



Gas TSO efficiency analysis for the Dutch transmission system operator (GTS)

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1 Introduction

1.1 Background

ACM, the Dutch energy regulator, aims to include a static efficiency measure in its method of regulation for GTS, the Dutch gas TSO. Article 13 of the European gas Regulation 715/2009 amongst others stipulates that tariffs of a TSO shall reflect the actual costs incurred, insofar as those costs correspond to those of an efficient and structurally comparable network operator. As GTS is the only gas TSO in the Netherlands, ACM has no national direct comparator to determine whether the costs of GTS are efficient. For this reason ACM uses the German gas TSO benchmark commissioned by BNetzA to determine the static efficiency of GTS.

ACM has commissioned Frontier Economics (“Frontier”) and Consentec to undertake a static efficiency analysis for GTS. The aim of the benchmark study is to determine the static efficiency of the costs for GTS based on the data from all gas TSO’s participating in the German benchmark. The analysis is based on data from the year 2010. In the course of the project, GTS has claimed some country specific differences between GTS and the German gas TSOs, which might have to be taken into account in the benchmarking analysis.

From sixteen country specific claims, raised by GTS, five claims remain still open as a follow up of the discussions with ACM. This report specifically focuses on these five open claims.

1.2 Structure of the report

This report is structured as follows:

- **Section 2** presents the concept and general framework for efficiency benchmarking and introduces the handling of different supply tasks of TSOs;
- **Section 3** goes through five open categories of country specific claims raised by GTS. It elaborates on the methodologies applied for their evaluation and presents the quantitative and qualitative results; and
- **Section 4** summarizes the most significant findings and conclusions.

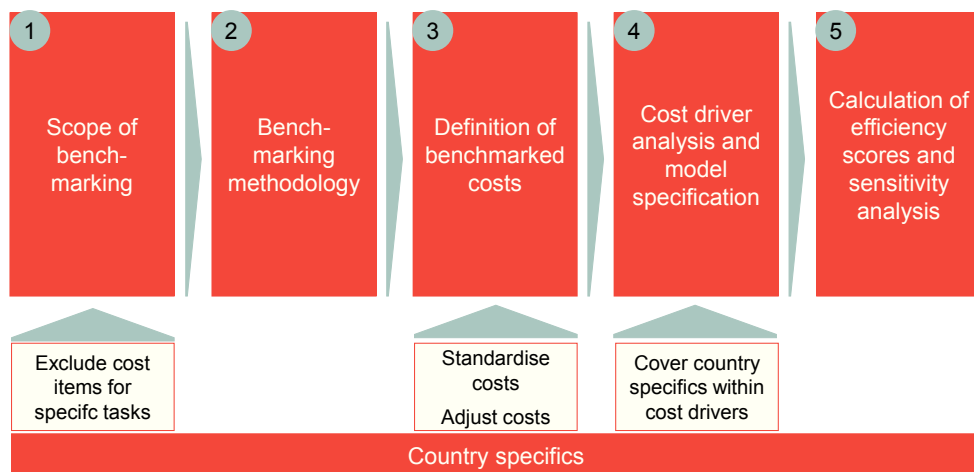
2 Generic overview on benchmarking analysis

In the following we briefly describe the sequence of steps for the benchmarking analysis and where we are taking into account possible GTS specific claims. We note that we have not undertaken any calculations of efficiency scores for GTS.

2.1 Steps in benchmarking analysis and dealing with country specifics

In principle any efficiency analysis can be described as a sequence of the following steps (**Figure 1**):

Figure 1. Steps in benchmarking analysis



Source: Frontier/Consentec

- **Scope of benchmarking** – TSOs typically carry out several activities. This step defines the transmission tasks involved in the benchmarking analysis. In this step, activities that are not comparable between different TSOs can be excluded, thus improving the comparability of the tasks considered in the benchmarking.
- **Benchmarking methodology** – Several benchmarking approaches are available. The approaches differ e.g. in relation to assumptions on functional forms of the cost functions (parametric vs. non-parametric) or how they deal with noise in the data (deterministic vs. stochastic). Which approach is best employed depends on the size of the sample of comparators among other factors.

- **Definition of benchmarked costs** – The costs (input parameters, in short: inputs) may include operating expenditures (OPEX) or total expenditures (TOTEX) also including capital expenditures (CAPEX). Some standardisation of costs may be necessary to make cost data between firms comparable. In particular, the cost definition reflects the above-mentioned scope of the TSOs' activities thus guaranteeing full comparability.
- **Cost driver analysis and model specification** – This step prepares the selection of benchmarking parameters in order to capture fully the supply task of gas TSOs. The cost driver analysis shall identify those output parameters (in short: outputs), which best reflect the
 - supply task of the transmission system operator; and
 - other structural and environmental parameter with an impact on the TSOs' costs.

The supply task of the transmission system operators consists of various dimensions which may not be fully reflected by a single cost driver. In the additional step “model specification” different costs drivers are gathered into one benchmarking model in order to get the best representation of the full dimension of the supply task of the transmission system operator. The model specification is based on transparent selection criteria.

- **Calculation of efficiency scores and sensitivity analyses** – In the final step the efficiency scores of the TSOs are calculated using the benchmarking methodology, benchmarked costs and identified costs drivers. In addition sensitivity analyses can be used to validate the robustness of the results. E.g. outlier analyses may give important information on the impact of individual TSOs on the efficiency scores of the other companies.

International efficiency analysis includes an additional challenge as it has to ensure comparability between companies operating in different countries. Those companies may be exposed to various country specifics. Hence, it is important to take these country specifics into account in the course of the efficiency analysis.

GTS raised various country specific claims. Dealing with country specifics can be done at different stages of the analysis and we already dealt with most of the GTS claims in a separate note for ACM:

- **Scope of benchmarking** – Some GTS claims are not relevant simply due to the scope of the benchmarking analysis. As agreed with ACM the scope of this benchmarking analysis is limited to the “transport task” of GTS. As a consequence all claims related to other tasks have to be rejected per se.

Generic overview on benchmarking analysis

- **Definition of benchmarked costs** – Some GTS claims refer to differences between costs for the German TSOs and GTS. Some claims can be rejected *per se*, because they do not correspond to the scope of benchmarking and hence are not included in the database, e.g. investment measures not included on German TSO cost base, while others can be covered by adjusting /standardising costs, e.g. differences in depreciation periods.
- **Cost driver and model specification** – Some GTS claims refer to differences in the specific supply task of GTS compared to the German TSOs. Hence, some claims have to be rejected *per se* because their effects cannot be proven on an empirical basis; others may be covered by certain output parameters, or a further adjustment of costs may be necessary.

The GTS claims will be analysed in detail according to these stages.

2.2 Principles on Cost drivers

Any efficiency comparison must account for differences in the outputs and the structural environment of the companies. A key challenge is to identify a set of variables:

- that describe the tasks (the cost drivers) that most accurately and comprehensively explain the costs of the TSOs;
- that affect costs but cannot be controlled by the firm (environmental factors); and
- for which data can be collected consistently across all firms and with a reasonable effort.

2.2.1 Criteria for cost-drivers

The following generic criteria may be applied in the selection of output and structural parameters. The criteria constitute an ideal, although in practice some trade-offs may be required:

- **Exogeneity** – Output and structural parameters should be exogeneous, i.e. outside the influence of TSOs to control or change them by their decisions.
- **Completeness** – The output and structural parameters should cover the tasks of the TSOs under consideration as completely as reasonable.
- **Operability** – The parameters used must be clearly defined and they should be measurable or quantifiable. Qualitative indicators or subjective assessments should not be used.

- **Non-Redundancy** – The parameters should be reduced to the essential aspects, thus avoiding duplication and effects of statistical multi-collinearity and interdependencies which could affect the clear interpretation of results.

Not least given the limited number of TSOs (14), when selecting the output parameters the number of parameters should be limited to parameters that describe the different dimensions of the supply task. If the model is over-specified (too many parameters) there is a possibility that almost all firms appear notionally efficient, even though the true efficiency in the sector may be lower than this.

2.2.2 Dimensions of the supply task of gas TSOs and long-list of cost-drivers

In the German gas TSO benchmarking analysis three general dimensions for the gas TSOs' supply tasks were identified:

- **Capacity provision/gas transport** – This dimension should reflect, that meeting a high level of demand for transport capacity from the feed-in points to the withdrawal points results in a higher cost for provision and operation of the infrastructure compared to the case when demand is low. Hence, the costs are primarily driven by the provision of transport capacities (or peak load). The transported gas volumes (or work) can also drive costs e.g. owing to compression.
- **Network expansion** – This dimension reflects the size that the network must have in order to fulfil its supply task. A more expanded network infrastructure must be provided and operated in order to supply and transport gas over a large geographical area compared to the case that the supply task is geographically limited.
- **Network granularity** – With a more complex and more granular supply task, e.g. due to a higher number of connection points, more mains must generally be laid with (in part) smaller diameters, and more infrastructure must be provided compared to the case that consumption is concentrated at a limited number of connection points. This is reflected in the granularity of the network.

We note that these general dimensions for the supply task of TSOs also apply to the transportation task of GTS.

Figure 2. Potential cost drivers and dimensions of the supply task

	Parameter candidates – potential cost-drivers
Capacity provision/ Gas transportation	• Annual peak load • Annual offtaken gas volume • Gas pressure difference • Gas pressure level
Network expansion	• Pipeline volume • Pipeline surface area • Transport momentum • Transport momentum area • root („Transport momentum area “) • Mean transport distance
Granularity of network	• Service area
	• Feed-in/withdrawal points

Source: Frontier Economics / Consentec / ITE

Consentec (2012) identified in a preceding cost-driver analysis a long-list of cost drivers, which can be assigned to the dimensions of the supply task as follows (**Figure 2**):

- *Annual peak load*: Captures capacity provision taking into account the capacity load at the point of annual peak load;
- *Annual off taken gas volume*: Corresponds to the capacity provision over the year and reflects gas transport;
- *Pressure difference and pressure level*: Proxy for the need of compression and can therefore be one element in representing capacity provision (however, the parameters cannot describe capacity provision on their own);
- *Pipeline volume and pipeline surface area*: Are generally associated with large network expansion and high capacity;
- *Transport momentum*: Includes information concerning load and transport distance and can therefore describe the dimension of capacity provision and/or network expansion;
- *Transport momentum * area and Root transport momentum * area*: Includes information on load and transport area coverage and can therefore describe the dimension of capacity provision and/or network expansion;

- *Mean transport distance*: Includes information on load and transport area coverage and can therefore describe the dimension of capacity provision and/or network expansion;
- *Polygonal area*: Can clearly be assigned to network expansion; and
- *Number of feed-in/withdrawal points*: Reflects the dimension of granularity.

On the background of this long-list of costs drivers for the German TSO benchmarking we analyse in the following section if and/or to what extent there are country specifics for GTS which make additional adjustments of costs or cost-drivers necessary.

3 GTS country specific claims – Conceptual approach and quantitative evaluation

This section gives an overview of the general approach on dealing with the country specific claims and proceeds in five subsections corresponding to five open categories of GTS country specific claims. In each subsection, we start out with a general description of the corresponding claim followed by a comprehensive overview on the methodology for analysis applied. Subsequently the quantitative evaluation is presented.

Throughout our analysis we apply the data provided by GTS and thirteen German gas TSOs for the year 2010, namely

- ▣ Thyssengas GmbH
- ▣ jordgasTransport
- ▣ GRT Gaz
- ▣ Nowega
- ▣ Open Grid Europe
- ▣ GASCADE Gastransport GmbH
- ▣ ONTRAS - VNG Gastransport GmbH
- ▣ EWE
- ▣ Bayernets
- ▣ terranets bw GmbH
- ▣ Gasunie
- ▣ Fluxys
- ▣ Dong

The analysis differentiates between various gas qualities. GTS covers three gas qualities of G, H, and L¹, while the German gas TSOs covers the gas qualities of H and L.

Due to confidentiality reasons we neither represent the name of corresponding TSOs in the following evaluations nor the value of the calculated parameters but express them in relative terms.

¹ The full amount of L-Gas transported is exported to the Belgian and German market.

3.1 General approach on country specific claims

In order to assess the GTS claims we apply a stepwise approach:

- **Evaluate GTS claim** – In this step we analyse to what extent the claim raised by GTS is justified. In case that there is no evidence for a substantial difference between GTS and the German TSOs, we will propose to reject the GTS claim. In case that there is substantial difference we will enter the next step.
- **Evaluate if GTS claim is covered by output parameters** – In this step we analyse to what extent the GTS claim is covered by categories of output parameters. Output parameters are meant to describe the tasks (the cost drivers) that most accurately and comprehensively explain the costs of the TSOs. Hence, differences in the supply tasks of a TSO may already be covered by these output parameters if they enter the final benchmarking model specification. This means in particular, that differences in the parameter values are not critical for the application of benchmarking techniques but a normal phenomenon in the datasets; only extreme differences – e.g. in the order of a magnitude – would have to be treated separately. In case relevant output parameters are not included, there may be a further iterative process in the model specification phase.
- **Evaluate how to take GTS claim into account** – If a difference between GTS and the German TSOs exists and the difference may not (fully) be covered by output parameters which are candidates for the final benchmarking model we will enter a further step. In this step we analyse the material effect of the claim with respect to the costs of GTS which will enter the benchmarking. This step may result in particular in an adjustment in costs.

3.2 Distance between storage and industrial consumers

3.2.1 GTS claim

Storage of natural gas is a process that balances the variable market demand against the preferably constant supply of natural gas. Storage facilities help to maintain supply flexibility and security and meet customer requirements during peak periods. Gas is injected into storage during periods of low demand and withdrawn from storage during periods of high demand. The most important type of gas storage is underground reservoirs. There are three principal types of underground storage:

GTS country specific claims – Conceptual approach and quantitative evaluation

- depleted reservoirs in oil and/or gas fields,
- aquifers, and
- salt caverns.

The location of storage facilities is mostly dependent on geology. The location of consumers is not under the control of the TSO, either. As a result, distances between storages and consumers cannot be influenced by the TSO.

Storage facilities are used in the GTS network as well as by the German gas TSOs to facilitate the operation of the grid. GTS claims that its network is characterized by higher distances between storages and consumers as compared to the German gas TSOs and that this results in higher costs. According to GTS, the benchmarking analysis should take this structural difference into account.

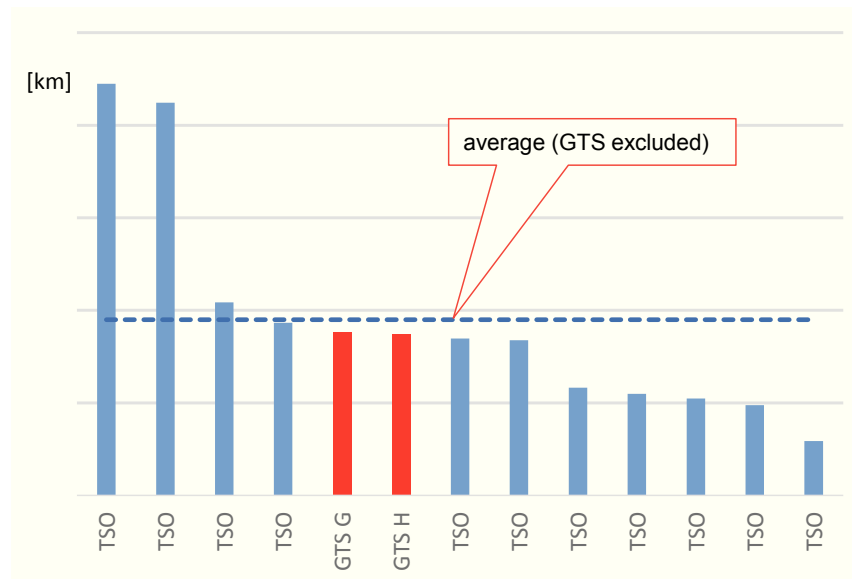
For further details about this claim we refer to the Memorandum of GTS, claim No. 13 “Flexibility” (GTS, 2014).

3.2.2 Assessment of GTS claim

In order to deal with the claim of GTS, we compare the distances between storage facilities and industrial consumers among all TSOs, including GTS and the German TSOs. As a first step we calculated the weighted average distance to industrial facilities for each individual storage. The individual distances are weighted by the size of industrial facilities, i.e. annual peak of exit flows.

Figure 3 illustrates the maximum calculated distance over the individual storage facilities for the German gas transmission networks and GTS, differentiated for various gas qualities. The red bars represent the distances of GTS for H- and G-Gas, while the blue bars represent the German TSOs. Subgrids without storage, like the L-Gas grid of GTS, are neglected².

² A Subgrid is a part of the whole network where all entry- and exit-points are connected by pipelines operated by the same TSO. Subgrids are subdivided in gas qualities.

Figure 3. Maximum distance over individual storage facilities

Source: Frontier Economics / Consentec

We normalise the largest maximum distance from all TSOs at 100%. The corresponding smallest maximum distance takes a value of 13%. The average maximum distance for all German TSOs is 42 %. GTS has a maximum distance of around 38 % for gas qualities of H and G and is slightly below the average of the German TSOs.

Hence, we conclude that GTS is characterized by a medium storage-to-consumer distance. The largest distance over the comparison sample is around two times of the GTS level. We note that three of the German TSOs do not have any storage at all³, which may indicate higher network costs for these TSOs.

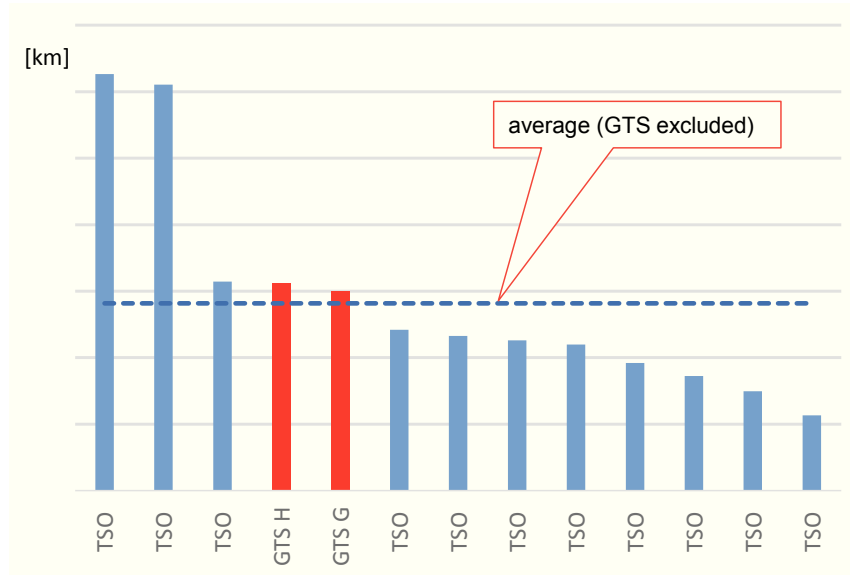
In a further step we calculated the average distance over all storages for each subgrid. The individual distances for each storage facility are weighted by its size, i.e. annual peak of entry/exit flows.

Figure 4 compares the average distance between storage and industrial consumers for the German gas transmission networks and GTS. The average distance for GTS is again differentiated for various gas qualities. We normalize the largest average distance from all TSOs at 100%. We represent the distances for the other TSOs as the ratio of the TSOs' average distances and this largest average distance. The average distance for all German gas transmission networks is approximately 47% in terms of the ratio of the highest level over all TSOs. For the GTS network, the distance is 50% for both gas qualities H and G. The

³ One TSO does not have industrial load, which is excluded from the sample.

highest distance over the whole sample is around two times of the GTS level. The results are similar to those for the maximum distance.

Figure 4. Average of distances between storage and industrial consumers



Source: Frontier Economics / Consentec

In addition to the analysis above, we analysed whether the distance between storage and consumers is covered by the dimensions of the supply task of a gas TSO set out in **Section 2.2.2**.

The characteristic of gas transmission networks with regard to the distances between storage and consumers is properly covered by cost drivers covering the supply task dimensions:

- Capacity provision/gas transport
- Network expansion

Higher storage-to-consumer distance increases the need for compression and the level of demand for transport capacity, which is covered by the dimension of capacity provision/gas transport.

As described, the network expansion reflects the size the network must have in order to fulfil its supply task. Higher storage-to-consumer distance requires an expanded network infrastructure which is properly covered by this supply task dimension.

Therefore, we note that even in case GTS could claim on good grounds an extraordinary storage-to-consumers distance, the cost drivers reflecting “Capacity provision/gas transport” and “Network expansion” are already capable to take this into account, because higher storage-to-consumer distances are reflected in both dimensions.

Distance between storage and industrial consumers – Proposal

GTS claims that its network is characterized by higher distances between storage and consumers as compared to the German gas TSOs and this would result in higher costs for GTS. We note that this claim cannot be confirmed by empirical analysis. We propose to reject this claim.

3.3 Transit

3.3.1 GTS claim

Transit pipelines are an inherent component of the European gas transmission system. Most of the pipelines pass through several countries (transit countries). For example, Belgium transmits Norwegian and Dutch gas destined for France, Italy, Spain, UK, Luxemburg, and Germany. German TSOs transit Dutch gas to Switzerland, Russian gas to France and Norwegian gas to the Netherlands. Dutch and Norwegian gas is sent through Switzerland to Italy.

Figure 5 illustrates the GTS network including the export points (transit flows) to the German and Belgian market.

GTS country specific claims – Conceptual approach and quantitative evaluation

Figure 5. GTS network including transit flows to German and Belgian markets



Source: Frontier Economics / Consentec based on Grid map by GTS

GTS states that the supply task of transit is extraordinary due to the

- ▣ high share of transit, in combination with
- ▣ provision of a high flexibility of the transit flows.

GTS claims that the share of transit is extraordinary compared to the transit share of the German TSOs. In order to deal with this higher share, GTS claims that the GTS network has to provide additional capacity resulting e.g. in a higher number and/or capacity of compressor stations or a higher pipeline volume. In addition, GTS states that the transit is characterized as highly volatile (thus GTS is providing flexibility) resulting in a relatively low annual energy withdrawal (compared to what would be feasible under a high utilization factor). As the energy withdrawal is identified as one possible output parameter (**Section 2.2.2**), it may not mirror the supply task of GTS with regard to the transit. Hence, GTS claims for a consideration of this volatility or corresponding flexibility offered by the grid.

GTS country specific claims – Conceptual approach and quantitative evaluation

For further details about this claim we refer to the Memorandum of GTS, claim No. 13 “Flexibility”⁴.

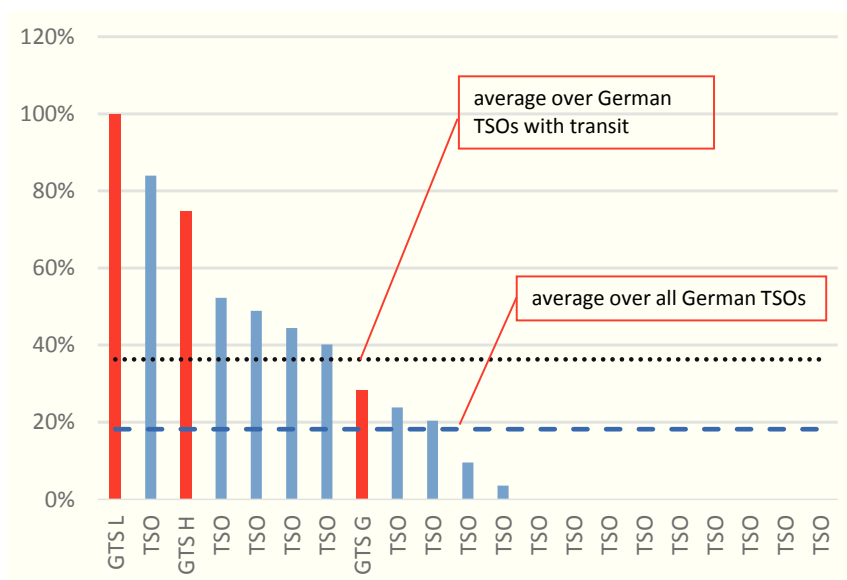
3.3.2 Assessment of GTS claim

In order to assess the GTS claim, we compare the share of transit among different TSOs. The data provided by the German TSOs and GTS classifies the network connections to other grids into

- connection points with adjacent networks⁵ as one category and
- connection points with upstream networks⁶ as another category.

Thus, for the evaluation of transit we summed up the gas flows to/from adjacent grid operators as well as upstream networks to account for all the gas flows between the considered TSOs and their interconnected networks.

Figure 6. Share of transit: transit flows relative to annual energy feed-in/withdrawal



Source: Frontier Economics / Consentec

Figure 6 illustrates the share of transit in terms of the ratio of transit flows to the annual energy feed-in/withdrawal. Five of the German gas TSOs have zero or a very low share of transit (differentiated in gas qualities representing nine bars for

⁴ GTS, Verschillen tussen GTS en de Duitse netbeheerders: memorandum, December, 24th, 2014.

⁵ “adjacent networks” is the English translation for the German word “Nachbarnetze” used in the original network data provided by the TSOs.

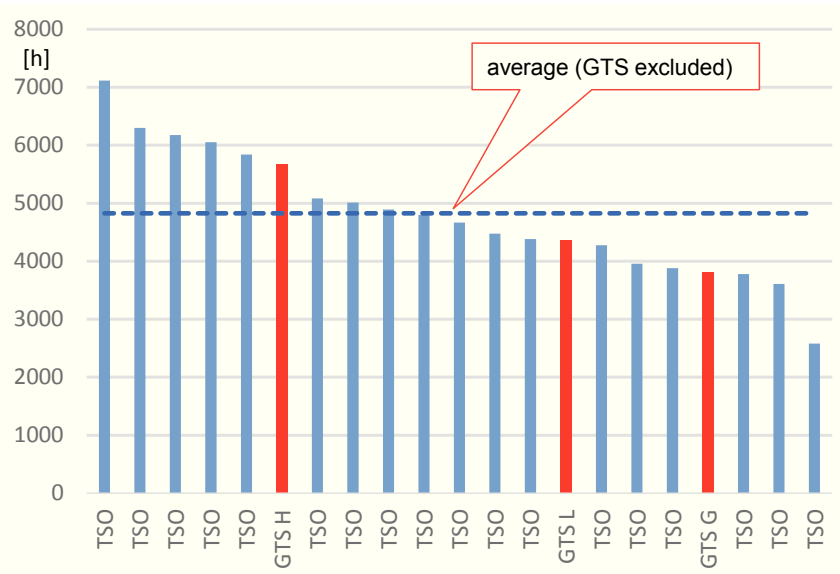
⁶ “upstream networks” is the English translation for the German word “Vorgelagerte Netze” used in the original network data provided by the TSOs.

nine networks of these five TSOs in **Figure 6**). The GTS share of transit is 100% for the L-Gas meaning that the L-Gas is completely exported to the German and Belgian markets.

In case of H-Gas, GTS has a 75% share of transit, which is in the same order of magnitude like several German TSOs in the dataset. GTS' share for G-Gas is only slightly above the average, 28% compared to the average transit share over all German gas TSOs of 18%. Compared to German TSOs with transit the share of transit for G-Gas is below average (28% vs. 36%).

This means that transit is a main task for the H-Gas network of GTS, while it plays a secondary role in the G-Gas-subgrid, which largely supplies the national consumers; but in both cases, for H-Gas as well as for G-Gas, there are several German TSOs with similar values. Hence, we conclude that in none of the cases, neither for H-Gas nor for G-Gas, the GTS share of transit can be defined as extraordinary. In addition we note that the high transit share for L-Gas is a result of its definition and the special treatment of L-Gas as a pure export quality – specifically destined for the foreign markets⁷.

Figure 7. Grid operation time: annual energy withdrawal relative to peak load



Source: Frontier Economics / Consentec

In a next step we approach the volatility of the transit task by comparing the grid operation time (GOT) among the TSOs. **Figure 7** illustrates the grid operation

⁷ The conversion of H-Gas to L-Gas is covered in a cost category that is excluded from the benchmarking scope and consequently does not represent any additional burden to the transmission network. This conversion then contributes to the flexibility provided in the L-Gas exports.

time in terms of the ratio of annual energy withdrawal to peak load. The higher the GOT, the lower the volatility of the transit task. The average GOT is 4800h for the German gas transmission networks, the minimum reaches 2600h and the maximum is 7100h. For GTS H-Gas a level of 20% above average can be identified – but still in range where several of the German TSOs operate as well. Hence, the claimed lack of comparability due to extraordinary volatility cannot be confirmed.

Although an exceptional share of transit combined with high volatility could not be approved here for H- and G-Gas, the conversion of these two gas qualities near the German and Belgian markets into L-Gas can be counted as an extraordinary task. We therefore propose to adjust the cost base for GTS by excluding the costs for the converter stations. This adjustment of costs for quality conversion was already approved at a prior stage of the project.

In addition to the above, we analysed whether the aspect of transit is covered by the general dimensions of the supply task of a gas TSO as set out in **Section 2.2.2**. Amongst those, the two dimensions "capacity provision/gas transport" and "network expansion", are suitable to capture the effects of transits; this is due to the fact that transit leads to the same technical and physical strain for a gas transmission network like domestic gas transport. In addition, the transit might also increase the number of connection points, which falls under the dimension of the "granularity of network".

Thus, the transit task of a gas transmission network is properly covered by the cost drivers covering all supply task dimensions:

- ▣ capacity provision/gas transport;
- ▣ network expansion; and
- ▣ granularity of network.

We note that even in the case that GTS could claim on good grounds an extraordinary task of transit, the cost drivers reflecting "Capacity provision/gas transport", "Network expansion" and "Granularity of network" are already capable to take this into account.

Transit – proposal

GTS claims that the task of transit in reference to a high share of transit combined with a low operational time is extraordinary in comparison to the German TSOs. We note that this claim cannot be confirmed by empirical analyses. We propose to reject this claim.

3.4 Trade off “Compressor stations vs. pipeline volume“

3.4.1 GTS claim

Compressor stations facilitate the transportation of natural gas. The compressor station compresses the natural gas (increasing its pressure) thereby providing energy to move the gas through the pipeline. Natural gas, while being transported through a gas pipeline, needs to be constantly pressurized at intervals of approximately 40 to 100 miles. The size of the stations and the number of compressors vary, depending on the diameter of the pipe and the volume of gas to be transported.

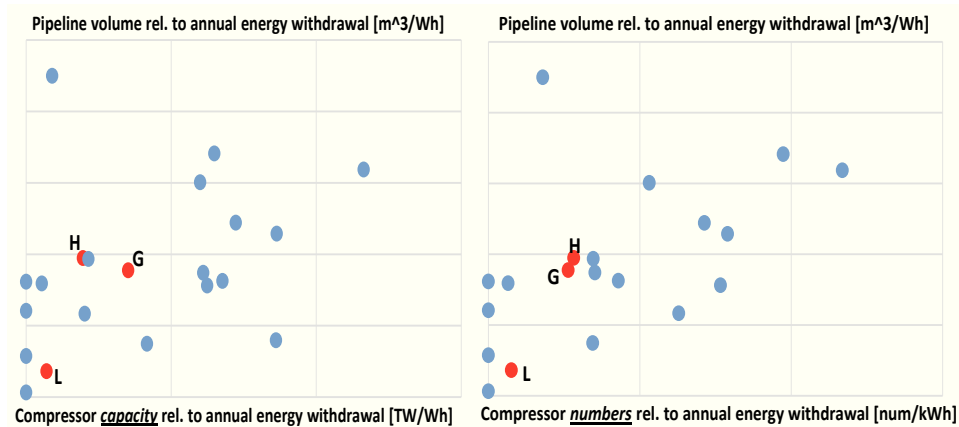
If a given amount of gas needs to be transported over a specified distance, there is a trade-off between the number/capacity of compressor stations and the pipeline volume.

GTS claims that its network is characterized by lower pipeline volume compared to the German Gas TSOs. Correspondingly, in order to accomplish the same supply task GTS claims a requirement of a higher number/capacity of compressor stations. Only considering pipeline volume as an output parameter in benchmarking analysis would, according to GTS, not adequately reflect this trade-off.

3.4.2 Assessment of GTS claim

In order to analyse the justification of this claim, we analyse whether the GTS network shows particular effects of this trade-off with respect to a higher number/capacity of compressor stations compared to the network extension and tasks. Hence, we compare the pipeline volume on the one hand and the number/capacity of the compressor stations on the other hand with parameters reflecting the supply task of the gas transmission network e.g. the annual energy withdrawal or the annual peak load.

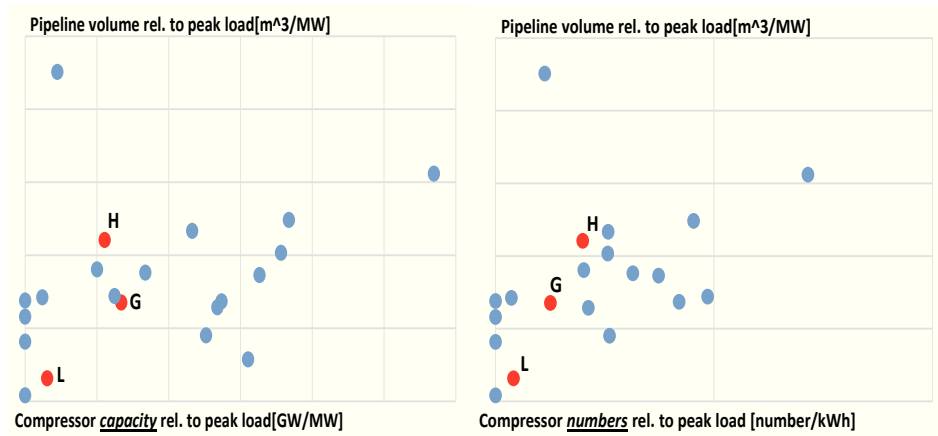
Figure 8. Ratio of pipeline volume and capacity/number of compressor stations to annual energy withdrawal



Source: Frontier Economics / Consentec

Figure 8 illustrates the ratio of pipeline volume to annual energy withdrawal versus the corresponding ratio for the compressors capacity on the left and the number of compressor stations on the right. In this analysis, a network favouring pipeline volume over the usage of compressor stations can be classified at the upper left of the plot. Respectively, a network favouring compressor stations would be shown at the bottom on the right side. Networks with a balanced trade-off are positioned nearby the line through the origin. No extreme correlation between pipeline volume and number/capacity of compressors can be identified for the networks of GTS while some of the German TSOs show a clear bias; e.g. the network at the upper left of the diagram, which is clearly dominated by pipeline volume compared to compressor stations.

Figure 9. Ratio of pipeline volume and capacity/number of compressor stations to peak load



Source: Frontier Economics / Consentec

Figure 9 illustrates the ratio of pipeline volume to peak load versus the corresponding ratio for the compressors (capacity and number of stations). The results of this analysis are completely in line with those for the annual energy withdrawal.

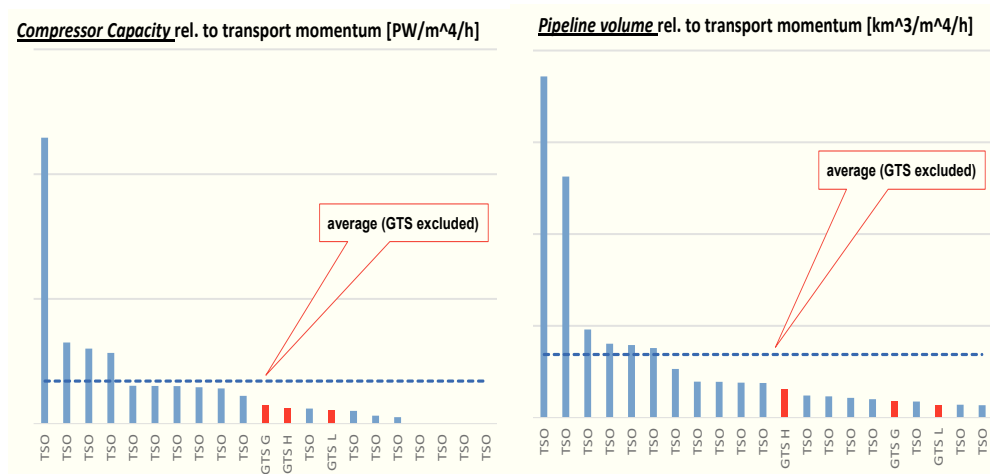
According to the X-axes in **Figure 8** and **Figure 9**, the GTS' compressor capacity for the G-Gas is around the average compressor capacity over the German gas TSOs. Concerning the compressor capacity of H-Gas and L-Gas, GTS positions 50% and 80% below average, respectively.

With respect to the pipeline volume (Y-axes in **Figure 8** and **Figure 9**), the GTS level for G-Gas and H-Gas is near the average volume over the German Gas TSOs, while in the category of L-Gas the GTS level is 80% below average. This underlines that the GTS networks are not in an extreme position concerning the trade-off between pipe volume and compressor capacity.

In a final step of this analytical part, we investigated the ratio of capacity of compressor stations/pipeline volume to the transport momentum (**Figure 10**). We selected the transport momentum as output parameter, which properly mimics the supply task of gas transportation with focus on load and transport distance⁸. Below GTS is positioned near the average for all three gas qualities of G, H, and L.

⁸ In the simplest case of a direct point-to-point pipeline, the transport momentum is the product of throughput (maximum of feed-in and withdrawal in [m³/h]) and distance between entry and exit point (transport distance in [m]).

Figure 10. Ratio of capacity of compressor stations/pipeline volume to transport momentum



Source: Frontier Economics / Consentec

According to these analyses, we conclude that GTS' claim of having an outstanding requirement for a higher number or capacity of compressor stations cannot be confirmed by empirical data.

Trade off "Compressor stations vs. pipeline volume" – proposal

GTS claims that its trade-off between compressor stations and pipeline volume results in less pipeline volumes compared to the German gas TSO. We note that this claim cannot be confirmed by empirical analysis of the available data for pipeline volume and compressor stations. We propose to reject this claim.

3.5 Joint venture

3.5.1 GTS claim

GTS claims that they do not have the possibility to form joint ventures with other network operators to build and operate a pipeline as some German TSOs are doing. Due to this there are cost disadvantages for GTS. In addition GTS claims that some output parameters may lead to double counting at a disadvantage for GTS.

3.5.2 Assessment of GTS claim

We note that for the German benchmarking analyses BNetzA decided to allocate the costs for the joint ventures to the German gas TSOs according to the share in the joint venture. The same approach was applied to the cost driver

GTS country specific claims – Conceptual approach and quantitative evaluation

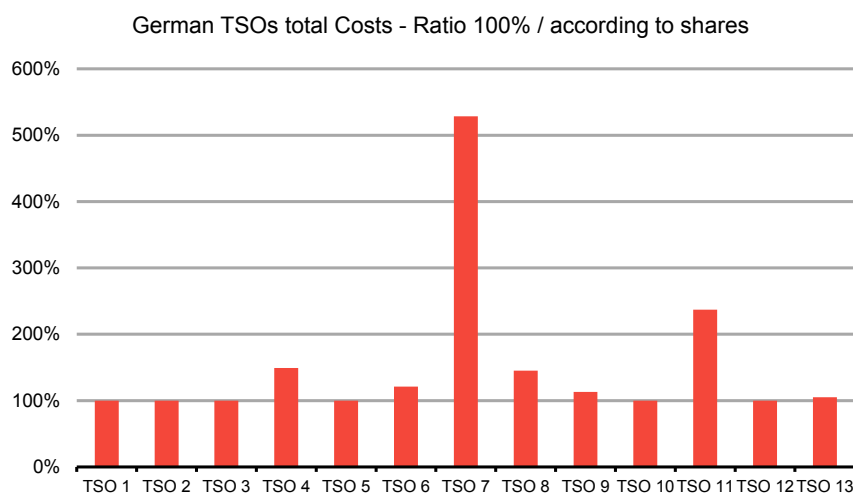
parameters, as well, with the exemption of two costs drivers (service area, number of connection points) where the allocation according to the share in the joint venture is not feasible due to conceptional reasons. This was the case for “connection points” where specifying a share for a connection point, e.g. 30% connection point would not make sense, because the connection point is reflecting the obligation for the network operator to reach this point with the network.. The same holds true for the “service area”: if the company had built the pipeline on its own this would not have an impact on the affected area where the pipeline runs through.

In the following we discuss:

- the impact on total costs from allocating 100% of the joint venture costs to the German TSOs;
- the impact on the input/output ratios for the two output parameters (service area and connection points) where the allocation is not based on the share of the joint venture but according to 100% by using either the total costs allocating 100% of the joint venture costs or allocating joint venture costs according to the share in the joint venture; and
- possible options to deal with joint ventures.

In a first step we calculate the potential impact from allocating 100% of the joint venture costs to German TSOs operating a joint venture (instead of allocating only costs according to the share in the joint venture). BNetzA provided us with detailed cost data for the joint ventures and the respective shares of the German TSOs in the joint venture. This enables us to calculate total costs which include 100% of joint venture costs for each TSOs engaged in a joint venture. We note that the maximum number of TSOs having a stake in one joint venture is three.

Figure 11. German TSOs total costs – Ratio for 100% cost allocation from JV to cost allocation according to shares



Source: Frontier Economics / Consentec

Figure 11 illustrates the results from our analysis as the ratio between

- ▣ total costs including 100% joint venture costs for the German TSOs being part of the joint venture;
- ▣ total costs including joint venture costs according to shares in the joint venture.

Six German TSOs are not affected from the 100% allocation as they are not part of a joint venture, meaning that they are in the same position as GTS. For the other German TSOs the impact on the costs can be classified within different ranges:

- ▣ 100% to 115%: three TSOs fall into this range;
- ▣ 115% to 150%: three TSOs fall into this range;
- ▣ > 150%: two TSOs fall into this range including one substantial outlier.

In a next step we analyse individual output/input ratios as a first indication on the impact from allocating 100% joint venture costs to the German TSOs. As we apply DEA as the relevant benchmarking methodology this may serve as a first indication for the impact on the efficiency frontier. The reason is that by applying DEA, the relatively simple approach of comparison of partial indicators of efficiency is generalized, in order to compare companies with several inputs and outputs. The formal approach consists of enveloping the recorded input and output data of the companies by an optimal frontier. The frontier is being described by those companies which realize the most favourable output-input

combination (most outputs given the inputs). The relative efficiency of those companies which do not meet the frontier is being calculated as relative distance to the frontier.

We restrict our analysis only to the two output parameters (service area, number of connection points) where the allocation is not based on the share of the joint venture but according to 100%. We get the following results:

- **Number of connection points** – The company having the best output/input ratio with regard to this cost driver does not change by including 100% of the joint venture costs. In addition, the company having the best ratio belongs to the group of the 6 German TSOs not engaged in a joint venture. Hence, this means that at least for this single ratio there should not be an effect on the relevant benchmark for GTS.
- **Service area** – The company having the best output/input ratio with regard to this cost driver changes by including 100% of the joint venture costs. In case of allocating joint venture costs according to the share of the joint venture a company belonging to the three TSOs within the range of 115% to 150% has the best ratio. In case of allocating 100% joint venture costs a TSO from the group of the 6 German TSOs not engaged in a joint venture sets the best ratio.

One further important finding from the analysis is that the two German TSOs which are substantially affected by the 100% allocation of joint venture costs do not set the respective benchmark for either the connection point or service area ratio.

Hence, the above analysis for the output/input ratios indicates that GTS will not be affected by “double counting of outputs” with regard to the parameter “connection point” if one uses total costs allocating cost from joint ventures according to the shares in the joint venture.⁹

When it comes to “service area” we note that one could:

- **Adjust output** – This would mean adjusting the service area according to the share of joint venture. However, we note that the counterfactual for building the pipeline in a joint venture would likely be that each TSO built their own pipeline (but with a smaller pipeline volume). Hence, this means that in the counterfactual case the service area (and the number of connection points) would not be affected¹⁰.

⁹ As DEA is a multidimensional analysis including more than one output/input ratio the final verification is only possible after running the DEA.

¹⁰ There may be an impact on the costs in the counterfactual, as two parallel lines with a smaller pipe volume are likely to be more expensive than one big line. However, the size of this cost impact

- **Adjust costs** – This would mean to use the costs including 100% joint venture costs. However, we note that these costs will be “too high” for all corresponding outputs, except “connection point” and “service area”. In addition, we note that the company having the best output/input ratio for the output “connection point” would not be affected from this cost adjustment. Adjusting costs, which means overestimating the costs from more than half of the German TSOs, in order to avoid a not certain disadvantage for GTS with regard to the single output parameter “service area” seems disproportionate.

Concluding, we note that both options (adjust output and adjust costs) have their drawbacks. Hence, we would propose at this stage to allocate the costs for the joint ventures to the German gas TSOs according to the share in the joint venture (the approach also implemented by BNetzA) and make no adjustments for the output parameters and costs. However, we note that in the next stage of model specification we will be cautious on the possible impact from service area on the efficiency scores for GTS.¹¹

depends on various parameters and assumptions, e.g. TSOs using same corridors, which may save digging costs, the chosen pipeline volumes, etc. In addition, we note that for the service area of GTS, some double counting of service areas results from largely overlapping H- and G-gas networks and network areas.

¹¹ Further, we note that when calculating DEA efficiency scores, which will take place in the next stage of the project, we will use e.g. generic approaches to mitigate the impact from companies with characteristics materially different from those of the majority of the sample (outlier analysis). These companies will be removed from the sample and the analysis will be repeated without the outlier. This increases the robustness of the analysis.

Joint ventures – proposal

GTS claims that the possibility of forming joint ventures by German TSOs poses a disadvantage for GTS due to possible “multiple counting of outputs”. Based on our analysis we propose to reject this claim at this stage and use the same output definitions and cost definition with regard to joint ventures as in the German benchmarking analysis. However, we note that in the next stage of model specification we will be cautious on the possible impact from service area on the efficiency scores for GTS.

3.6 Capacity products

3.6.1 GTS claim

Gas networks can be planned and operated under the consideration of different capacity products. Capacity products are to some extent defined by the national regulator and can have an impact on the network configuration (especially in terms of network planning) and costs. GTS claims that it provides more firm capacity products as compared to the German gas TSOs.

For further details about this claim we refer to the Memorandum of GTS, claim No. 11 “Restrictions on capacity products” (GTS, 2014).

3.6.2 Assessment of GTS claim

GTS correctly refers to the fact that in Germany different types of capacity products/rights are offered by the gas transmission operators on the market. The main categories of capacity products consist of firm and freely allocable capacity, capacity with conditional firmness and free allocability, firm and dynamically allocable capacity, firm capacity with restricted allocability, and interruptible and freely allocable capacity.

Within a decoupled entry-exit system shippers can contract entry and exit capacity independent of each other. Characteristic of a decoupled entry-exit system is further the presence of a virtual trading point (in order to allow transfer of gas), and a common balancing regime. A decoupled entry-exit system can be realized by one operator (like GTS in the Netherlands) or by several operators jointly in a co-operation based market area (like in Germany for the two market areas Gaspool and NetConnect Germany, each consisting of several TSOs).

In a fully decoupled entry-exit system no limitation applies to (the use of) capacity offered without restrictions. GTS operates within such a fully decoupled entry-exit system. In the market areas in which the German operators operate, certain conditions are placed on the use of a limited share of the contracted capacity. In practice, however, this does not mean that the capacity products

booked from the German network operators are of a completely different quality than the capacity product of GTS. Nonetheless, certain differences exist, and on a general level the claim is not without good grounds.

However, there are three main mechanisms that clearly limit the quantitative effects of the different product categories on the network costs of GTS:

- 1) *The restrictions only apply to a limited share of the German TSO capacities:* The vast majority of capacities in Germany are of essentially the same quality as in the Netherlands. This varies in details, depending on the different market areas, TSOs, Entry vs. Exit sides etc. and detailed data are not available; but at least for the general level, the BNetzA monitoring report for several years¹² shows the limited (and decreasing) importance of restrictions in practice. For several German TSOs restrictions do not play an important role at all.
- 2) *The restrictions are not effective in many of the cases:* Network customers in Germany have pointed out in surveys that their preferences are acceptably met with the different (restricted) capacity products, see e.g. BNetzA's monitoring report for the year 2013. In the most restricted category, interruptible capacities, out of 64 customers that were holding capacities in this category, only 11 were effectively affected by interruptions, many of them only for several hours. In total, only 0.08 % of the nominated gas transports were interrupted in reality.
- 3) *The differences between the capacity definitions in the Netherlands and Germany are relatively new:* In both jurisdictions, the Netherlands and Germany likewise, network development took place over decades without these differences; network access was granted over many years on a common basis of a path-dependent point-to-point access regime in both jurisdictions; the differences that are the basis for GTS's claims are new, dating from the time after introduction of entry-exit-regimes and the entering into force of Art. 19 of Regulation 715/2009; more precisely, only after the obligation to offer *unrestricted* capacities has become effective, the respective claim of GTS could have become a reason for investment decisions. Thus, only costs for network development after that could partially be explained by the difference in capacity qualities.

There are further aspects that need to be taken into account, e.g. the size of market areas (because there is a trade-off between the range of a market area and

¹² See e.g. Monitoringbericht gemäß § 63 Abs. 3 i. V. m. § 35 EnWG und § 48 Abs. 3 i. V. m. § 53 Abs. 3 GWB, 14-11-2014, Bundesnetzagentur & Bundeskartellamt, Bonn; all monitoring reports are available at: http://www.bundesnetzagentur.de/cdn_1432/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/DatenaustauschundMonitoring/Monitoring/monitoring-node.html

potential restrictions), different methods of capacity calculation, likelihood of different flow conditions that alter the framework for capacity assessment etc.

However, exact quantitative analyses are not feasible for this claim due to a lack of available data that would need to cover the total amount of capacities, offered and/or booked, in the different categories for each TSO, the likelihood of interruption and the economic value of the real interruptions. These data, if available at all, would cause an investigative effort not acceptable on the backdrop of the likely very limited impact on the final benchmarking results.

Thus, it is preferable to choose the values of the real usage (in terms of peak load) instead of the different capacity values as benchmarking parameters, in particular for the additional reason that offered capacities may be oversized compared to the real demand in the market.

Based on the consideration 3) above we therefore suggest not to utilize (different categories of) capacity values and to correct the cost basis for those investments that can be proven to be a consequence of the unrestricted capacity rights after their obligatory introduction by GTS. We suggest to request a motivated list of investments (including documentation that shows internal decision making) specifying type, date and size that have taken place because of the obligation to offer unrestricted capacities; investments for the replacement of previously existing network infrastructure must be eliminated from the total sum of these investments.

Capacity products – proposal

GTS claims higher costs due to different capacity products compared to Germany. We note that (i) the restrictions only apply to a limited share of the German TSO capacities; (ii) the restrictions are not effective in many of the cases; and (iii) the differences between the capacity qualities in the Netherlands and Germany are relatively new due to the implementation of the entry/exit system according to the 3rd package. In order to deal with this claim we propose to use values of the real usage (in terms of peak load) instead of the different capacity values as benchmarking parameters. In addition, we understand that ACM already asked GTS to substantiate the investments which are a consequence of the unrestricted capacity rights in the entry/exit system, but has not yet received an answer on this.

4 Conclusions

As commissioned by ACM, the Dutch energy regulator, Frontier Economics and Consentec undertake a statistic efficiency analysis for GTS, the Dutch gas TSO. As GTS is the only gas TSO in the Netherlands, ACM uses the German gas TSO benchmark commissioned by BNetzA to determine the static efficiency of GTS.

Throughout the project, GTS has claimed some structural differences between GTS and the German gas TSOs, namely country specific factors, which would need to be taken into account in the benchmarking analysis. This report has dealt with five country specific claims raised by GTS, which remain still open after discussions with ACM. We elaborated on the analysis methodologies and presented the quantitative results.

Our first conclusion concerns the storage-to-consumer distance. Our analysis shows that GTS is characterized by a distance near the average distance over the German gas TSOs for both of the gas qualities of G and H. The highest distance is around two times of the distance level of GTS. Three German TSOs do not have storage at all which indicates higher network costs. The storage-to-consumer distance is already covered by the cost drivers reflecting “Capacity provision/gas transport” and “Network Expansion”. We therefore propose to reject this claim.

Our second conclusion focuses on the transit share. Our evaluation indicates that the GTS share of transit is below average for the category of G-Gas and cannot be seen as extraordinary. An above share of transit is noticed only for the L- and H-Gas, however, in contrast to the GTS claim with a constant gas flow and correspondingly low level of volatility. Furthermore, the cost drivers reflecting “Capacity provision/gas transport”, “Network Expansion” and “Granularity of network” are taking an extraordinary share of transit into account. We therefore propose to reject this claim.

The third conclusion concerns the trade-off between compressor stations and pipeline volume. This trade-off does not – in contrast to GTS’ claim – show an extreme characteristic; on the contrary, several German TSOs show a wider variation in both directions (more pipelines vs. more compressor intensity) than GTS; therefore a lack of comparability of GTS inside the data set cannot be confirmed. GTS’ ratio of capacity/number of compressor stations to transport momentum, an output parameter which properly mimics the supply task of a TSO, is below average for all three gas qualities of G, H, and L. We therefore propose to reject this claim.

The forth conclusion concerns the impact from joint ventures. Our analysis show that although allocating 100% of joint venture costs to German TSOs engaged in a joint venture has a substantial impact on some German TSOs, the impact with regard to the output/input ratios for “connection point” and “service area” to

the costs is not that straightforward. The analysis indicates that GTS may only be affected by “multiple counting of outputs” with regard to the parameter “service area”. However, the possible impact is uncertain. We therefore propose to use at this stage to allocate the costs for the joint ventures to the German gas TSOs according to the share in the joint venture (the approach also implemented by BNetzA) and make no adjustments for the output parameters and costs. At the same time we note that in the next stage of model specification we will be cautious on the possible impact from service area on the efficiency scores for GTS.

The fifth conclusion concerns different capacity products that cannot be analysed in a quantitative way due to lacking data. The qualitative arguments show, however, a high likelihood of only very limited effects that could be attributed to this claim. We suggest correcting these potential differences on the input side (costs) on the basis of a list of proven investments after the obligation to offer unrestricted capacities became effective for GTS, excluding replacements.

Finally, according to these analyses, we conclude that, in general, GTS cannot be characterized to be extraordinary when comparing the GTS network characteristics with German gas TSOs. Differences exist between GTS and German gas TSOs concerning the network configuration and its characteristics, but this does not lead to a uniqueness or non-comparability of the GTS network in general. Even under circumstances where this held true, the considered output parameters are capable to properly mimic the supply tasks of the gas transmission networks in the data sample, including GTS.

Conclusions

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