contrary, the Austrian VTP, notwithstanding its direct interconnection to Germany, continues to exhibit a slight price disconnection to the adjacent NCG, with a rather volatile premium over the German price, especially over the summer months.

There are also other markets that, although being directly physically connected to the core North West European hub group, show poor price alignment to neighbouring hubs, pointing to barriers to the free flow of gas across borders.

Firstly, we observe price disconnection between the Italian PSV and North West European (NWE) gas markets, although there is an improvement compared to 2015: day ahead OTC price correlation between PSV and the German NCG in 2016 (97%) was weaker than that observed between the NWE hub core group. (Between NCG and TTF the score was virtually 100% in the same period). Moreover, at the Italian hub, gas was always traded at a premium on the OTC market compared to the neighbouring NCG and TTF hubs: the PSV OTC day ahead price premium on the German price (on average equal to 1.7 €/MWh in 2016) was rather volatile (ranging from 0.5 to 4.3 €/MWh). Further, day ahead prices quoted by the Polish gas exchange are weakly correlated to the adjacent German market. The British NBP, also, experienced periods of price delinkage.

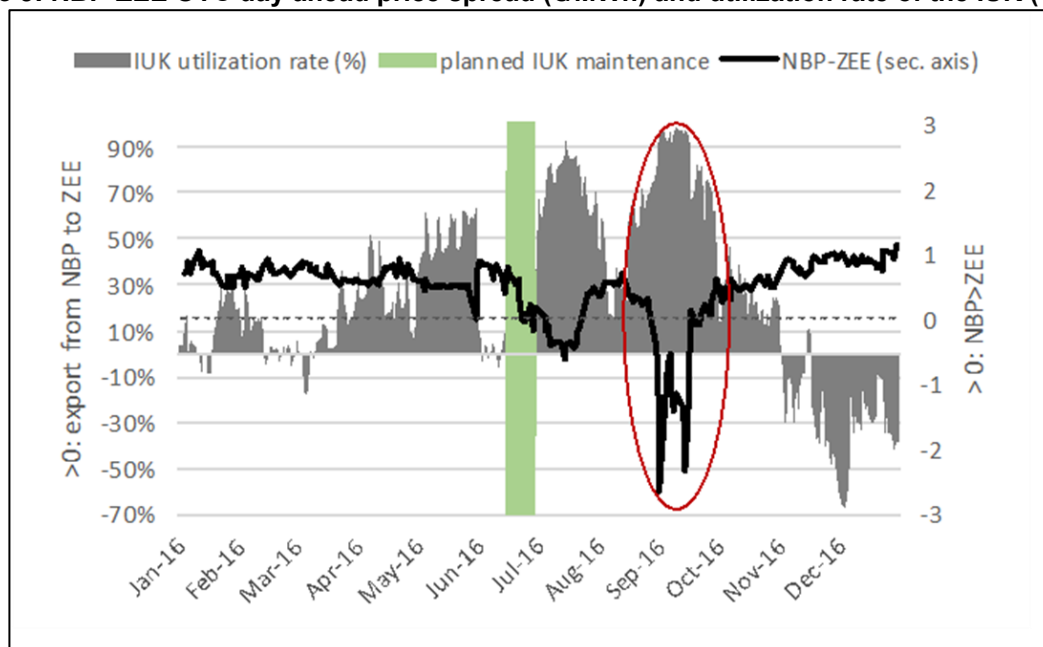
Weak price correlation can also be observed within France and between France and Spain in 2016. Starting from the summer of 2016, gas in the Trading Region South (TRS) was charged at a substantial and rather volatile premium compared to the rest of the country. The Spanish exchange day ahead price was weakly correlated to the adjacent TRS, notwithstanding the existing physical interconnection.

The drivers behind these periods of price delinkages are, however, not the same for all hubs: while those involving the NBP, TRS and the Austrian VTP are caused by physical congestion on the connecting pipeline system, those involving the PSV, Spain and Poland appear to be caused by non-physical barriers to trade gas across borders, meaning barriers in procuring transmission capacity between markets.

### Physical barriers to price alignment

The periods of low correlation experienced by the NBP, such as the one occurring in the first half of September 2016, when British prices collapsed and reached a 1.5+ €/MWh discount over Belgium prices (highlighted by a red circle in **Figure 9**), are driven by the impossibility of shipping gas through the bidirectional Interconnector pipeline (IUK) which connects the British hub with the Zeebrugge hub in Belgium<sup>22</sup>. In the beginning of September 2016, in fact, the IUK was running at almost full capacity (average utilization rate for export capacity to Belgium exceeded 95%, **Figure 9**), physically disconnecting the NBP from Continental Europe. Looking forward, the impact of Brexit on gas interconnectors regulation<sup>23</sup> may result in higher volatility in NBP prices and more frequent delinkages from Continental European prices.

**Figure 9: NBP-ZEE OTC day ahead price spread (€/MWh) and utilization rate of the IUK (%)**



Sources: Tankard Parties, IUK

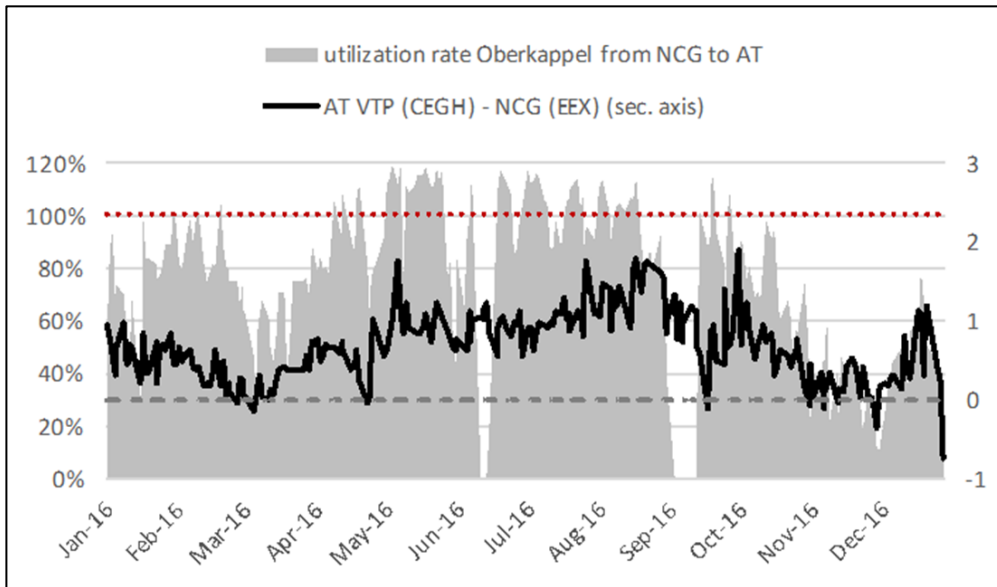
Similarly, the disconnection between the Austrian VTP and the adjacent NCG, occurring mostly during the summer, is driven by saturation of the transmission capacity between Germany and Austria, due to high eastwards flows through the Oberkappel interconnection point (**Figure 10**). These are partially

<sup>22</sup> This is somewhat of a simplification as it is also possible to connect the two hubs indirectly via the BBL pipeline, connecting NBP to TTF, which in turn is linked to ZEE. However, the IUK is a very flexible pipeline, allowing for a quick response to price movements, due to an active secondary market for transport rights.

<sup>23</sup> As discussed in Bros (2017).

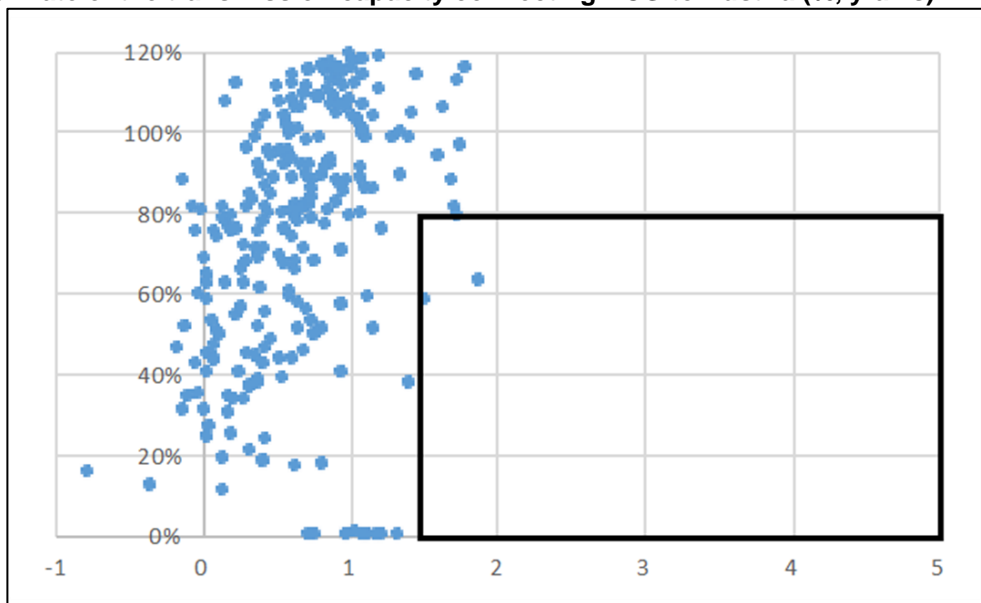
motivated by arbitrage opportunities with the Italian hub, as explained below, and possibly reverse flow to Ukraine<sup>24</sup>. Austrian gas was priced at over 1.5 €/MWh compared to the German market virtually only when the utilization rate of the interconnecting capacity was above 80% (**Figure 11**).

**Figure 10: Austrian VTP-NGC exchange day ahead price spread (€/MWh) and utilization rate of the transmission capacity from NCG to Austria<sup>25</sup>**



Sources: CEGH, EEX, ENTSOG Transparency Platform

**Figure 11: Scatterplot: Austrian VTP-NGC exchange day ahead spread (€/MWh, x-axis) against utilization rate of the transmission capacity connecting NCG to Austria (% , y-axis)**



Black square: NCG-AT VTP price spread stayed above 1.5 €/MWh and more than 20% of the transmission capacity connecting NCG to AT VTP unused

Sources: CEGH, EEX, ENTSOG Transparency Platform

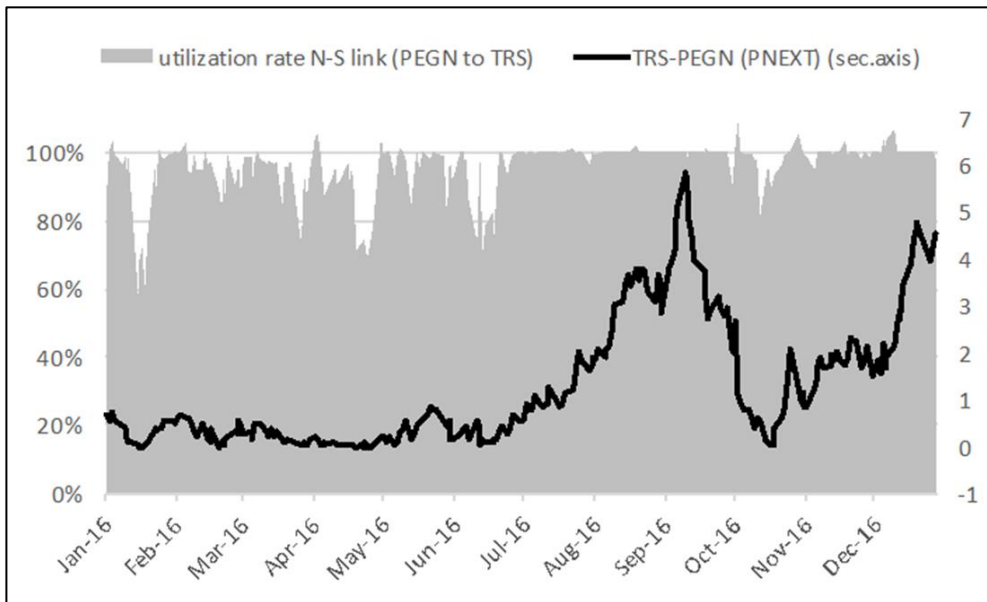
<sup>24</sup> For a detailed discussion: Petrovich et al. (2016).

<sup>25</sup> For details on the determination of the utilization rate, refer to Petrovich (2015).



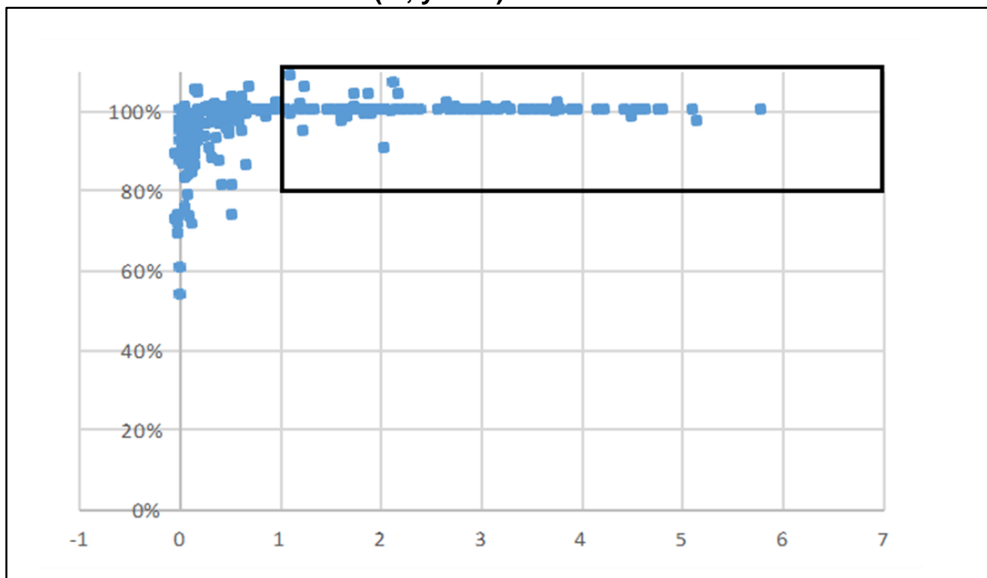
The physical congestion of the North-South link (N-S link) in France explains weak price correlation between TRS and PEGN: the spread between the two French zones widens as soon as the interconnecting link approaches its full capacity, as is evident starting from July 2016 (Figure 12). Spreads above 1 €/MWh can be observed in fact only when the load factor of the N-S link is above 90% (Figure 13).

**Figure 12: TRS-PEGN exchange day ahead price spread (€/MWh) and utilization rate of the N-S link<sup>26</sup>**



Source: Powernext, GRTgaz

**Figure 13: Scatterplot: TRS-PEGN exchange day ahead price spread (€/MWh, x-axis) against utilization rate of the French N-S link (% , y-axis)**



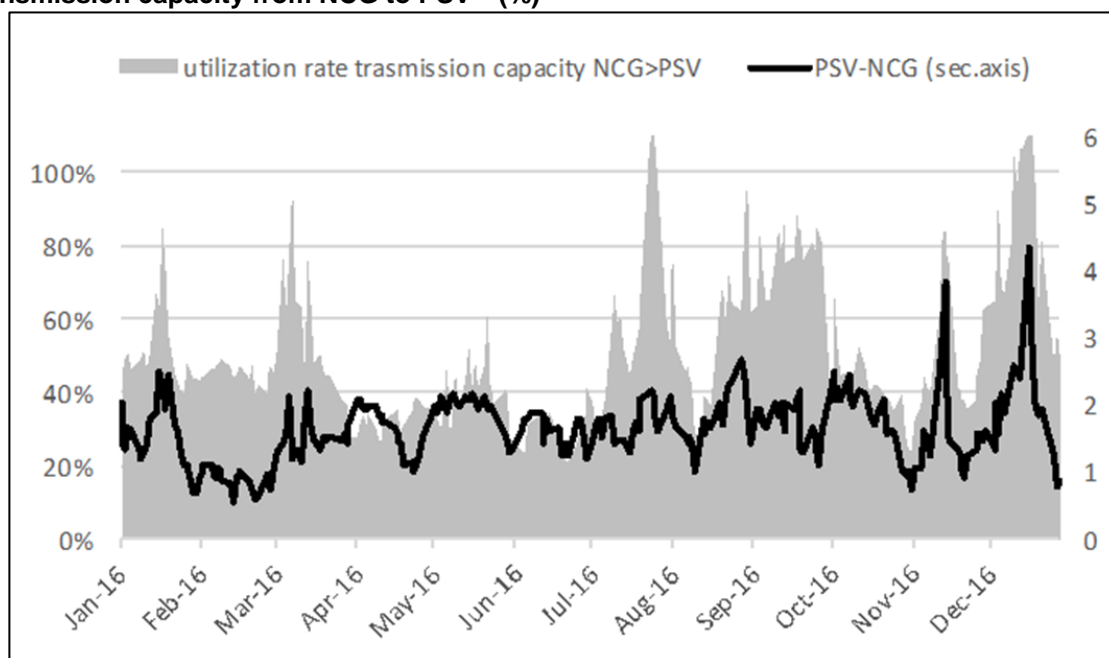
Black square: TRS-PEGN price spread stayed above 1 €/MWh and more than 80% of the N-S link capacity used  
Sources: Powernext, GRTgaz

<sup>26</sup> For details on the determination of the utilization rate, refer to Petrovich (2015).

## Non-Physical barriers to price alignment

The first case of price delinkage not caused by physical congestion is the one involving the Italian hub. In fact, notwithstanding the presence of a substantial PSV-NGC price spread, there was spare transmission capacity on the route from NCG to PSV via Switzerland<sup>27</sup> signalling that, despite there being no physical congestion, full price arbitrage does not occur (**Figure 14**).

**Figure 14: PSV-NGC OTC day ahead price spread (€/MWh) and utilization rate of the transmission capacity from NCG to PSV<sup>28</sup> (%)**



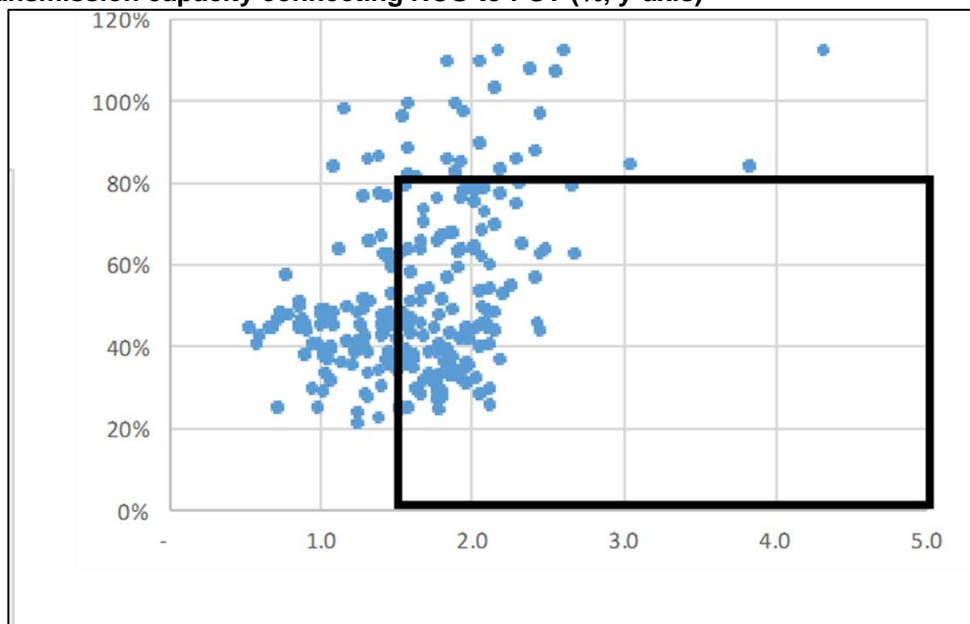
Source: Tankard Parties, ENTSOG Transparency Platform, Snam Rete Gas

More specifically, more than 20% of the capacity connecting NCG to PSV on the Transitgas route was unused when the PSV-NGC price spread stayed above 1.5 €/MWh (**Figure 15**), a very different situation compared to that observed for the Austrian and Southern France hubs. On some days, more than 50% of the capacity on the interconnecting link was free (i.e. utilization rate below 50%) and the price differential was above 2 €/MWh.

<sup>27</sup> North West Europe's gas can flow from NCG in Germany heading to the Italian PSV either passing through Switzerland (TENP-Transitgas route) or passing through Austria via Oberkappel IP and then Tarvisio IP. The Transitgas pipeline in fact, crosses Switzerland from Wallbach, at the end of the TENP pipeline located on the border with Germany, to Griespass/Passo Gries, located at the Swiss-Italian border. Note that the capacity to exit Germany at Wallbach IP is lower than the capacity to enter Italy at Passo Gries.

<sup>28</sup> For details on the determination of the utilization rate, refer to Petrovich (2015).

**Figure 15: Scatterplot: PSV-NGC OTC day ahead spread (€/MWh, x-axis) against utilization rate of the transmission capacity connecting NCG to PSV (%), y-axis)**



Black square: NCG-PSV price spread stayed above 1.5 €/MWh and more than 20% of the transmission capacity connecting NCG to PSV unused

Sources: Tankard, ENTSOG Transparency Platform, Snam Rete Gas

Why were such arbitrage opportunities left on the table? The reasons most likely lie in the “inefficient” utilization of the Transigas route, which is due to the presence of ENI’s long term shipping contracts on this route (which concern, according to our estimates, 80% of transmission capacity on the route from NCG/TTF to PSV via Switzerland), combined with the difficulty of making this capacity available to other users for arbitrage purposes, when ENI is not using it. Such difficulty, in turn, may be due to slow implementation of congestion management procedures, ineffective release of ENI’s unused capacity on the Swiss-Italian border, insufficiently flexible capacity allocation procedures<sup>29</sup>.

In the second half of 2016, however, regulatory changes were implemented which are likely to foster soon a closer price alignment of the PSV to its neighbouring markets. More specifically, the implementation of the congestion management procedures on the Italian side of the Griespass/Passo Gries interconnection point started to be fully effective late in 2016. The so called long term use-it-or-lose-it (LT UIOLI)<sup>30</sup>, mandated by the Italian Energy Regulator in 2013, was finally implemented in July 2016<sup>31</sup>. Released transmission capacity pursuant to this mechanism is available on the PRISMA platform, so that every shipper has access to it<sup>32</sup>. Further, hourly renomination at entry points to Italy started in October 2016<sup>33</sup>, allowing a more flexible use of the interconnections.

<sup>29</sup> For a detailed discussion on these points see Petrovich et al. (2016).

<sup>30</sup> EC Regulation No 715/2009, paragraph 2.2.5., Annex 1, mandates that regulatory authorities require TSOs to partly or fully withdraw contracted capacity that is systematically underutilized on an interconnection point by a network user where the latter has not offered his unutilized capacity under reasonable conditions and where other network users request firm capacity.

<sup>31</sup> Resolution 422/2016/R/gas (dated July 21, 2016) and Chap.7, P.20, of SRG Network code.

<sup>32</sup> The day-ahead “use-it-or-lose-it” mechanism (FDA UIOLI) does not apply to Passo Gries/Gries Pass IP. Since the end of 2016, the FDA UIOLI was implemented by the IPs of Tarvisio and Gorizia Res. 464/2016/R/gas (dated August 4, 2016).

<sup>33</sup> Source: SRG workshop presentation dated November 23rd, 2017, P. 29, available at:

[http://www.snamretegas.it/export/sites/snamretegas/repository/file/dialoga\\_con\\_noi/news/Workshop\\_bilanciamento\\_2016/03\\_2016-11-\\_Interventi\\_del\\_Responsabile\\_del\\_Bilanciamento\\_sui\\_mercati\\_\\_\\_Capizzi.pdf](http://www.snamretegas.it/export/sites/snamretegas/repository/file/dialoga_con_noi/news/Workshop_bilanciamento_2016/03_2016-11-_Interventi_del_Responsabile_del_Bilanciamento_sui_mercati___Capizzi.pdf)

This said, performing arbitrage trading on the TTF/NCG-Switzerland/PSV route is likely to remain a rather costly option which will likely be triggered only when it is not possible to ship cheaper North West European gas to Italy via the cheaper and more flexible Germany-to-PSV route passing through Austria (i.e. via Oberkappel and Tarvisio). In fact, ENI's long term capacity on the TENP-Transitgas route that is released regularly through auctions is marketed at a price<sup>34</sup> that most of the other players are not willing to pay, unless in the presence of exceptional PSV price premia, as occurred for instance in the second week of December 2016<sup>35</sup>. The intensive and very flexible<sup>36</sup> use of the Austrian route heading towards Italy can worsen the physical congestion at Oberkappel in the direction from Germany to Austria, as discussed in detail in Petrovich et al. (2016).

The second case of non-physical barriers to trade analysed here is Spain. The price dynamics showed that the Spanish exchange day ahead price is weakly correlated to the adjacent TRS, despite:

- the existing physical interconnection,
  - substantial premia for the Spanish PVB prices compared to those quoted at the neighbouring French TRS (above 1 €/MWh in the January to April and September to December periods,
  - and spare transmission capacity in the France to Spain direction (only rarely exceeding 80%).
- (Figure 16).

According to traders, transmission capacity between France and Spain is not easily available for players who are not active shippers in those markets and only those who own long term capacity on this route may be able to easily perform arbitrage trading. Also, scarce TRS liquidity may hinder the feasibility of cross-border trade. As a result, despite the presence of a constant daily price signal for spot traded gas, arbitrage flows are not triggered unless the price spread is exceptionally high (Figure 17) and the Spanish gas market is not yet fully integrated with its neighbours. PVB prices are still heavily dependent on local market conditions, with levels influenced by the price of LNG imports to Spain.

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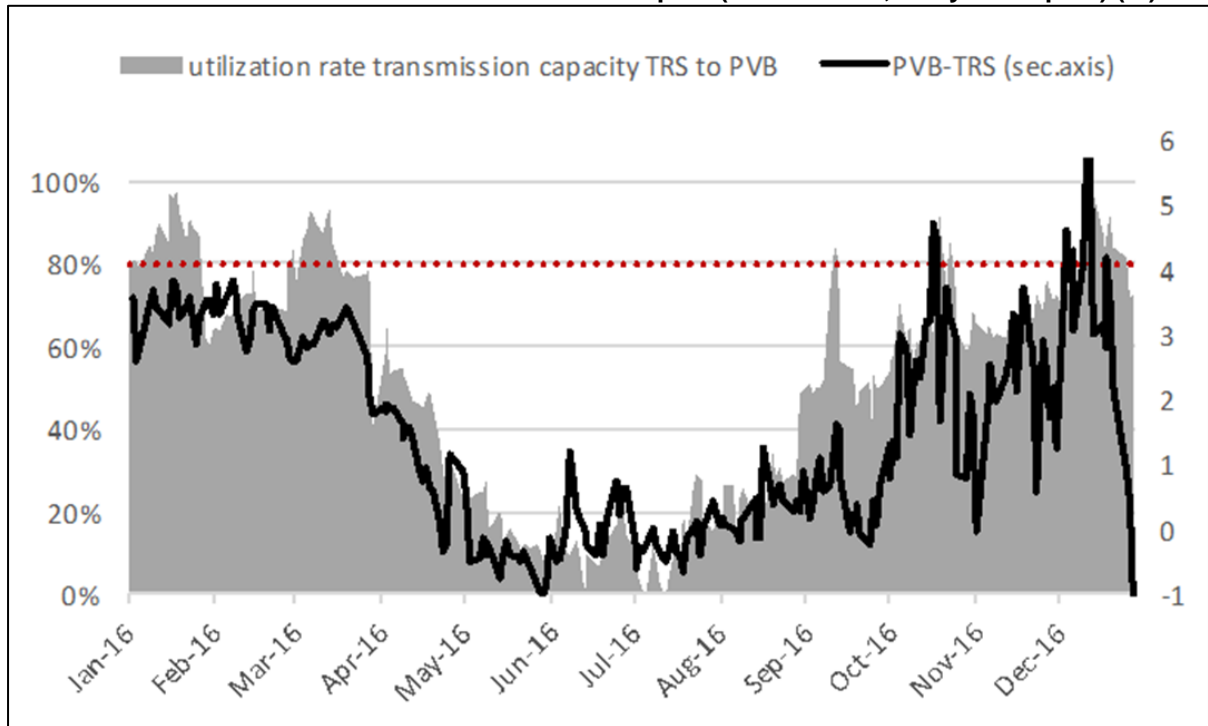
<sup>34</sup> For a detailed discussion on these points see Petrovich et al. (2016).

<sup>35</sup> See data showing substantial purchases of day-ahead and with-in day transmission capacity at Passo Gries IP (direction: entry into Italy) offered by the Italian TSO Snam Rete Gas (SRG) between the 9th and the 12th of December 2016, as reported in SRG workshop presentation dated February 1st, 2017, P. 33, available at: [http://www.snamretegas.it/repository/file/dialoga\\_con\\_noi/news/2017/03\\_-\\_Interventi\\_del\\_Responsabile\\_del\\_Bilanciamento\\_sui\\_mercati.pdf](http://www.snamretegas.it/repository/file/dialoga_con_noi/news/2017/03_-_Interventi_del_Responsabile_del_Bilanciamento_sui_mercati.pdf)

<sup>36</sup> See for instance evidence of intra-day commercial exports at Tarvisio in SRG workshop presentation dated November 23rd, 2016, P. 29, available at: [http://www.snamretegas.it/export/sites/snamretegas/repository/file/dialoga\\_con\\_noi/news/Workshop\\_bilanciamento\\_2016/03\\_2016-11-\\_Interventi\\_del\\_Responsabile\\_del\\_Bilanciamento\\_sui\\_mercati\\_\\_\\_Capizzi.pdf](http://www.snamretegas.it/export/sites/snamretegas/repository/file/dialoga_con_noi/news/Workshop_bilanciamento_2016/03_2016-11-_Interventi_del_Responsabile_del_Bilanciamento_sui_mercati___Capizzi.pdf)

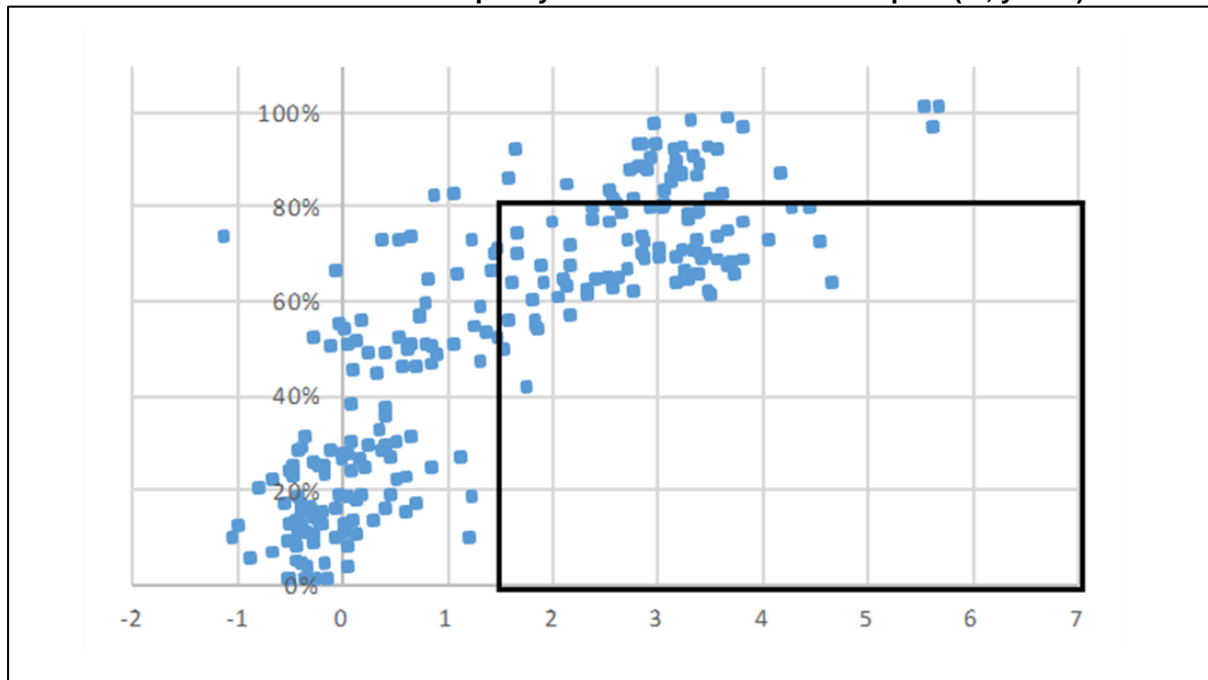


**Figure 16: PVB-TRS exchange day ahead price spread (€/MWh) and utilization rate of the interconnection between the South of France and Spain (Pireneos VP, entry into Spain) (%)**



Sources: Powernext, MIBGAS, ENTSO-G Transparency platform

**Figure 17: Scatterplot: PVB-TRS exchange day ahead spread (€/MWh, x-axis) against utilization rate of the transmission capacity the South of France and Spain (% , y-axis)**

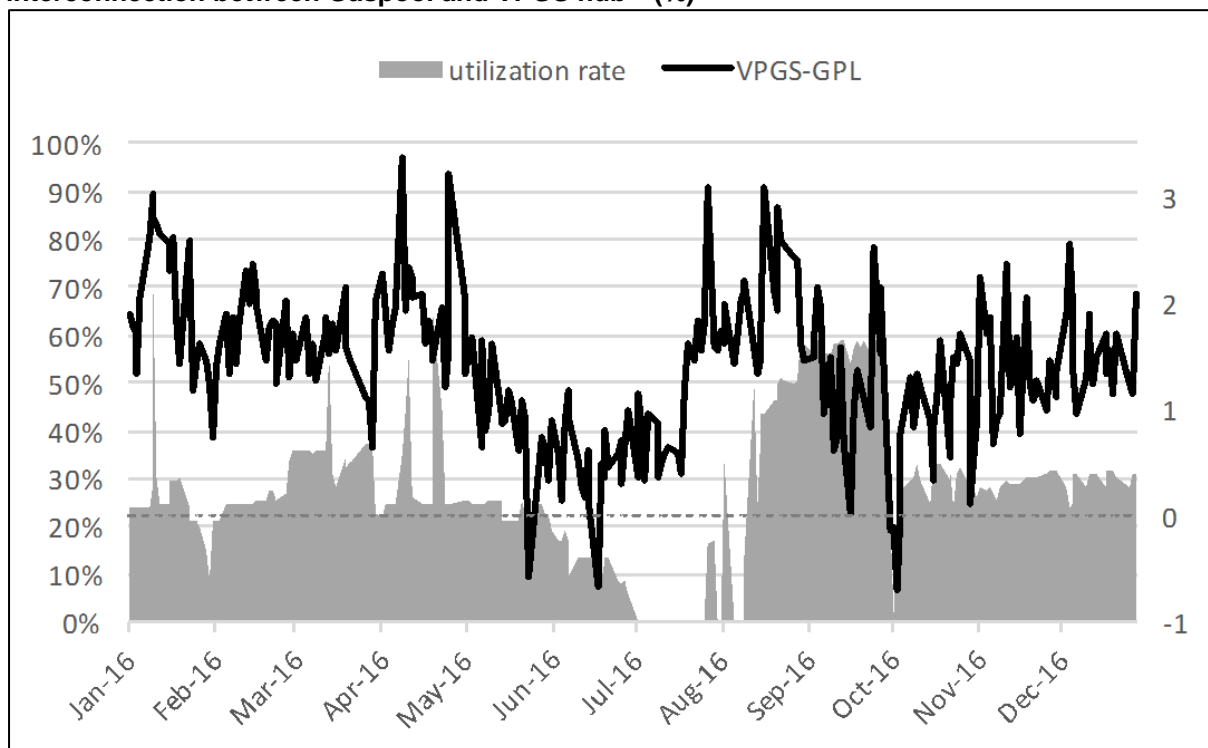


Black square: PVB-TRS price spread stayed above 1.5 €/MWh and more than 20% of the transmission capacity connecting PVB to TRS unused

Sources: Powernext, MIBGAS, ENTSO-G Transparency platform

Finally, Poland is a similar case. The trading hub in Poland (VPGS) is connected to GPL and to the Czech hub, but Polish day ahead prices are weakly correlated to the adjacent markets. In particular, notwithstanding the high premium for day ahead gas quoted on the Polish exchange with respect to adjacent markets and the presence of ample spare cross border capacity<sup>37</sup>, gas did not flow from the lower-priced Czech/GPL markets to the higher-priced Polish hub (**Figure 19**). This signals a non-physical barrier to trade gas into Poland, and suggests that the market in this country is not yet fully integrated and not fully liberalized. Polish gas price levels appear to be heavily dependent on local conditions, although an improvement compared to 2015 has occurred.

**Figure 18: Gaspool-VPGS day ahead price spread (€/MWh) and utilization rate of the interconnection between Gaspool and VPGS hub<sup>38</sup> (%)**



Sources: EEX, POLPX, ENTSO-G Transparency platform

<sup>37</sup> For detailed discussion: Petrovich (2016).

<sup>38</sup> The two TSOs operating the interconnection between the German Gaspool and the Polish market, ONTRAS and GAZ-SYSTEM, agreed to offer the capacity at one virtual interconnection point (GCP GAZ-SYSTEM/ONTRAS, source: <http://en.gaz-system.pl/press-centre/news/information-for-the-media/arttykul/202198/>). Utilization rate of the interconnection from Gaspool to Poland computed using Lasow IP's data until April 1<sup>st</sup>, 2016; then using GCP GAZ-SYSTEM/ONTRAS IP's data.

## Chapter 4. Conclusions

As far as the hubs liquidity analysis is concerned, it is clear that the two mature hubs have consolidated their position, with the TTF now the largest traded hub, after a 30% rise in volumes year on year, to 22,230 TWh in 2016. All hubs (except NBP and ZEE) continued to grow but at very different rates:

- a. NBP -4%, now behind TTF; ZEE+ZTP -3%, dropping to 6th place in volume terms.
- b. NCG+GPL: +16-17%, staying in 3rd/4th place but just 14% (combined) of the size of TTF.
- c. PSV +23% to overtake Belgian hubs into 5th place.
- d. PEG Nord still struggling with +10% but TRS +54%, just shy of 100TWh.
- e. The fledgling Spanish PVB recorded +>200%, but from a very low base!

The types of products traded varied widely from hub to hub, continuing the divergence between those hubs being used for balancing activities and those for risk management activities: all hubs are balancing hubs but only two can be classified as mature risk management hubs: NBP and TTF.

There remained a significant number of active traders at both NBP and TTF (although possibly slightly fewer than in 2015), and a large number at the German hubs (although slightly more than in 2015). There were a moderate number of active traders at PSV, ZEE, VTP and PEG Nord (with both PSV and PEG Nord registering a small increase on 2015). Finally, the remaining hubs had a poor number of active traders (<10).

When looking at the Net Churn rates, only two hubs can be considered as mature, with a score over 10 times. The TTF surged ahead to reach >57 times but the NBP eased back a little to >22 times (still a very commendable result). Only one hub scored between 5 and 10 times: the VTP, at 5.7 (from 3.9 in 2015). All the other hubs scored poorly with Belgian hubs and NCG leading at 4.1 and 4.0 respectively but then a drop to 2.5 for GPL, under 2 times for PEG Nord, PSV and VOB; and under 1 times for TRS and PVB.

The summary table of the 5 Key Elements (**Table 5**) shows that the overall rankings of the European traded gas hubs remained the same as in 2015. However, GPL, VTP and VOB improved their overall scores by one point each; PVB by 2 points. The Czech VOB and the Spanish PVB have moved up from 'illiquid' to 'poor'.

The summary table of the 3 Main Indicators (**Table 6**) shows that the top 4 hubs remain the same, with PEGs and ZTP joining that group. The mid-band has moved around a little, with some small increases, apart from PVB which increased by 6½ points, the largest of all hubs. Again, as in 2014 and 2015, the EFET rankings are very similar to those reached from the analysis in the 5 Key Elements.

In conclusion, as far as the hubs liquidity analysis is concerned, there are only two mature hubs (TTF, NBP), two active hubs (NCG, GPL) and seven poor hubs (PSV, ZEE+ZTP, PEG Nord, VTP, VOB, TRS, PVB). In essence, 2016 was the Year of the TTF, recording the largest overall traded volumes and highest net churn rate. TTF is now the pre-eminent benchmark gas hub in Europe.

As far as the price analysis is concerned, it is clear that the growth in liquidity and the increasing use of hubs for balancing has resulted in the fact that traded gas now has a "price tag" in most of the gas hubs in Europe, including in emerging ones.

The day ahead contract (by and large, the most frequently traded across all the hubs) features a continuous daily price signal, either on the exchange or on the OTC market in Britain, the Netherlands, Belgium, Denmark, France, Spain, Italy, Austria, the Czech Republic, Poland (and possibly Slovakia next). This is good for transparency. However, if we consider the within-day contract, most of the hubs in Continental Europe do not provide a continuous daily price signal.

But, are such hub prices aligned across Europe as they would be in the Single Energy Market for gas in Europe that is envisaged in the Gas Target Model? We can say that North West Europe (TTF, NCG, GPL, ZEE, PEG Nord) is a single price area for gas where the price alignment is virtually perfect and price level convergence is high.

To this group we can add the Czech hub (VOB) which shows prices very closely correlated to prices in the neighbouring German market, suggesting an absence of barriers to cross border trade, although it has a significantly lower liquidity than North West European hubs.

In contrast, the other hubs experienced periods of price delinkages from this core group for two distinct reasons:

- a. **For physical reasons:** the British NBP due to the impossibility of shipping gas through the Interconnector pipeline; gas at the French TRS was priced at a substantial and rather volatile premium compared to the rest of the country, due to the physical saturation of the French North-to-South link; and the price misalignment between the Austrian VTP and the German NCG, still occurring in 2016, was driven by physical congestion at Oberkappel interconnection point.
- b. **For non-physical reasons:** despite existing interconnections, the Polish and Spanish gas markets are not yet fully integrated with their neighbouring markets and are still heavily dependent on local market conditions; arbitrage forces are still not fully operating between the Italian PSV and the connected hubs, although there was a significant improvement compared to 2015 and further significant improvement is expected for 2017.

The results of this paper show that the natural gas markets in Europe are continuing to develop but very much in different ways and at differing speeds across the continent. In response to the questions we posed in the Introduction, it is clear that there are a number of hubs, mostly in Western Europe, that are working well and that are functioning in line with policy makers' ambitions, to a greater or lesser degree; however, there are as many hubs, mostly in Eastern Europe, that are not yet developed to anywhere near the same degree.

With regards to price signals, the data clearly identifies a core group of hubs, where price alignment and price level convergence continue to be strong: these regions behave as if they were a single-price area. Many of the remaining hubs across Europe do not provide a reliable and competitive price signal, due to disconnections from the core group, or because they do not yet have a functional gas hub. Furthermore, the analysis is based on day ahead prices data, because there are at present only three countries that offer reliable within day prices (Britain, Belgium and Italy).

The effects of the United Kingdom leaving the EU cannot be forecast at this early stage of the separation process. What is known is that the UK has been a leader in the liberalisation process and has been a strong advocate of fully functioning commercial energy markets. There are many European countries, especially in Eastern Europe, that have a different political agenda and without the influence of the UK it may be difficult for the EU to enforce its Energy Directives. The final overall conclusion to this paper is that, despite the improvements being made to the liberalisation of gas markets in North Western Europe, the policy goal of the European Union of achieving a Single Energy Market in gas is probably still many years away, if indeed it can ever be fully realised.



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