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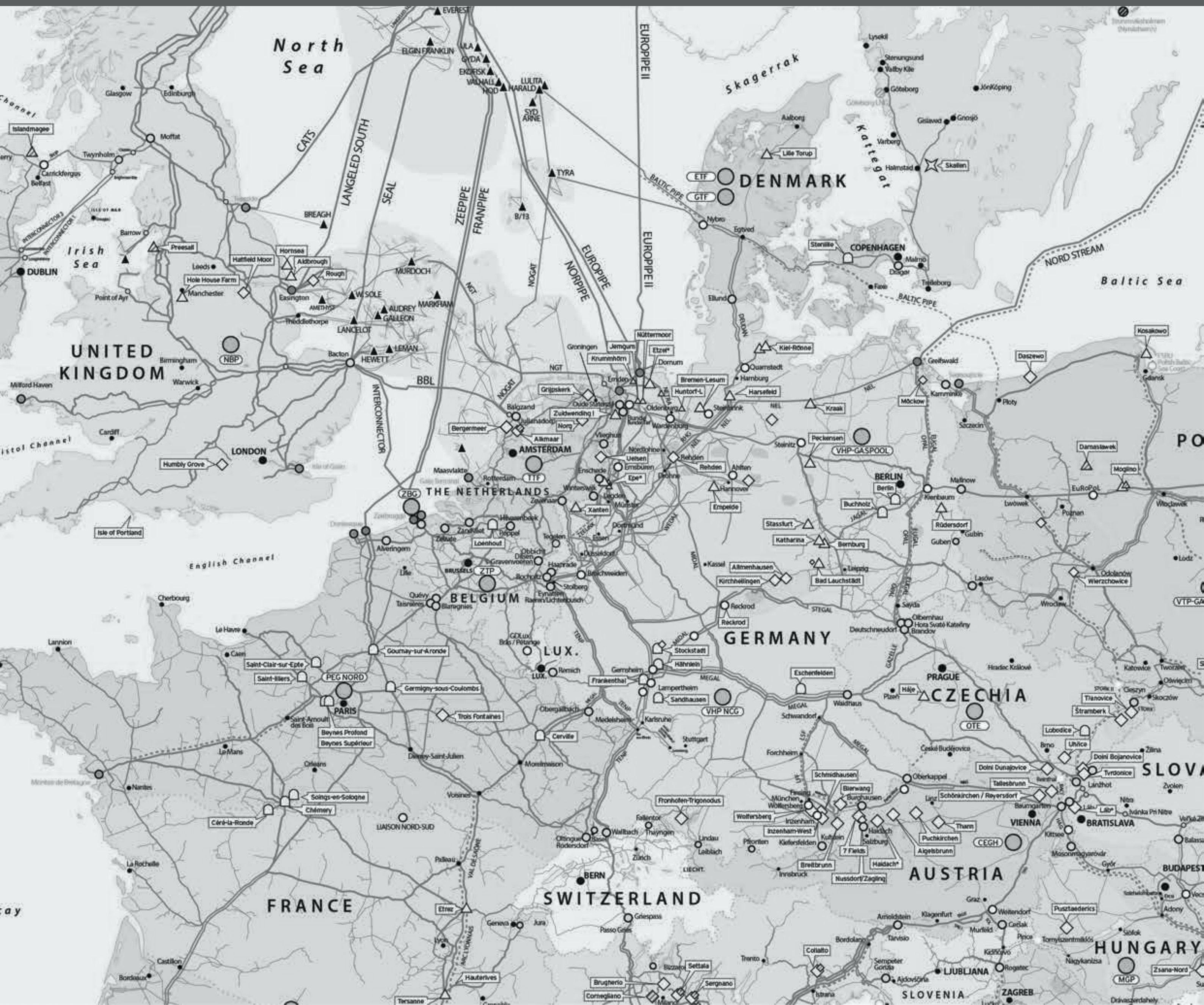
CENTRAL EUROPEAN GAS MARKET CONGESTION ANALYSIS



CENTRAL EUROPEAN GAS MARKET CONGESTION ANALYSIS

AUTHORS: Dr. Harald Hecking, Martin Hintermayer and Florian Weiser

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www.ewi.research-scenarios.de

ewi Energy Research & Scenarios gGmbH

Alte Wagenfabrik
Vogelsanger Straße 321a
50827 Cologne, Germany

Tel.: +49 (0)221 277 29-100
Fax: +49 (0)221 277 29-400
www.ewi.research-scenarios.de

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INTRODUCTION & SUMMARY

The Nord Stream 2 pipeline project is currently the focus of various analyses in scientific, business and political contexts. A recent study by ewi ER&S (2017a) shows that Nord Stream 2 has a decreasing effect on European gas prices, since Nord Stream 2 brings more Russian gas to North Western Europe at lower costs, implying intensified competition with LNG. LNG prices will hence decrease, and lower LNG prices result in lower wholesale prices in Europe. Not only does Nord Stream 2 imply lower prices in Europe on average, but every single country in the EU benefits from lower prices at a similar level.

There are several studies which come to a different result from ewi ER&S (2017a). Those analyses, e.g. Bruegel (2017), REKK (2017), FSR (2017), raise an interesting question: would Nord Stream 2 enable Gazprom to cause bottlenecks in the West-East direction to separate Eastern European gas markets from the rest of Europe in order to gain market power in Eastern Europe? After the European Union's (EU) energy directives have been implemented, it is relevant to ask wether the current gas market design is robust enough to preclude such a market separation strategy. Bruegel (2017) argues that there is a capacity limit of 110 bcm in the West-East direction along a line within Germany, while 145 bcm of residual import gas demand East of this line can only be imported either from the area West of the line or from Russia. According to Bruegel (2017), this yields a critical import demand of 35 bcm that can only be served by Russia for the countries East of the line creating market power for Gazprom.

The study at hand is intended to verify whether or not Nord Stream 2 could bring about a market separation of the Eastern European gas market from the rest of Europe by creating congestion in the West-East interconnections.

The study finds that such a strategy is not feasible for various reasons:

1) It is not possible for specific gas suppliers to create congestion along specific pipelines, since gas suppliers can only book entry / exit capacities into specific market areas while physical flows are determined by the unbundled and regulated transmission system operators based on capacity bookings and flow nominations at entry and exit points. This holds especially when taking into account virtual flows. This means that a line separating West and East as in Bruegel (2017) is not a viable concept when applied to the EU gas market, which is based on entry exit market zones.
2) Even without taking into account of 1), flooding Western Europe with cheap gas while exerting market power in Eastern Europe would be restricted by existing contractual relationships with specified delivery points, especially at Baumgarten: in other words large volumes of Russian gas cannot be flexibly routed to Western Europe in order to realize a price discrimination strategy against Eastern Europe.
3) Additionally, even ignoring points 1) and 2), the fact remains that there is not sufficient physical capacity to ship enough Russian gas to Western Europe to create congestion in the West-East direction.
4) What is more, regardless of 1), 2) and 3), even if one could create West-East congestion the gas infrastructure in Southern and Eastern Europe would still have sufficient spare capacities (over and above West-East capacity) that could be used for additional imports from third suppliers. Thus, creating a West-East congestion would not enable a market power strategy.
5) Only when constructing a hypothetical extreme scenario in which demand is higher in Eastern Europe, production is lower compared to 2015, and spare capacities are restricted in the area East of the line, would there be gas demand that could only be served by Russian gas. However, the amount would be rather low at 14 bcm.
6) Even in such an extreme scenario, a price discrimination strategy would not a long term economic equilibrium, as the price in the East would need to increase substantially in order to compensate for lower prices in the West, and this would trigger investments in infrastructure extensions.
7) Given the high investment costs of Nord Stream 2 and the relatively small time horizon in which the price segmentation strategy would be possible, it is not plausible that Gazprom would invest in Nord Stream 2 to pursue a market separation strategy.

In conclusion, the current design of the European gas market consisting of entry exit market zones where physical flows are determined by TSOs is robust enough to preclude a market separation strategy. Even if this were not the case, there is sufficient capacity to ensure that any market separation strategy would not be viable.

LITERATURE REVIEW

Market Separation of Eastern Europe by creating Congestion on the East-West interconnections?

Within the literature about gas policy, various contributions argue that Nord Stream 2 could lead to a market separation by inducing congestion in the European pipeline grid. REKK (2017) states that Nord Stream 2 has a neutral price effect in North Western, South Western and Central Europe, whereas prices would increase in South Eastern Europe due to congestion on certain interconnections. This conclusion differs from the findings of ewi ER&S (2017a). As discussed by ewi ER&S (2017b), the main driver for those different outcomes is the modelling of LNG imports, i. e. fixed imports irrespective of Nord Stream 2 as assumed in REKK (2017) and price-sensitive LNG imports as considered in ewi ER&S (2017a). Furthermore, REKK (2017) assumes that (a) transits to South Eastern Europe through Ukraine are reduced by Russia if Nord Stream 2 is available, and (b) congestion in the pipeline grid prevents arbitrage volumes from Central Europe reducing prices in South Eastern Europe. Additionally, REKK (2017) does not take account of infrastructure extensions whose "final investment decision" has already been made. CER (2018) repeat the arguments of REKK (2017) and discuss issues like the financial support for Ukraine and climate policy in connection with Nord Stream 2. The question whether gas infrastructure development is the appropriate policy instrument to address those issues is then left to the reader.

Another contribution discussing Nord Stream 2 from a more regulatory perspective is FSR (2017). It states that Bruegel (2017) would have demonstrated that Nord Stream 2 could harm competition in European gas markets. The central argument of Bruegel (2017) is that Nord Stream 2 enables a price discrimination strategy.

As can be seen in Figure 1, Bruegel (2017) introduces a red line through Central Europe — mainly by a separation of Germany. Furthermore, the paper argues that there is a certain demand east of the red line that could only be served either by imports from the area west of the red line, or by Russian gas. This demand that is denoted here as "residual import demand" in the following is quantified as 145 bcm based on actual demand and imports in 2015. According to Bruegel (2017), Russia could transport 110 bcm through Nord Stream 1 and 2 to the west of the red line decreasing prices in the West. Triggered by high price differentials between East and West, shippers would then congest the West-East pipeline capacities. Then, Bruegel (2017) concludes that Russia would have the opportunity to exert market power for the remaining volumes East of the line, i.e. for the remaining 35 bcm. This part of the residual import demand that cannot be satisfied by imports from west of the red line, is further denoted as "critical demand" in this study.

However, this line of argumentation is based on the following five (implicit) assumptions:

- Current market conditions (e. g. entry /exit-based market zones and existing contractual relationships) permit a price discrimination strategy along a line of specific pipelines.
- Russia can ship 110 bcm of natural gas to the west of the red line.
- There are only 110 bcm of pipeline capacity from West to East.
- In the area east of the red line, the residual import demand for volumes from Russia or from the area west of the red line is 145 bcm.
- There are no spare capacities in the infrastructure that could have an impact on the residual import demand.

FIGURE 1: MAP OF THE EUROPEAN GAS NETWORK WITH SEPARATING RED LINE
(Source: Bruegel (2017) based on ENTSO-G (2017))

ENTRY / EXIT MARKET ZONES INSTEAD OF A PIPELINE SPECIFIC VIEW

Bruegel (2017) argues that congestion along specific pipelines would separate Eastern and Western gas markets. However, this pipeline-specific view ignores the fact that there is an entry/exit system in European gas markets. Gas suppliers book entry capacity to a market area (cf. Figure 2 for a schematic overview of market areas in the countries adjacent to Germany) and then exit capacity either to another market area or to an offtake point within the same market area such as a power station or distribution network. When they wish to flow gas, suppliers nominate how much gas they wish to flow at the various entry and exit points within the capacity they have booked. Then, the transmission system operator (TSO) determines the physical gas flows so that suppliers' nominations are met, but also so that gas flows in the most efficient way within the network. This means that physical flows of gas are not necessarily the same as suppliers' nominated flows. This is possible because gas molecules are the same whatever the source, and therefore TSOs can net off nominations in opposite directions to ensure physcial flows are as efficient as possible.

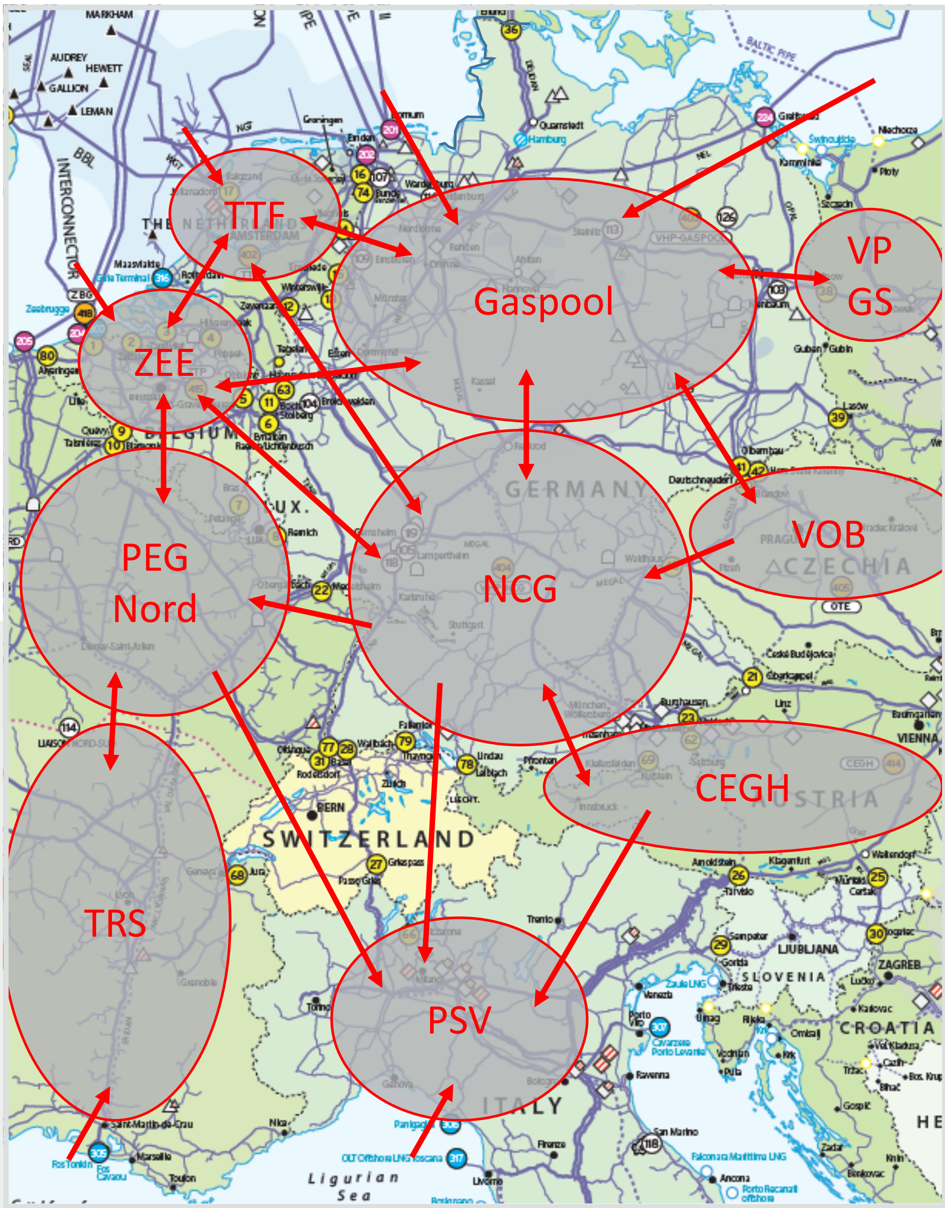

FIGURE 2: SCHEMATIC ILLUSTRATION OF EUROPEAN GAS MARKET AREAS (Source: ENTSO-G (2017)

This difference between virtual trade flows and physical flows is ignored in Bruegel (2017). Even if Russian gas is nominated to flow to consumers in Western Europe, it could be the case that the actual Russian gas molecules are routed to consumers closer to the entry point of the Russian gas due to virtual flows and swaps, rather than physically flowed to Western Europe. Similarly Norwegian gas molecules could be routed closer to their point of entry into Europe even if Norwegian gas companies are supplying customers in Eastern Europe.

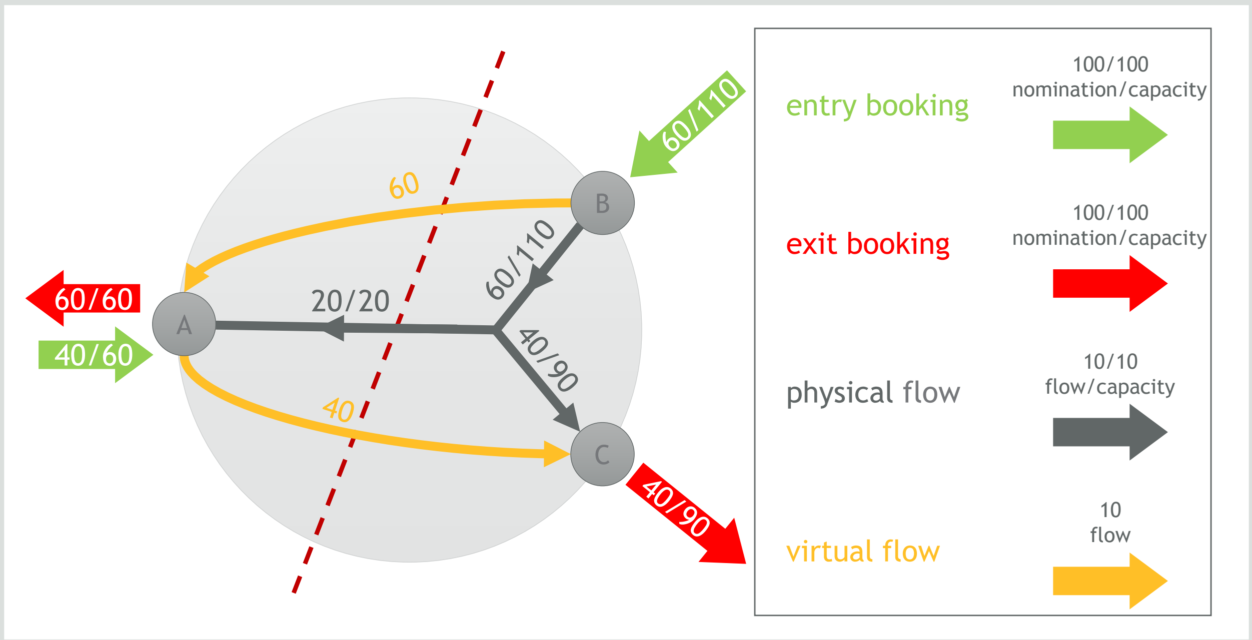

FIGURE 3: SCHEMATIC ILLUSTRATION OF ENTRY/EXIT IN EUROPEAN GAS MARKET AREAS
(Source: ewi ER&S (2018))

Those interdependencies can be made clear when considering a schematic market area, as illustrated in Figure 3. Point A is an entry and exit point, whereas point B is a pure entry point and point C is a pure exit point. Let us assume that a shipper X books an entry capacity of 60 at the entry point B, and an exit capacity of 60 at point A. Shipper Y, however, books an entry capacity of 40 in point A and an exit capacity of 40 in point C. Those virtual trade flows are illustrated by the yellow arrows in Figure 3. However, the physical flows can be realized as indicated by the grey lines. Despite a physical bottleneck of 20 along the red line, the single shippers can virtually transport larger volumes than 20 to their respective exit points that lie on different sides of the red line, because of the option to swap flows. Generally any nomination from point B to A can be counteracted with a virtual reverse flow from A to C as long as there is spare capacity between B and C. This illustrates the difference between virtually traded volumes and physical dispatch. In the context of our report, the example shows that a “red line” is not the right concept to assess bottlenecks, but market regions following entry-exit capacities. Table 1 summarizes the bookings and actual flows from the example. For the case of Gaspool, the example shows that if Gazprom were to flood Western Europe with cheap gas, this would enable virtual flows from West to East, making a congestion strategy impossible.

	Entry capacity	Exit capacity	Booking of shipper X	Booking of shipper Y	Physical flow
Point A	60	60	60 exit	40 entry	20 exit
Point B	110	–	60 entry		60 entry
Point C	–	90		40 exit	40 exit

TABLE 1: CAPACITIES, BOOKINGS AND PHYSICAL FLOWS FROM THE EXAMPLE ILLUSTRATED IN FIGURE 1

Furthermore, it is unclear how a specific market area could be split into a high priced Eastern part and a low priced Western part given that there is only one price within the whole market area. For the case of Germany, only one common market area will exist as of 2022 according to the request of the German regulator. As already mentioned, TSOs determine the physical flows within the network, based on capacity bookings and nominations, not the upstream gas suppliers.

The view articulated in Bruegel (2017) may have been valid in the old gas world before the liberalization of energy markets: in those days vertically integrated gas companies bought gas and transported it through specific pipelines belonging to the company. In today's world, however, in which transmission and trading is unbundled with effective Third Party Access (TPA), the critique of Bruegel (2017) falls short of addressing the reality of gas markets. This means that today's market design makes a "red line" congestion strategy impossible.

CONTRACTUAL RELATIONS HAMPER "FLOODING" OF WESTERN GAS MARKETS

In the previous section we established that the hypothesis of Nord Stream 2 being used to separate the Eastern European gas market from the West (as claimed, e. g. in Bruegel (2017)) can be rebutted simply by taking account of the current market design of entry/exit market zones with unbundled TSOs guaranteeing effective TPA. However, even without taking account of current market design, there is another issue which makes the market separation hypothesis implausible: not all of the Russian export volumes can be routed flexibly, as a substantial amount of gas is marketed via long term contracts (LTC) which often stipulate a specific delivery point. If Gazprom were to aim to flood the markets west of the red line with cheap gas, as argued in Bruegel (2017), large flexible spot volumes would be needed to enable such a strategy.

As mentioned by OIES (2015), Gazprom exported more than 150 bcm to Europe in 2014. Additionally, OIES (2015) illustrates that even in a scenario in which Gazprom would focus its sales activities increasingly on Asian customers, still at least 80 bcm would be sold as contracted volumes to European customers (70% of the take-or-pay volume) in 2030. Therefore, it is unrealistic to expect Russian long-term contracts to be phased out within the next decade. For 2020, OIES (2015) expects at least 122 bcm of contracted exports.

DIW (2015) provides an overview of contracts in the natural gas industry in which the origin as well as the destination (company and country) is specified. Additionally, the start and the end date of the deliveries are mentioned. Adding all mentioned contracts and their volumes (annual contracted quantities) in Russian contracts to Europe, that have (a) an end date of deliveries after 2020, and (b) a destination east of the red line defined by Bruegel (2017)[1], yields a volume of 42 bcm (excluding contracts in which the destination is in Germany). Table 1 illustrates the contractual volumes with respective destination countries east and west of the red line.[2] Besides the fact that this contracted volume of 42 bcm is above the critical import demand of 35 bcm mentioned in Bruegel (2017), those contractual relations generally limit the potential to reroute flows to Western markets while keeping Eastern markets short.

	contracted volume (bcm)
east of the red line	
Austria	7
Czech Republic	9
Poland	10
Italy[3]	9
Romania	2
Serbia	5
Sum	**42**
west of the red line	
Denmark	2
Germany	41
Netherlands	4
Sum	**47**

TABLE 2: CONTRACTED RUSSIAN GAS VOLUMES IN 2020 OF BUYERS IN THE COUNTRIES EAST AND WEST OF THE RED LINE BASED ON DIW (2015)

1 DIW (2015) do not contain information about specific destination points, only about the countries of LTC holders. However, all possible destination points of LTCs (via Nord Stream, Yamal or the Central Corridor) are east of the red line. Therefore, it can be assumed that it is possible to transport the contracted gas volumes from the delivery point to the respective countries of the LTC holders without crossing the red line in West-East direction.

2 The sum of all contract volumes in Table 2 adds to 89 bcm. This is below the value of OIES (2015), i. e. 122 bcm in 2020. This difference is likely due to the confidentiality of LTCs, i.e. not all contracted volumes are included in DIW (2015).

3 The actual contracted volumes of Italian importers are higher than the figure from OIES (2015) mentions 27 bcm/y of contracted volumes between ENI and Gazprom.

DISCUSSION OF PIPELINE CAPACITIES

Can 110 bcm flow from Nord Stream 2 to Western europe?

As previously stated, beside the current EU gas market design, the existence of long-term contracts with specified delivery points makes a market separation hypothesis implausible. Even without those two issues, there are further reasons to discount the hypothesis: the underlying assumptions implicitly made in the analysis in Bruegel (2017). The starting point of the analysis is the assumption that Russia would be able to transport 110 bcm of Russian gas through Nord Stream 1 and 2 and then physically westwards across the red line. However, there are only three pipelines that allow westwards transportation connected to Greifswald: NEL, NETRA (by OPAL) and STEGAL (by OPAL) with annual transport capacities of 20 bcm[1], 21 bcm[2] and 14 bcm[3] respectively. Therefore there is only capacity of 55 bcm to flow from Russia to Western Europe directly. How Bruegel (2017) can argue that another 55 bcm of natural gas could flow from Russia to Western Europe directly is not straightforward. Even with capacity expansions that would be realized with Nord Stream 2 (e.g. 9 bcm/a between Germany and the Netherlands, and 10 bcm/a to Gaspool) the maximum quantities that could be shipped from Greifswald (where Nord Stream 1 and 2 enter the German gas grid) to the area west of the red line would likely be below 80 bcm/a. Instead of requesting the additional East-West capacities that would be necessary to flood Western markets, the participants of the PRISMA auction on the 6th of March 2017 demanded West-East capacity on the Czech system corresponding to EUGAL's capacity. This triggered a corresponding reinforcement on the Czech system between Deutschneudorf and Lanzhot.

Beside the capacities in the East-West direction, Bruegel (2017) argues that the capacities along the red line from West to East would also be 110 bcm. In this point we can confirm the numbers by Bruegel (2017) for the pipelines NEL (20 bcm), NETRA (21 bcm), MIDAL (13 bcm[4]), MEGAL[5] (22 bcm[6]) and Transitgas (35 bcm[7]). Adding up those numbers gives a total of 111 bcm to flow from West to East.

While Bruegel (2017) calculates the capacities along the red line correctly, it remains unclear how Russia could ship 110 bcm to the area west of the red line which would be a prerequisite for the congestion strategy. Nevertheless, we assume in the following scenario that this would somehow be possible while still ignoring the implausibility of the market separation hypothesis (i.e. neglecting entry/exit market zones and long-term contracts) and therefore concentrate on the residual import demand in the area east of the red line.

1 https://www.nel-gastransport.de/netzinformationen/die-nordeuropaeische-erdgasleitung/
2 http://jordgastransport.de/en/company/about-us.html
3 https://www.gascade.de/netzinformationen/unser-leitungsnetz/stegal/ and https://books.google.de/books?id=dcVoAgAAQ-BAJ&pg=PA208&lpg=PA208&dq=netra+bcm&source=bl&ots=jl4i3ZaeHu&sig=Q_il_OCMQpjT7E8g5-4XgSzFodA&hl=de&sa=X&ved=0ahUKEwj6ycytj5bY-AhVSZlAKHenLBDYQ6AEILzAB#v=onepage&q=netra%20bcm&f=false
4 https://www.gascade.de/presse/presseinformationen/pressemitteilung/news/midal-erweiterung-bau-eines-neuen-teilabschnitts-startet/
5 Capacity refers to the MEGAL pipeline between Rimpar and Rothenstadt.
6 https://en.wikipedia.org/wiki/MEGAL_pipeline
7 https://en.wikipedia.org/wiki/Transitgas_Pipeline

MARKET SEPARATION IS ONLY POSSIBLE IN AN EXTREME SCENARIO

Reproduction of the residual import demand in Bruegel (2017)

The residual import demand is calculated by subtracting indigenous production and imports (LNG and pipeline gas), that are neither Russian nor from the area west of the red line, from the demand in the area east of the red line. Spare capacities in the gas infrastructure, e.g. in LNG regasification terminals, are not considered in a first step in order to reproduce the results for the residual demand in Bruegel (2017). Table 3 provides an overview of the necessary inputs. The demand and production values are based on 2015 values from the Natural Gas Information (IEA, 2017). For Germany that is segmented by the red line, it is assumed as in Bruegel (2017) that demand and production are split into two halves, and all non-Russian imports are counted in the Western part of the country. For the other countries east of the red line, production and demand are not segmented by the line. In 2015, LNG was imported in the countries East of the line with regasification terminals, i.e. in Italy, Greece and Poland. Additionally, there are third country pipeline imports east of the red line, i.e. imports that are neither Russian nor originate in the area west of the red line, for example imports from North Africa and Turkey. The residual import demand can be calculated by subtracting the production, LNG imports and third country pipeline imports from the demand.

Our calculation yields a total residual import demand of 139.4 bcm east of the red line. As Table 3 also indicates, Bruegel (2017) finds a total residual import demand of 144.7 bcm east of the red line. This means that the figure of Bruegel (2017) can be approximately reproduced. The small differences between the figure in our analysis and the figure in Bruegel (2017) are due statistical effects in the underlying data sources and due to different treatments of certain countries.

2015	demand (bcm)	production (bcm)	LNG-imports (bcm)	3rd country pipeline imports (bcm)	residual import demand (bcm)	residual import demand (Bruegel) (bcm)
50% Germany	40.7	4.4			36.3	36.6
Albania	0.1	0			0.1	
Austria	8.4	1.3			7.1	10.4
Bosnia a. Herzegovina	0.2				0.2	
Bulgaria	3.2	0.1			3.1	2.7
Croatia	2.7	1.8			0.9	
Czech Republic	7.9	0.2			7.6	7.5
Greece	3.1	0	0.6	0.6	1.9	3.2
Hungary	9.4	1.8			7.7	7.3
Italy	67.5	6.8	5.8	14.7	40.3	39.1
Moldova	2.9				2.9	
Poland	18.2	6.1	0.2		12	12
Romania	11.5	11.1			0.4	0.2
Serbia	2.2	0.6			1.6	2.8
Slovakia	4.6	0.1			4.5	4.5
Slovenia	0.9	0			0.9	
Ukraine	31.5	19.5			12	18.4
East of red line	**214.9**	**53.7**	**6.6**	**15.3**	**139.4**	**144.7**

TABLE 3: CALCULATION OF NATURAL GAS DEMAND AND SUPPLY 2015 FOR THE COUNTRIES EAST OF THE RED LINE[1]

1 Data from IEA Natural Gas Information (2017), details for all countries can be found in the appendix.

Corrections to the residual import demand calculated in Bruegel (2017)

While the figure of 145 bcm of residual import demand in the area east of the red line can be reproduced, the calculation that leads to this figure is based on two important assumptions:

- The division of Germany to the areas East and west of the red line is conducted in a very specific way. i.e as explained above German demand and production are split into exactly two halves and all non-Russian imports are accounted in the Western part of Germany.
- Spare capacity in the infrastructure in the area east of the red line (which would permit additional LNG imports or additional third country pipeline imports) is not accounted for.

In this section, we challenge those two assumptions. If we follow the red line strictly, it is not correct to split Germany in two parts having the same production and demand. However, it would be more correct to consider only the demand in Bavaria and Eastern Germany East of the line.

Those parts of Germany account together for approximately 30 % of German demand.[1] Since German gas production (8.8 bcm in 2015) is mainly in Lower Saxony, it is counted in the area west of the red line. Furthermore, all non-Russian imports are also counted in the Western part. Figure 4 illustrates the two different approaches to splitting Germany. With the approach illustrated on the right hand side of Figure 4, we derive a residual import demand for Germany of 24.4 bcm instead of 36.6 bcm as in Bruegel (2017). With this different treatment of Germany, the total residual import demand east of the red line totals 127.6 bcm, which is already a difference of more than 17 bcm compared with the figure of 144.7 bcm in Bruegel (2017). Correspondingly, the "critical demand" that could only be satisfied by Russia would only be 17.6 bcm instead of 34.7 bcm.

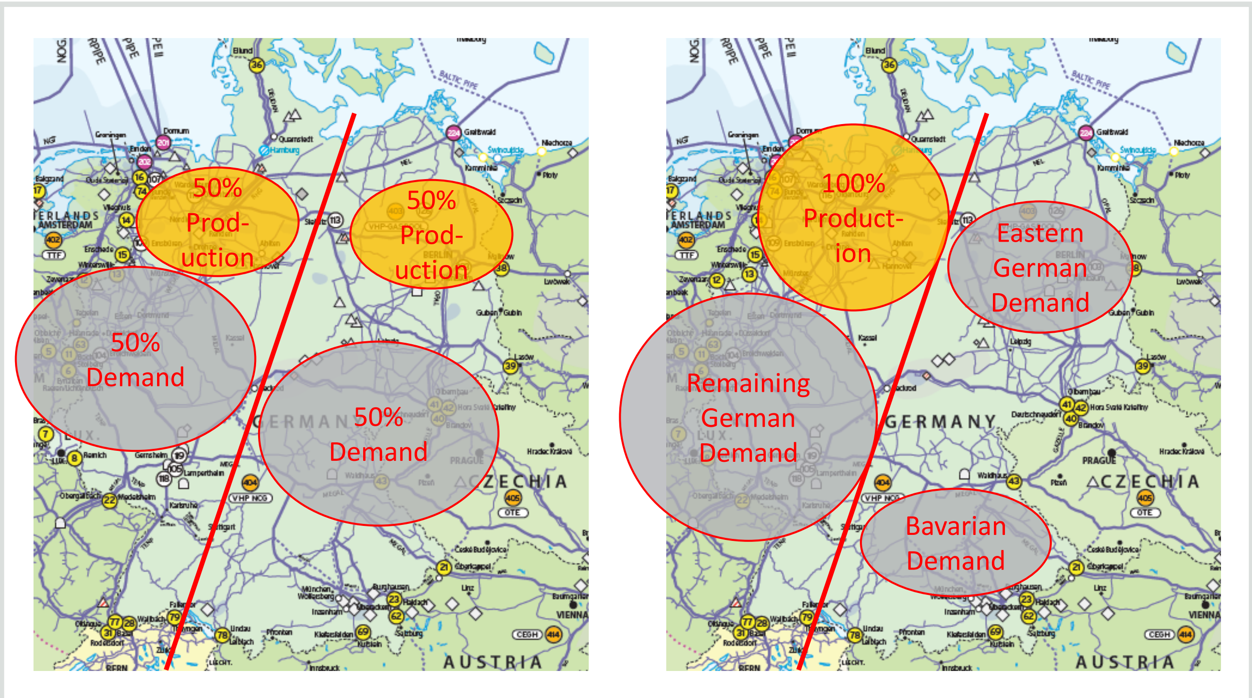

FIGURE 4: ILLUSTRATION OF DIFFERENT WAYS TO DIVIDE GERMANY, DIVISION BASED ON BRUEGGEL (2017) ON LEFT HAND SIDE, CORRECT DIVISION ON RIGHT HAND SIDE
(Source: own illustration based on ENTSO-G (2017))

1 This figure is in line with data from the statistical offices of the federal states in Germany, i. e. in 2014 there was a demand of 23.4 bcm in Bavaria and Eastern Germany is found while the 2014 total demand in Germany was 87.7 bcm (IEA, 2015). This yields a share of 26.8 % which is even slightly below 30 %.

2015	demand (bcm)	production (bcm)	LNG-imports (bcm)	3rd country pipeline imports (bcm)	residual import demand (bcm)
Germany (Bavaria + Eastern Germany)	24.4	0	0	0	24.4
East of red line	**198.7**	**49.4**	**6.6**	**15.3**	**127.6**

TABLE 4: CALCULATION OF NATURAL GAS DEMAND AND SUPPLY 2015 FOR THE COUNTRIES EAST OF THE RED LINE[1]

The second important and critical assumption made by Bruegel (2017) is that one could ignore spare capacities in the gas infrastructure. If Russia were to exert market power with respect to the critical demand of 35 bcm (or rather 17.6 bcm with a more realistic split of Germany), it is likely that the resulting price signal would attract additional LNG imports and also pipeline imports from third countries (e. g. from North Africa) in the area east of the red line given that the respective import infrastructure was far from full utilization in 2015 (the year which Bruegel (2017) uses for the calculation of the residual import demand). Based on 2015 infrastructure capacities, Table 4 shows spare capacities in Italy, Poland and Greece which are all completely east of the red line. For the LNG terminals, the spare capacity can be calculated as the difference between the regasification capacity of all terminals in a country and the actual LNG imports. In Greece, there are additionally pipeline import options from Turkey, which has the option to import LNG from the global market. Here, the difference between the pipeline capacity and the actual historical flows can be used as an indicator for spare capacities. Additionally, there are imports from North Africa, e. g. Algeria and Libya, to Italy. The nominal capacity of the North African import pipelines is very large (more than 45 bcm according to ENTSO-G (2017)). In this case, production levels in the North African countries are likely to be the limiting factor for exports, not pipeline capacities.

Since 2015 was a year with relatively low gas demand, we use values for the exports from North Africa to Italy in 2012 (a year with relatively high demand that is after the start of the Libyan civil war in 2011) as a proxy for the capacity limit of the imports from North Africa. In 2012, Italy imported 27.3 bcm from North Africa (20.8 bcm from Algeria, 6.5 bcm from Libya, IEA (2015)). This means that the spare capacity is given by the difference between 27.3 bcm and 14.7 bcm (imports in 2015), i. e. 12.6 bcm. If we assume that only Bavaria and Eastern Germany is in the area east of the red line, the residual import demand of 127.6 bcm has to be corrected for spare capacities of 31.6 bcm. With this assumption, the residual demand is 96 bcm. This means that there is no critical demand at all, if 110 bcm can be imported from west of the red line. Even if we assume that 139.4 bcm of residual import demand were the correct number (50 / 50 split of Germany), we would end up with a residual import demand including spare capacities of 107.8 bcm, i. e. a figure below 110 bcm. If those spare capacities are taken into account, Russia's market power potential would likely be severely limited, if it existed at all.

1 Data from IEA Natural Gas Information (2017), details for all countries can be found in the appendix.

2015	residual import demand without spare capacities (bcm)	spare LNG capacities in 2015 (bcm)	spare third country pipeline capacities in 2015 (bcm)	total spare capacities in 2015 (bcm)	residual import demand – spare capacities in 2015 (bcm)
Italy	40.3	8.9	12.6	21.5	18.8
Poland	12.0	4.8	0	4.8	7.2
Greece	1.9	4.4	0.9	5.3	–3.4
Remaining countries	73.4	0	0	0	73.4
East of red line	**127.6**	**18.1**	**13.5**	**31.6**	**96.0**

TABLE 5: CONSIDERATION OF SPARE CAPACITIES EAST OF THE RED LINE IN 2015

If the infrastructure situation in 2020 (the year when Nord Stream 2 is likely to be available) is considered instead of 2015, there will be even more spare capacity in the system, since several infrastructure extensions are planned. The TAP pipeline will be an import option of 10 bcm to Italy. If Italy does not use the full 10 bcm, the remaining volumes could be shipped to South Eastern Europe via the Interconnector Greece-Bulgaria. Therefore an additional 10 bcm can be imported into the area east of the red line. Furthermore, the LNG terminal in Poland (Świnoujście) will be extended by 2.5 bcm[1], and the LNG terminal in Greece by 2 bcm (Gas Infrastructure Europe, 2017). Therefore, the total spare capacities in the area east of the red line will increase by 14.5 bcm. Table 6 can be compared with Table 5 and shows the capacity of the infrastructure in 2020. There is a residual import demand of only 81.5 bcm in 2020 when newly constructed spare capacities are taken into account.

2020	residual import demand without spare capacities (bcm)	spare LNG capacities in 2020 (bcm)	spare third country pipeline capacities in 2020 (bcm)	total spare capacities in 2020 (bcm)	residual import demand – spare capacities in 2020 (bcm)
Italy	40.3	8.9	22.6	31.5	8.8
Poland	12.0	7.3	0	7.3	4.7
Greece	1.9	6.4	0.9	7.3	–5.4
Remaining countries	73.4	0	0	0	73.4
East of red line	**127.6**	**22.6**	**23.5**	**46.1**	**81.5**

TABLE 6: CONSIDERATION OF SPARE CAPACITIES EAST OF THE RED LINE IN 2020

1 http://www.polandatsea.com/polish-lng-terminal-will-increase-its-annual-capacity-to-75-bcm/

	Germany	Spare Capacities	residual import demand – spare capacities	critical demand
Bruegel (2017)	50% division	not considered	139.4	29.4
Correction for Germany	Bavaria + Eastern Germany	not considered	127.6	17.6
Spare capacities in 2015 considered	Bavaria + Eastern Germany	state of 2015	96.0	–14.0
Spare capacities in 2020 considered	Bavaria + Eastern Germany	state of 2020	81.5	–28.5

TABLE 7: SUMMARY OF THE DIFFERENT CONSIDERED CASES

Table 7 gives an overview of the different scenarios discussed so far. Depending on how Germany and the spare capacities in the area east of the red line are treated, different figures for the critical demand follow. We see that in all four scenarios the critical demand is quite small compared with the quantity of 110 bcm Russia has to sell at competitive prices west of the red line. The critical demand in Bruegel (2017) is likely to be too high due to the above-mentioned simplifying assumptions on the division of Germany and the failure to consider the spare capacities in 2015 and in 2020. If spare capacities are considered in the analysis, the critical demand becomes negative, which means that there are no quantities left for Russia to exert market power. As we consider it most reasonable to see the critical demand in the context of 2020 spare capacities, we conclude that there is even an excess quantity of 28.5 bcm. This can be seen as a security buffer for a potential outage of a gas infrastructure element or high demand.

In order to generate even more robustness for our quantitative analysis we construct a hypothetical extreme scenario with a "critical demand" above zero. For this purpose, we alter the scenario with consideration of 2020 capacities and the correct division of Germany to a scenario with different adverse conditions which would cause the critical demand to be high. This situation is shown in Table 8. We assume that the demand east of the red line is 10 % higher compared with 2015. This gives a total demand east of the red line of 218.5 bcm. Furthermore, we reduce the production east of the red line by 10 % to 44.4 bcm. The historic LNG and 3rd country pipe imports of 2015 remain unchanged. But we assume that (a) the LNG terminals are only available with 80 % of their nominal capacity (–5.8 bcm spare capacity), (b) that the TAP pipeline brings only 5 bcm instead of 10 bcm (–5 bcm spare capacity) and (c) that North African imports to Italy remain below 20 bcm (-7.3 bcm spare capacity). This gives in total in 2020 a spare capacity of 28.0 bcm which results in an extreme "critical demand" of 14.2 bcm in 2020. This number is however still somewhat below the critical demand as derived in Bruegel (2017), which has derived 45 bcm, but without accounting for spare capacities and making different assumptions about demand in Germany.

In order to conclude this quantitative analysis we give a short overview of the three main findings of this section:

- Based on certain simplifying assumptions we can confirm the critical demand calculated in Bruegel (2017).
- However, we develop more reliable scenarios by using a more realistic division of Germany and accounting for spare LNG and pipeline capacities. The consideration of spare capacities in particularresults in a "critical demand" below zero in 2020 and therefore no opportunity for Russia to exert market power.
- Based on some adverse hypothetical assumptions we develop an extreme scenario which yields a critical demand of 14.2 bcm for Central and South Eastern Europe, demand that can only be served by Russia.

These findings raise the question, if market separation is at all possible – given the relatively small volumes which might be compensated by demand reaction and substitution – would it even make economic sense for Russia to pursue a market separation strategy? After all, the demand of approximately 15 bcm potentially exposed to market power is small compared with the 110 bcm sold to Western Europe through Nord Stream 2 at a rather low price, as described in more detail in the next section.

	demand [bcm]	production [bcm]	LNG + 3rd country pipe imports (2015) [bcm]	spare capacities (with only 80% LNG) [bcm]	residual import demand – spare capacities [bcm]	critical demand
East of red line	218.5	44.4	21.9	28.0	124.2	14.2

TABLE 8: EXTREME SCENARIO IN 2020 WITH HIGHER DEMAND, LOWER PRODUCTION AND LESS LNG CAPACITY

MARKET SEPARATION WOULD NOT BE A RATIONAL STRATEGY EVEN IN AN EXTREME SCENARIO

As outlined in the previous sections, the entry/exit market design, existing long-term contracts as well as physical features of the European pipeline grid enable us to discount the market separation hypothesis. Additionally, even if it is assumed that Russia would be able to ship 110 bcm east of the red line and to congest all the pipelines along the red line, the figure of 35 bcm for the critical demand derived by Bruegel (2017) is too high, because it neglects additional import options in the area east of the red line. Correcting this number for a more realistic German demand assumption and available spare import capacities in Central and Eastern Europe, no critical demand can be identified for this region. Hence market segmentation through Nord Stream 2 would not be possible. Only when constructing an extreme scenario, with higher demand, lower production and lower import opportunities, a critical demand — hence a demand which could only be met with Russian gas — of approximately 15 bcm seems to be realistic. However, even in such a scenario, the question remains whether or not it would be a rational strategy to market Russian gas by separating the Eastern European gas market from the West pricewise.

Let us assume that Russia could sell 125 bcm in Europe at a given price. 110 bcm are sold West of the line defined by Bruegel (2017), and 15 bcm East of this line. Assuming additionally an inelastic demand and no substitution processes, Russia could, according to Bruegel (2017), lower the price West of the line in order to cause congestion, and increase the price east of the red line without changing the total volumes sold. Then the question arises: if the price were to decrease by 1 EUR/MWh west of the red line because of the 110 bcm from Nord Stream 2 flooding the Western European market, how much would the price need to increase east of the red line in order to make the Russian gas exporter indifferent to charging an equal price East and West of the line? A simple back-of-the-envelope calculation leads to a price increase of 110/15= 7.3 EUR/MWh in the East. However, if the price decrease in Western Europe is higher, e.g. 2 EUR/MWh, prices in Eastern Europe would need to increase by 14.6 EUR/MWh.

Such large price spreads between Eastern and Western Europe would not be a stable long run equilibrium, as such a situation would trigger investments into additional interconnector capacities mitigating the market power potential. Therefore, Russia could only apply the price discrimination strategy during a relatively small time-window. Typical planning and construction times for infrastructure generally require a time frame of about 5 years.

If one assumes that a price discrimination strategy is the sole motivation behind building Nord Stream 2, the total investment costs for the infrastructure (approximately 10 billion EUR) would have to be earned within a timeframe of 5 years. Assuming a discount rate of 10%, this corresponds to an annual payment of 2.63 billion EUR which has to be earned through Gazprom's supposed price discrimination strategy of. If one relates this sum to the 15 bcm east of the red line, this implies a break-even price increase of approximately 15.78 EUR/MWh that Gazprom would need to realize in order to amortize the investment costs of Nord Stream 2 with a market segmentation strategy. This means that together with the losses incurring from lowering prices in Western Europe (here assumed to be by 1 EUR/MWh) gas prices would need to be raised by more than 23 EUR/MWh in Eastern Europe. Assuming 2 EUR/MWh price reaction, prices in Eastern Europe would need to increase by over 30 EUR/MWh.

In conclusion, it seems unlikely that a price discrimination strategy would be pursued by Gazprom given the short timeframe within which it would be possible. To even reach a break-even point, very high price spreads would be necessary. However, those price increases would trigger infrastructure investments and possibly a demand reaction, i.e. a shift of consumers to other energy carriers or a decrease in energy consumption. In order to earn a positive profit, even higher price spreads would be necessary. Given the investment costs of Nord Stream 2, it is not plausible that Gazprom would finance Nord Stream 2 for such a short-term price discrimination strategy. Moreover such high price spreads would inevitably attract regulatory scrutiny making the likelihood of such a strategy being sustainable for any longer period of time even less likely.

CONCLUDING DISCUSSION

This study has assessed the hypothesis whether Nord Stream 2 could lead to a market separation of Central and Eastern Europe and exposure to market power through congestion, as claimed by e.g. Bruegel (2017). The analysis at hand shows that the hypothesis can be dismissed as there are several shortcomings in the argumentation:

1) The concept of a separating "red line" used in Bruegel (2017) is not viable in an entry/exit based market with market zones where gas suppliers only trade their volumes virtually and afterwards the TSOs determine the physical dispatch of gas flows.
2) Even if we assume that gas suppliers could induce physical congestion in an entry/exit- based market area, the existence of long term contracts restricts the potential to induce a market separation as suggested by Bruegel (2017).
3) Disregarding problems of a price discrimination strategy with current market conditions as outlined in points 1) and 2), Gazprom could still not physically transport enough gas in the area West of the bottleneck line defined by Bruegel (2017) in order to decrease prices in Western Europe and to create congestion in the pipeline capacities from West to East.
4) Even if one were to assume that it would be physically possible to send 110 bcm to Western Europe and congest the West-East direction, Central and Eastern Europe would have sufficient alternative import options such as spare LNG import capacities and pipeline imports from North Africa, especially when accounting for certain infrastructure extensions that will supply the area in 2020. This means that there is no "critical demand", i.e. demand that could only be served by Russia without any alternatives.
5) Therefore, only when constructing a hypothetical extreme scenario with relatively high demand and low availability of alternative supplies, would there be a critical demand greater than zero in the Eastern region of approximately 15 bcm that could only be supplied by Russia.
6) Even in the extreme scenario which disregards all the problems discussed previously, it is difficult to see an economic rationale behind a price discrimination strategy given the small amount of critical demand. Very high price differences between the areas East and west of the red line would be necessary for Gazprom earning a positive profit while pursuing a market separation strategy. Such price differences would likely trigger investments in additional infrastructure elements and lead to demand reactions in the Eastern area. High price spreads caused by a market separation strategy would also inevitably attract regulatory scrutiny making the likelihood of such a strategy being sustainable for any period of time even less likely.
7) Furthermore, the impacts of a price discrimination strategy on the reputation of natural gas should be taken into account. Given various climate-related political constraints there will be strong competition on price and quality between the different fuels in the future. However, if gas prices would be artificially high in certain parts of Europe because of a market segmentation strategy, alternative decarbonization options like the deployment of renewables and energy efficiency could be the focus of policy makers, leading to a faster phase-out of gas. No supplier would have an interest in such a development, since it would shrink the export market. It is in the interest of Russia as the largest holder of gas reserves in Europe not to damage the reputation of gas.

In conclusion, there is no basis for using Nord Stream 2 to realize a price discrimination strategy through market separation of Central and Eastern Europe given the current and expected structures of the European gas market.

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Authors
Dr. Harald Hecking, Martin Hintermayer
and Florian Weiser

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Alte Wagenfabrik, Vogelsanger Straße 321a
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ewi Energy Research & Scenarios gGmbH

Alte Wagenfabrik
Vogelsanger Straße 321a
50827 Cologne, Germany

Tel.: +49 (0)221 277 29-100
Fax: +49 (0)221 277 29-400
www.ewi.research-scenarios.de