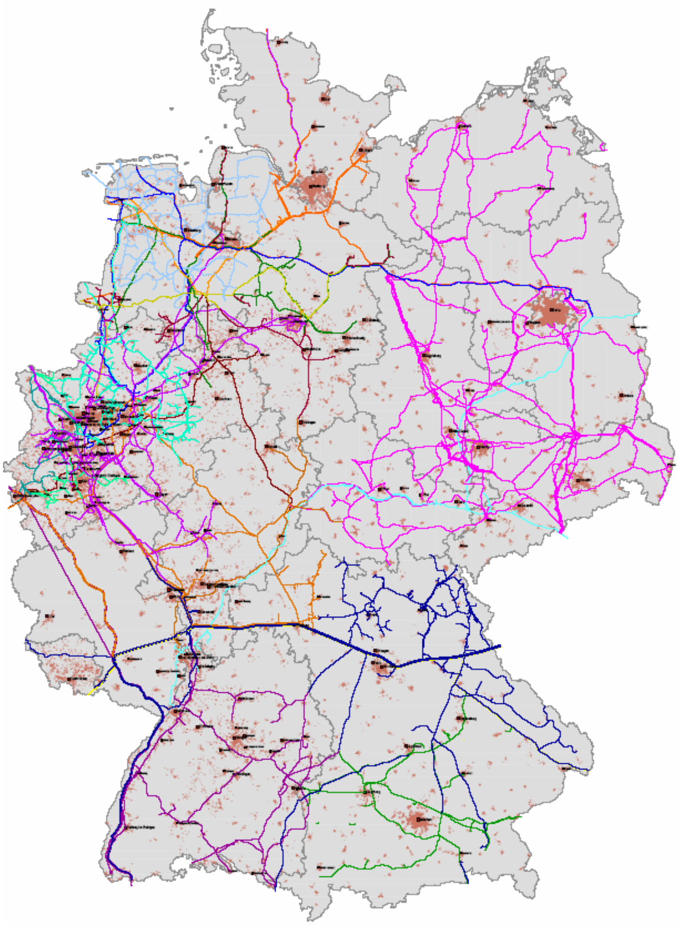
Competition in Natural Gas Transportation? Technical and Economic Fundamentals and an Application to Germany



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Executive Summary

1. Positive experiences with natural gas restructuring in the UK and the US suggest that a competitive wholesale market and a regulated transmission pipeline system yield the best market outcomes in terms of low prices and reliable supply According to §3 section 2(1) of the Ordinance on Gas Network Tariffs [GasNEV, "Gasnetzentgeltverordnung"] a competitive wholesale market is necessary before Germany's pipeline operators can be free to set their network access tariffs according to their peer companies' levels ["Vergleichsmarktkonzept"].
2. However, due to the high share of sunk costs, economies of scale in network expansion and network operation, and the network effects of a pipeline system, there is no workable or potential competition in natural gas transmission. Collusion and cooperation appear to be more likely strategies than intensive price competition even where pipeline territories overlap, or there is partial ownership of one pipeline. Consequently, one finds price regulation in almost all gas sectors around the globe, and also in competitive sectors such as the US or the UK.
3. Intensive competition among pipeline operators is as unlikely as intensive competition within Germany's Federal Highway System. Both are "typical" natural monopolies with a high degree of network synergies. By contrast, long-distance telephone networks ("backbones") have been transformed from monopolistic to competitive structures over the last decades due to i) a large surge in demand, and ii) decreasing costs. Since neither can be expected in natural gas transmission, the emergence of competition is unlikely in the future as well.
4. In Germany, network structure, the low share of relationships with a potential for competition, and the rather collusive behavior of pipeline operators do not favor the development of competition. We show that the minimum conditions for a competitive market as defined in §3 section 2(1) GasNEV are not fulfilled: i) dominance of exit points with access to multiple network operators; and ii) potentially viable business cases for pipeline newbuilds to access these points.
5. We conclude that the absence of competition in German natural gas transmission does not provide room for exempting pipeline operators from cost-based regulation, and that encouraging network competition will not fulfill the objectives of EU directive 2003/55 or the German Energy Law (EnWG). We suggest instead that creating a single network operator, establishing a German-wide wholesale market, and implementing competitive storage markets will bring about workable competition and put pressure on prices.

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1 Introduction

Positive experiences with natural gas restructuring in the UK and the US suggest that a competitive wholesale market and a regulated transmission pipeline system yield the best market outcomes in terms of low prices and reliable supply. We are now observing the natural gas industry in continental Europe transform itself from mainly vertically integrated monopolies to more competitive structures. Following the path laid out by the European Gas Directive (98/30/EC) and the "Acceleration Directive" (2003/55/EC), natural gas reforms are also high on the agenda in Germany: Indeed, the new Germany Energy Law [EnWG] of July 7, 2005, and the Regulation on Access Tariffs to Gas Networks [Gasnetzentgeltverordnung, GasNEV] of July 25, 2005, reflect the desire by policymakers to quickly implement European law and to enhance competition in the country's natural gas sector.

A critical decision for the German Federal Network Agency [Bundesnetzagentur, BNetzA] is whether long-distance transmission companies presently operating should be permitted to escape from individual, cost- or incentive-based regulation, or whether their prices should be based on self-calculated average costs ["Vergleichsmarktkonzept"]. GasNEV (§3 section 2 (1)) provides this escape clause for network operators that are "dominantly" ["überwiegend"] facing real or potential pipe-to-pipe competition. A necessary, but not sufficient, condition for workable competition is that a dominant part of the exit points must be accessible to more than one subsequent market network or that such access can be established under "reasonable business conditions" ["kaufmännisch sinnvolle Erreichbarkeit"].

The Chair of Energy Economics and Public Sector Management at Dresden University of Technology (EE²) has been mandated by EFET Germany (German section of the European Federation of Energy Traders) to determine the current degree of competition in Germany's long-distance natural gas transmission. This study analyzes the technical, economic and strategic industrial and organizational aspects of natural gas transmission. In particular, we analyze whether the exemption from individual regulation requested by twelve transmission operators is well-founded. Section 2 of this study lays out the fundamentals of natural gas transmission, and Section 3 applies these to Germany. Due to its cost structure, the network character of transmission, and the potential for strategic behavior, we find neither effective competition generally nor in Germany specifically. Section 4 concludes with suggestions for reform measures to foster competition in the German natural gas sector[1].

[1] This English version accompanies a long version of the study which also contains detailed analyses of technical aspects and calculations (see Hirschhausen, Neumann, and Rüster, 2007).

2 Analyzing Competition in Natural Gas Transmission Networks

2.1 Competition, market power and monopolies

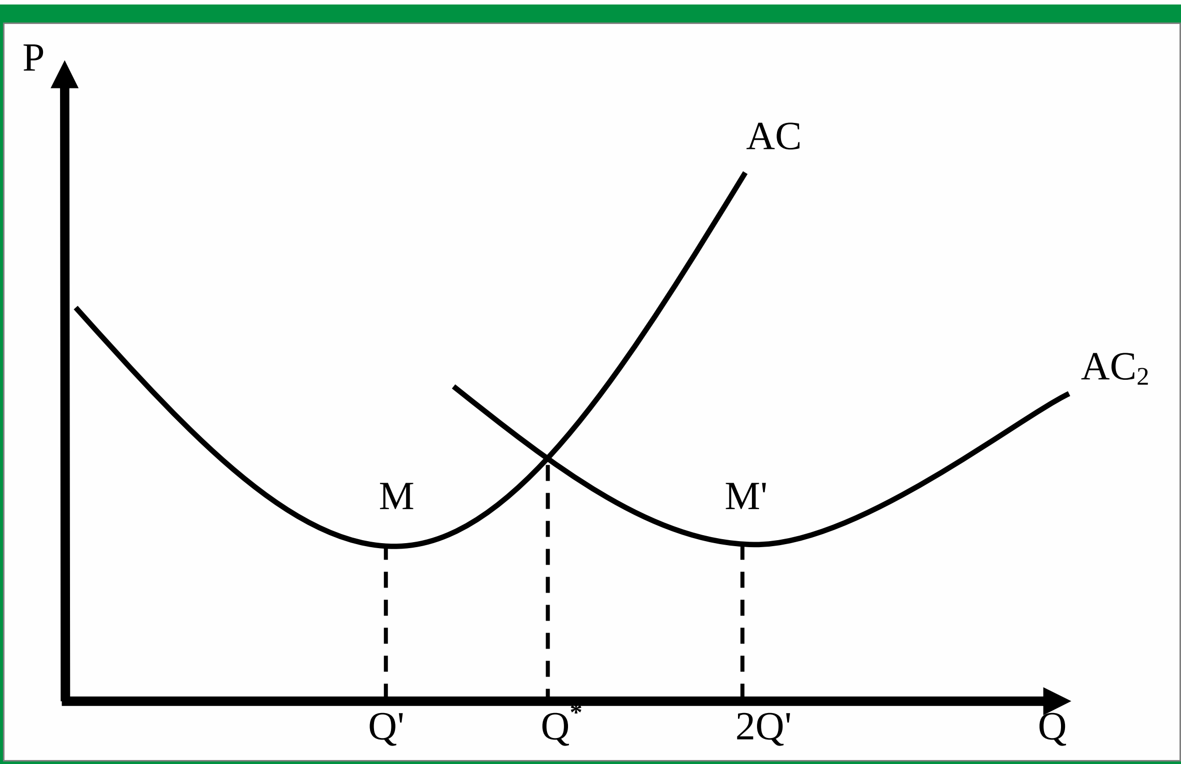
Economic policy generally aims at establishing the highest possible degree of competition, since this maximizes social welfare (i.e. the sum of consumer rent and producer rent). If competition does not emerge naturally, the State may intervene to establish conditions that simulate competition, i.e. through regulation.

In reality, competition is never perfect, due to a limited or finite number of suppliers and/or demand. The dynamic competition process, i.e. creative destruction or other forms of innovation, may also lead to temporary monopolies. The concept of “effective competition” adopts this dynamic perspective of competition: effective competition prevails if the static and dynamic functions of competition are realized to a large extent, and there is no permanent and relevant market power of certain enterprises (see Viscusi et al. (2005) or Motta (2004). Effective competition can be realized through *direct* competition in the market, or through *potential* competition with companies that are potential entrants into the market (Bormann and Finsinger, 1999, 274).

It is evident that there can be no effective competition in the case of a *natural monopoly*, i.e. when an industry is characterized by a subadditive cost curve and a high degree of sunk costs as illustrated in Figure 1. Where the service provided is a monopolistic bottleneck it must be regulated to avoid market power abuse (see Sharkey, 1968, and Newbery, 2000). Because network industries are particularly sensitive to synergistic effects among the management of different lines or connections, the coordination of network development, storage, etc., we often find that they are natural monopolies with no potential of direct competition.

Even in the absence of a natural monopoly, strategic behavior may limit or even bar the emergence of effective competition. For example, an incumbent network operator can set the price below the long-term marginal cost of the potential entrant, thus making it unprofitable for a competitor to enter the market (“limit pricing”). In the case of two existing network operators in a market, it is unlikely that a competitive price emerges because consumers have few options to “switch” between service providers due to technical, locational or institutional factors, or because implicit or explicit collusion between the providers is a more realistic outcome than price competition.

Figure 1: Natural monopoly (subadditive cost function)



Source: Sharkey (1982, 355)

2.2 No effective competition in natural gas transmission

2.2.1 Technical aspects and cost structure

Natural gas is transmitted under pressure (10-80 bar) and compressed in compressor stations about every 100-400 km. Pipeline diameters are between 100-1,400 mm (corresponding to 4 and 56 inches). The flow capacity of a cylindrical pipe increases as its diameter increases; however, the increase is more than linear (to the 2.65 exponent, Recknagel, 1990, 137; for details see Hirschhausen et. al, 2007). For example, if the diameter of pipe A is twice that of pipe B then the flow through pipe A will be considerably more than twice the flow through pipe B, all other things being equal.

Gas pipelines can also be used for storage purposes [Röhrenspeicher]. This is an important network character because the localization of the storage facility can be handled flexibly within a meshed network. In recent years, some transmission operators in the US, for example, have added (and marketed) additional storage capacity ("linepack") in response to policy concerns about "energy independence" or supply security.

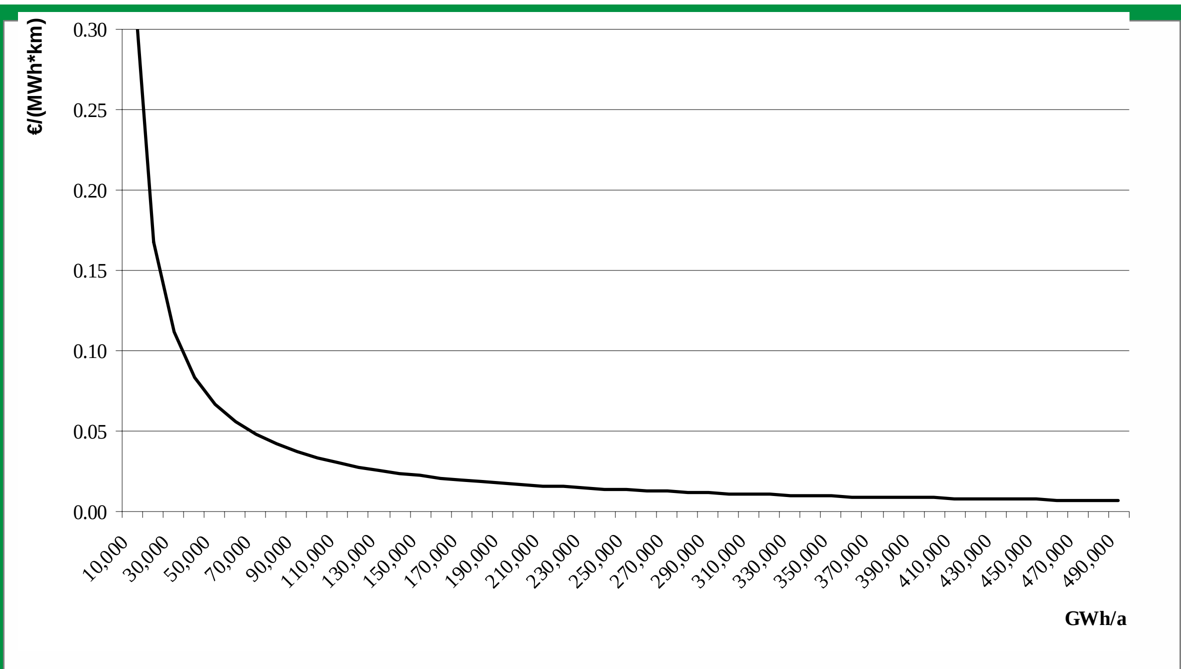
The cost structure of a pipeline network is characterized by high capital intensity and low variable costs. The majority of investment costs are "sunk" costs (in the true sense of the word). Transmission pipelines have long lives (35-60 years). Technical progress is slow, particularly when compared with the ever-evolving telecom industry. Thus, the sector is characterized by a low degree of innovation and relatively modest modernization requirements. Total costs are composed of fixed costs (the pipeline, compressor stations, metering) and operational costs (maintenance, variable fuel costs of compressor stations). Pipeline costs are mainly fixed costs, whereas in compressor station costs are mainly variable costs.

Construction costs are derived from a pipeline's length, pipe diameter and maximum operational pressure; technical improvements have resulted in reducing average costs (Pustisek, 2005, 43). Since variable costs increase in the flow, total costs are optimized with respect to the relation between pipeline diameter and the number of compressor stations (Dahl and Osmundsen, 2002, 2). Further economies of scale will result from extending capacity from one to several pipes in a trunkline as costs for additional construction, right-of-way security technology and surveillance costs decrease. It has been estimated that the investment costs of a second pipeline within a given corridor are about 80% of the costs of the first string; the second pipeline costs about 70% of the first pipeline, etc. [2].

2.2.2 Natural monopoly

Figure 2 shows the average costs of a three-string DN 1200/PN70-steel pipeline for a representative investment, e.g. from Emden into the Ruhr-area. Comparing the capacity of this pipeline with potential demand confirms the natural monopoly character. Its total capacity of 39 bcm corresponds to about 40% of German natural gas demand. Thus, one pipeline operator can manage the relationships within this network.

Figure 2: Average costs of a three-string DN 1200/PN70 steel pipeline

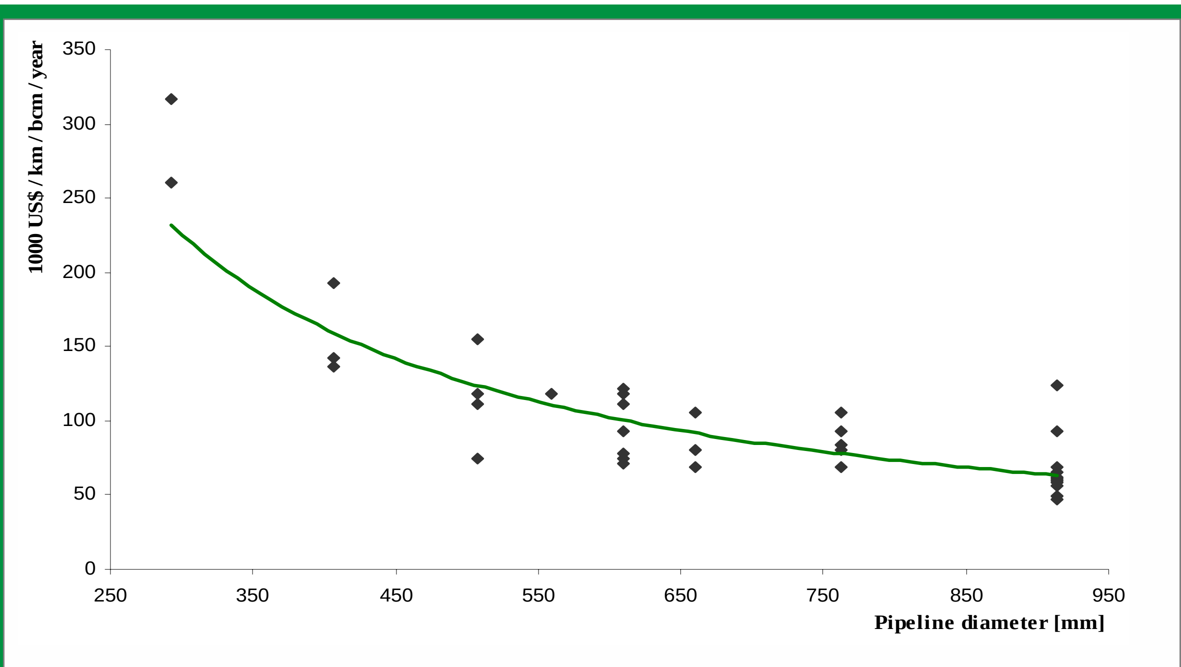


Source: Own calculation

[2] Source: Deutsche Beratergruppe Wirtschaft (1997): Financial Calculation of the Russian Yamal Project. Kiew; this assessment has been confirmed in interviews with several experts.

As mentioned above, the average costs of transmission fall as pipeline diameter increases, as shown in Figure 3. In sum, the network character of gas transmission reinforces the assumption of a natural monopoly. Larger networks are more efficient at balancing supply and demand, thus lowering the costs of transportation overall and also use storage functionality more efficiently.

Figure 3: Average costs dependent on pipeline diameter



Source: IEA (1994, 48)

2.2.3 Strategic behavior

Several aspects of strategic behavior can impede the emergence of effective competition. Even if there is more than one transportation operator, it is highly unlikely that price competition will emerge. In a network's largest segment, there will be no real alternative for buyers or traders to freely choose between two transmission suppliers. Implicit or explicit collusions are relatively easy to carry out in this narrow market. Potential competition through market entry by third companies can be avoided by strategic behavior, as described above ("limit pricing").

Empirically, there are fewer convincing examples for true pipe-to-pipe competition. This is also true for the US, even though supply (several independent pipeline operators) and demand (in the South, Northeast and Chicago) lend themselves to more competitive structures. However, the national regulator (Federal Energy Regulatory Commission or FERC) has maintained cost-based regulation of pipeline companies because of concerns about market power. On the other hand, the US has been able to establish a fully competitive wholesale market so that the consumers benefit from true gas-to-gas competition.

We conclude that the technical and economic analysis of natural gas transmission suggests that effective competition plays no role in this sector. There are significant economies of scale and of scope in this network industry. Even when there is high network density, multiple pipeline operators and transmission remains regulated, it indicates the low level of effective competition and the need for network access regulation.

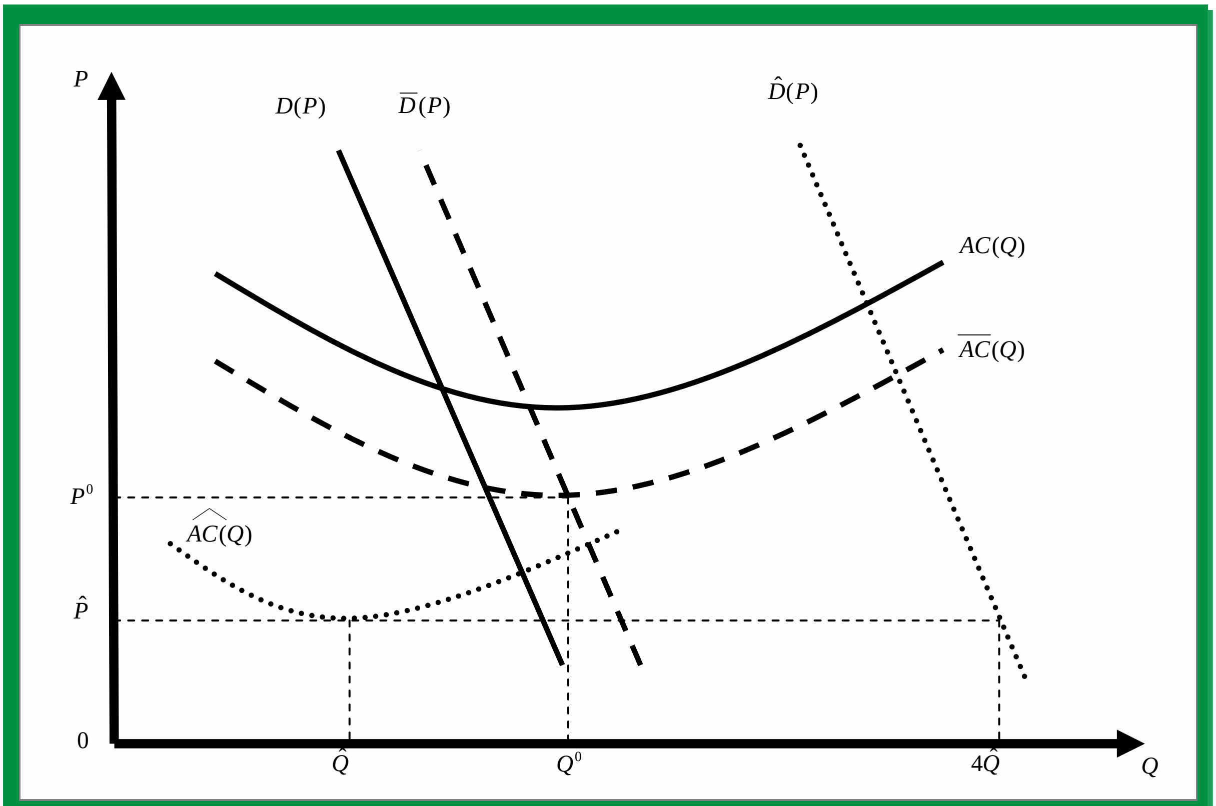
2.3 How natural gas is different from telecom

Restructuring proponents often use the telecommunications industry as an example of why natural gas should move from ex ante regulation to relaxing control. This occurred in some intercity, long-distance networks starting in the 1960s; a few observers even contend that the local loop [Teilnehmeranschlussleitung] is no longer a natural monopoly, because there are competing technologies available (e.g. cable, powerline). Figure 4 illustrates the dynamics of the intercity telecommunication markets that can be characterized by two factors:

- Demand shifts dramatically to higher levels *(D(P)* to $\hat{D}(P)$)
- At the same time, falling fixed costs push the average cost curve down and to the left, and as a result the optimal size of a company decreases (Q^0 to $\hat{Q}$).

There has been a clear tendency in long distance telecommunication to diminish the optimal size, and thus to escape the natural monopoly character that existed previously. However, the market dynamics of gas transmission differ markedly: demand increases are modest, and no particular developments are expected on the supply side, i.e. the cost function. It is therefore misleading to apply the experiences of the telecommunications industry to natural gas transmission.

Figure 4: Transformation from natural monopoly to deregulated market



Source: Viscusi et al. (2005, 537)

3 Natural Gas Transmission in Germany

3.1 The German transmission network

The natural gas transmission network in the formerly divided Germany was developed on both sides as the largely integrated system of two dominant suppliers: Ruhrgas, in the Federal Republic of Germany, and Gas Kombinat Schwarze Pumpe - VEB Verbundnetz Gas in the Democratic Republic of Germany (now Ontras). In the old Federal Republic there were also some regionally limited providers such as BEB in northwest Germany. The dominant market position of the incumbents in the respective territory was not substantially modified by the entry of Wingas, a new transport company in the early 1990s or by the growth of the local pipeline companies. Thus, the Federal Cartel Office (Bundeskartellamt, 2002), observed a strong dominance of Ruhrgas, particularly in large-diameter pipelines above 500 mm (see Table 1).

Table 1: Technical data on natural gas transmission companies in Germany (2005)

Name	Gas disposal (Mrd. kWh)	High pressure long-distance network (km)							
		Total	A (X>1000)	B (700 <=X<1000)	C (500 <=X<7000)	D (350 <=X<500)	E (225 <=X<350)	F (110 <=X<225)	G (X<110)
E.ON Gastransport	646	11.273	2.851	3.336	2.153	912	1.324	589	108
BEB	241	3.133	424	655	750	529	439	280	55
Wingas Transport	214	2.063	601	1200	7	126	37	92	-
RWE Transportnetz Gas	184	6.793	149	480	808	821	1.478	2.500	557
Ontras	164	6.862	117	1721	3281	802	651	207	84
Bayerngas	68	1.324	-	321	353	372	153	101	24
EWE Netz	41	4.008	-	-	29	858	337	1.900	884
Erdgas Münster Transport	38	833	-	-	154	222	102	334	22
GVS Transport	17	1.089	-	-	50	694	191	114	41

Source: Companies websites (structural data according to §27 (2) GasNEV)

Figure 5 shows that the structural network of 37,883 km, is characterized by several large transit or import pipelines, important connections between trading points and consumers (e.g. in the direction of the Ruhr area) and additional connections with local networks. However, only pipelines of structural classes A-C are relevant for long-distance transportation.

One further technical detail is that Northwestern Europe, (i.e. Northwest Germany, the Netherlands, and Northern France), is characterized by two separate networks for H-Gas (high-calorific) and for L-Gas (low-calorific). This also determines parallel pipelines in the North and the West of the German system. Because L-Gas is being phased out gradually in many instances. It is therefore likely that the H-Gas network will "take over" significant parts in the near future, although some minor L-Gas connections will remain.

Figure 5: Structure of the German natural gas transmission network

3.2 Absence of effective competition in Germany

We note that the cost structure of the pipeline system in Germany is similar to systems elsewhere where average costs are falling in the range of 28-39 bcm annually. This finding corresponds to about 40% of natural gas demand in Germany. Likewise, the network character of global systems suggests that a single operator results in more efficient management.

Some regions in the transportation system feature parallel pipelines, for example in northwest Germany (pipelines by EGT and Wingas), or the east-west connections in central Germany. However, it does not imply pipe-to-pipe competition, because the geographical range is limited and these islands do not offer a "network-wide" option.

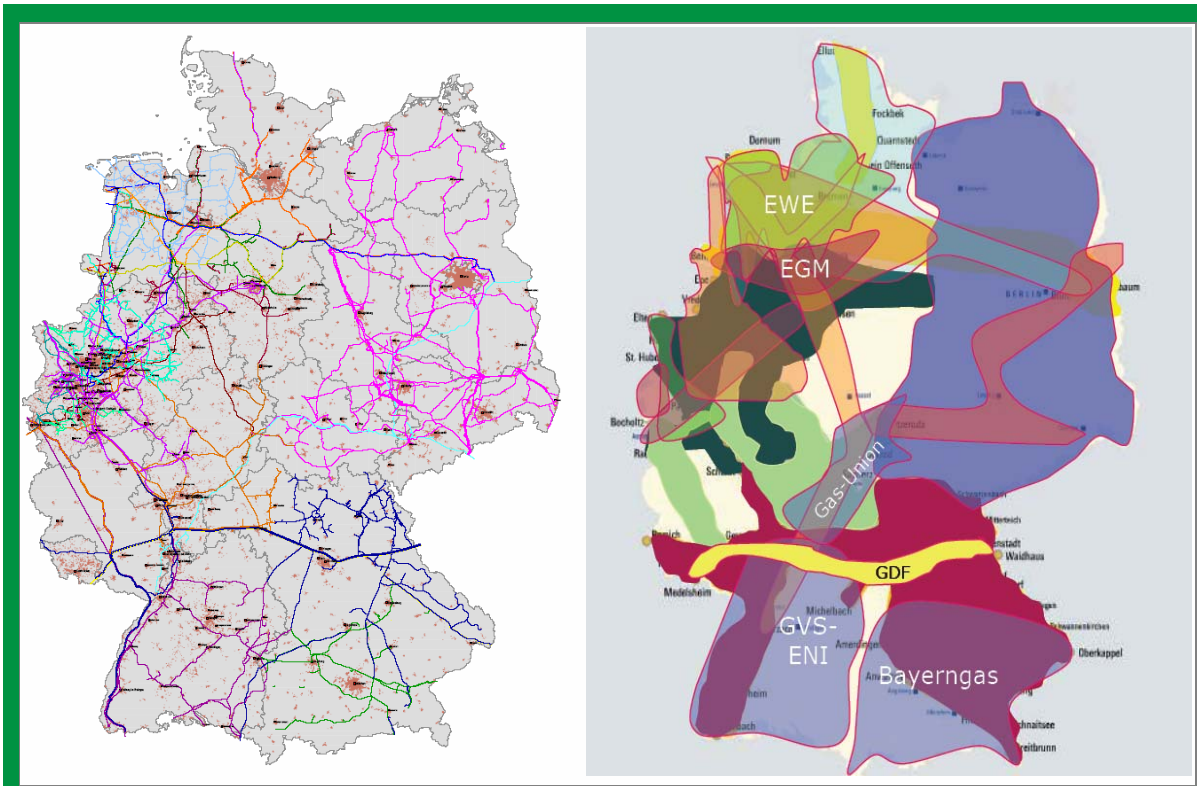
Strategic behavior by the network operators also suggests the absence of effective competition (see discussion above). Collusion and cooperation are also likely to dominate the management of jointly operated pipelines which is indicated by the contractor relationships related to the financing and operations of these pipelines (Hammerstein, 2004). Based on our analysis, we suggest that it is unlikely that a dominant pipe-to-pipe competition will emerge in Germany.

3.3 Analysis of §3 section 2(1) GasNEV

3.3.1 The structure of market areas and exit points

Germany's long-distance network is divided into 16 market areas based on a 2007 cooperative agreement. The agreement defined the areas according to their "technical possibilities and economic viability" and appointed a corresponding operator that connected adjacent networks so that transport could be utilized between entry and exit points. Figure 6 shows the current market areas and spanning networks. With the exception of Northern Germany, the market areas match the current ownership structure; some areas overlap, and a single transmission line has been declared a market area, ie, MEGAL, the GdF GTD tieline and Wingas I, II, and III.

Figure 6: Market areas of German transmission network



Source: BGW (2006) Source: EFET (2006)

A "market area" in the network extends from an entry point to a hydraulic reachable exit point leading to an end-user. Exit points for transport customers are allocated to market areas based on this definition. Market areas overlap when an exit point is directly or indirectly connected or accessible to more than one market-area spanning network. Explicit allocation rules are defined in §5 and annex 1 of the adjusted cooperation agreement of April 25, 2007 signed in conjunction with the "BGW/VKU-Leitfaden zur initialen Kunden- bzw. Ausspeisestellenzuordnung".

The BGW, a group of industry representatives, is required to regularly publish the survey results of the current state of exit point allocation. Table 2, the latest available documentation shows that only the market areas of EGMT, GdFDT, and Wingas I, II, and III fulfill the minimum requirements of §3 section 2 (2) GasNEV; hence we find multiple use of the majority of exit points.[3]

A closer look at northern Germany's market areas reveals multiple operations by BEB Transport, Dangas, Statoil and Hydro for H-Gas, while ExxonMobil Gastransport Deutschland (EMGTG) and BEB Transport are active in L-Gas. In Table 3, an analysis by transportation companies instead of market areas shows that only EMGTG, Erdgas Münster, Dangas, Statoil, and Hydro comply with the minimum requirements of §3 section 2 (2) GasNEV[4].

Table 2: Resulting structure of exit points

May 7, 2007	Südbayern	H-Gas Northern Germany	L-Gas Northern Germany	E.On GT H-Gas	E.On GT L-Gas	EGMT	Verbundnetz EWE	GdF Deutschland Transport	GVS-Eni	Ontras	RWE H-Gas	RWE L-Gas	Wingas I	Wingas II	Wingas III
Single	33	53	52	146	116	28	8	4	113	132	54	16	1	9	22
Multiple	1	24	20	110	32	30	-	39	2	17	18	5	23	15	53
..	11	-	-	-	1	-	-	11	-	-	-	1	-	-	-

Source: Own Calculation based on BGW (2007)

Table 3: Exit point structure of transport companies

	Single	Multiple	..
Bayerngas	33	1	11
BEB Transport GmbH	137	32	-
Dangas GmbH	-	3	-
E.on Ruhrgas Gastransport	265	126	1
Eni Gas & Power	-	-	k.A.
Erdgas Münster Transport GmbH & Co. KG	28	30	-
Exxon Mobil Gas Transport Germany	-	34	-
Gaz de France Deutschland Transport GmbH	26	-	10
Hydro Energie Deutschland	-	1	-
Ontras-VNG Gastransport Deutschland GmbH	132	17	-
RWE Transportnetz Gas GmbH	70	23	1
Statoil Deutschland	-	1	-

[3] Single: single (potential) hydraulic market area allocation; Multiple: multiple(potential) hydraulic market area allocation; ..: hydraulic market area allocation still to be clarified.
Four of the market areas (Wingas I-III and GdF) are trans-regional single-transport pipelines to which the concept of workable competition is not suitable.

[4] We follow the legal interpretation which implies a clear majority above 50%.

3.3.2 Is network access "commercially viable"?

Paragraph 3 section 2 (1) GasNEV also formulates a condition for effective competition in the commercial accessibility of exit points. A case-by-case business analysis that assesses the parameters of individual projects (ie, capital costs structure, attitudes toward risk, corporate structures, and other technical details of newbuilds) would be required to determine if the necessary conditions exist that will support effective competition. However, in the current institutional setting of vertically unbundled and cost-based regulated network companies, this type of analysis is inadequate since a cost-based regulated network operator will always cover its costs for the newbuild, and there is no potential for transfer pricing between trading activity and the pipeline business. Even if cross-financing could exist, an incumbent company would have a systematic cost advantage (i.e., lower investment costs and reduced capital costs due to the lower relation of sunk costs). Again, some strategic behaviors are likely to prevent entry.

4 Summary and Recommendations

This analysis confirms the general wisdom that due to the characteristics economies of scale and scope natural gas transmission are provided most efficiently by a single network operator. We found no exceptions of note to network regulation even in the US, where a large number of operators meet high demand. Nor is Germany an exception, although historically it developed a specific ownership structure. There is no dominating effective competition in the German pipeline network, and it is unlikely to emerge in the future as well. We note that the atomization of the country's network into 16 market areas that in most cases were delineated along property lines contradicts the now-desired goals of establishing effective competition and market transparency.

We also reject the minimum criteria defined in §3 section 2 (1) GasNEV. In almost all market areas and for almost all network providers the majority of exit points can only be reached via a single company/market area, and that access to these exit points through commercially viable newbuild is implausible.

Both the European Directives and German Energy Law were designed to promote competition in the Europe's natural gas sector. We assert that this will only be realized through competition at the wholesale level. Therefore, to promote competition and obtain lower prices, reforms in Germany's gas sector should target a competitive wholesale market. We consider the following measures to be conducive to more efficient functionality:

- *Implementing incentive regulations.* Since July 2006, when the BNetzA provided a blue-print for incentive regulation of electricity and natural gas networks, implementation has been delayed (at the time of this paper, most likely until 2009). Incentive regulation should be applied to natural gas transmission as well;

- *Additional structural reforms following the UK example.* We suggest combining Germany's 16 market areas into a single market area for H- and L-gas respectively; implementing a fully functioning entry-exit system; and creating a virtual balancing trading point.
- *A single independent system operator or commercial transmission company.* Full unbundling of ownership is a more stringent solution since it separates transmission from trading activities, but installing an independent system operator (ISO) may be a politically acceptable compromise.
- *Opening storage to competition following the vertical separation between trading and networks.* This could encompass auctioning available storage capacity; facilitating the construction of new commercial storage; and promoting Germany's storage capabilities to other countries in the EU.

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