Calculation of the technical capacities of Fluxys Deutschland GmbH

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Introduction

Transmission system operators are legally bound by the German Energy Management Act (EnWG) (§20, (1b)) to determine entry and exit capacities "that enable network access without the definition of a transaction-related transport path and that can be used and traded independently of each other." This decouples the physical transport path from the entry/exit capacity. These freely allocable capacities entitle shippers to connect from or to the virtual trading point (VTP) of the market area Trading Hub Europe (THE). In accordance with §9 of the German Regulations on Access to Gas Supply Networks (GasNZV), the freely allocable capacities are calculated "on the basis of state of the art load flow simulations". In this connection, transmission system operators (TSOs) take into consideration, among other things, historical and forecast capacity utilisation. Previously, a standardised, cross-industry method for performing such calculations did not exist. Accordingly, the individual transmission system operators are themselves responsible for developing a state-of-the-art methodology for such calculations. The method used by Fluxys Deutschland GmbH, in cooperation with the holding company's partners of the Nordeuropäischen Erdgasleitung (NEL) Gasunie Deutschland Transport Services GmbH (GUD) & NEL Gastransport GmbH (NGT), together with the holding company's partners of the Europäische Gas-Anbindungsleitung (EUGAL) GUD, ONTRAS Gastransport GmbH & GASCADE Gastransport GmbH (GASCADE), as well as is together with the holding company's partners of Ostsee Anbindungsleitung (OAL), GASCADE described below. A holding company among the above-stated partners exits for the corresponding pipeline system. This means, that shared rights exist to the transmission systems and to the entry and exit points that are marketed. Determination of capacity takes place in cooperation between all of the partners.

To provide an idea of the challenges of the method applied here, we refer to the initial situation in the gas market. Historically, gas networks in Germany have grown with the volumes of gas to be transported. In this context gas networks never initially needed to form a single unit or larger balancing zones (similar to how market access is now structured through recent market area cooperation agreements) but had to ensure point-to-point transports. Determining transport capacities in the context of the market access model for the gas transport market, which is decoupled from trading, is therefore not based on free gas networks without bookings and flows, but on an existing gas flow or an existing supply constellation. On the one hand, this situation makes it possible to analyse historical network flows and, in the context of a statistical model, make forecasts of end consumer behaviour, dependent upon the season and temperature. On the other hand, it raises the challenge of ensuring supply to end consumers (e.g., via so-called "downstream transmission system operators") in future too.

Accordingly, the determination of capacities is not only an issue of increasing capacities but is primarily one of maintaining capacities and increasing the quality of the capacities through free allocability. Some basic definitions and determinations are set forth in the following. This is followed by a detailed description of the challenges involved in determining freely allocable capacities.

Definition of terms

The following section explains the fundamental terms used in capacity calculation and the gas sector in Germany. These are based on the statutory regulations and the general terms and conditions of business of Fluxys Deutschland GmbH (Fluxys Deutschland). It should be noted that these terms are not necessarily universally accepted and may possibly deviate from those contained in relevant literature.

a. Network point:
   A network point is a bookable entry or exit point to/from the transmission system. This includes points that are used to supply the German market.

b. Capacity-limiting element:
   A capacity-limiting element is an element that has clearly allocable and adjustable boundary conditions and a resistive characteristic that allows the clear determination of a capacity limit.

c. Pipeline system:
   A pipeline system is a system of pipes that is delimited by capacity-limiting elements (compressors, gas pressure regulating and metering stations (M & R stations), regulator, etc.) or by its first aggregation stage (station) (see Figure 1).

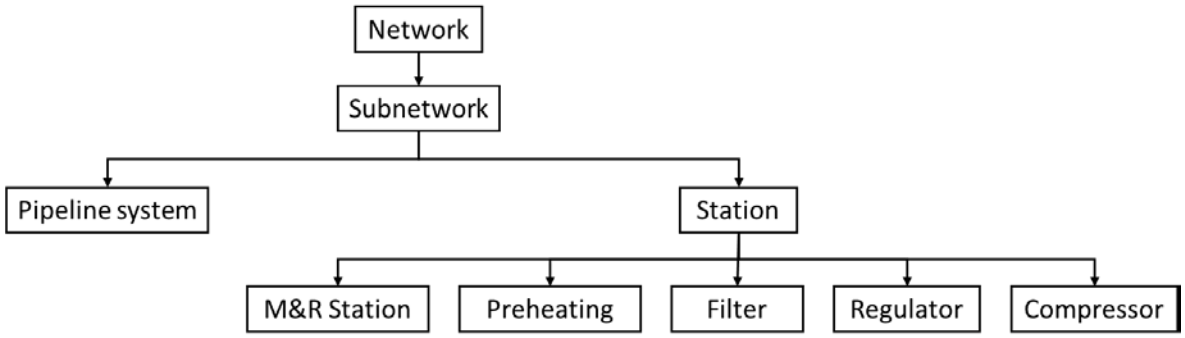

Figure 1: Components of a gas network

d. Firm capacities:
   Firm capacities are a form of capacity that cannot be interrupted and that can be transported by the network under all physical conditions.

e. Interruptible capacities:
   Interruptible capacities are a form of capacity for which transport is fulfilled on an 'as available' basis. Transport based on this form of capacity can be interrupted if necessary for network integrity reasons. In practice, interruptions only occur if transport is physically impossible. Accordingly, interruptible capacity is not taken into consideration in the determination of firm capacities.

f. Exit capacities:
Total capacities in kWh/h, that can be physically fed out from a network at an exit point (pursuant to §2 par. 5 EAV Ts&Cs)

g. Entry capacities:
Total capacities in kWh/h, that can be physically fed into a network at an entry point (pursuant to §2 par. 11 EAV Ts&Cs).

h. Technically available capacity (TAC):
The TAC corresponds to the maximum firm capacity that the network operator is able to offer shippers at a marketable network point, taking into consideration system integrity and network operation requirements. The TAC therefore amounts to the total of all firm capacities. These are the freely allocable capacities, the conditional freely allocable capacities and the dynamically allocable capacity.

i. Booked capacities:
The total capacities booked per hour at a network point.

j. Available capacities:
The available capacities at a network point are calculated by deducting the booked capacity from the TAC – or the TAC adjusted by measures – at the network point.

k. Freely allocable capacity (FZK):
See §9 par. 1 EAV Ts&Cs.

l. Dynamically allocable capacity (DZK):
See §9 par. 1 EAV Ts&Cs.

m. Capacity bottleneck:
A capacity bottleneck is a transport restriction that can have a limiting effect on the technical capacity of one or more network points. Under certain capacity bottleneck-specific conditions, a capacity bottleneck will cause capacities to become restricted.

n. Capacity restriction:
A capacity restriction exists if the commercially available capacity at a network point is less than the TAC of a network point (e.g., due to the failure of compressors system or as a result of maintenance work on compressor stations or pipelines).

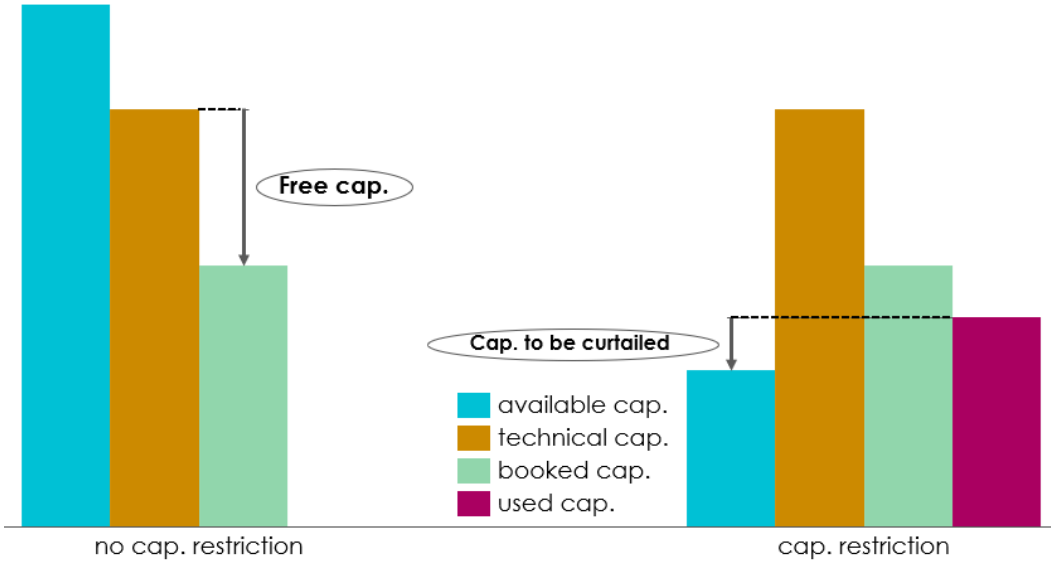

Figure 2: Scheme showing the effects of a capacity limitation at a network point.

Transmission system of Fluxys Deutschland GmbH

The transmission system of Fluxys Deutschland GmbH comprises the NEL, the EUGAL and the OAL . These systems are part of the THE market area.

With its overall length of approx. 441 km, the NEL connects the German market with the markets at the Baltic Sea. The NEL runs from the German Baltic Sea coast at Greifswald through the two German federal states of Mecklenburg-Western Pomerania and Lower Saxony, until it finally arrives at Achim, close to Bremen. At Achim the NEL feeds into the Open Grid Europe GmbH (OGE) network. The NEL then continues to Rehden, where it merges into the GASCADE network.

The EUGAL pipeline runs over a course of 480 km from Lubmin on the Baltic Sea coast as far as the German/Czech border at Deutschneudorf. It connects both the Czech and German markets to the markets at the Baltic Sea. The course of the pipeline takes in the three German federal states of Mecklenburg-Western Pomerania, Brandenburg and Saxony.

The OAL is an offshore pipeline with a length of 51 km, which connects the liquefied natural gas (LNG) terminal in the port of Mukran with the existing German pipeline network in Lubmin.

The transmission systems of Fluxys Deutschland GmbH (see Figure 3) provide a direct connection between the Russian, German and Czech markets.

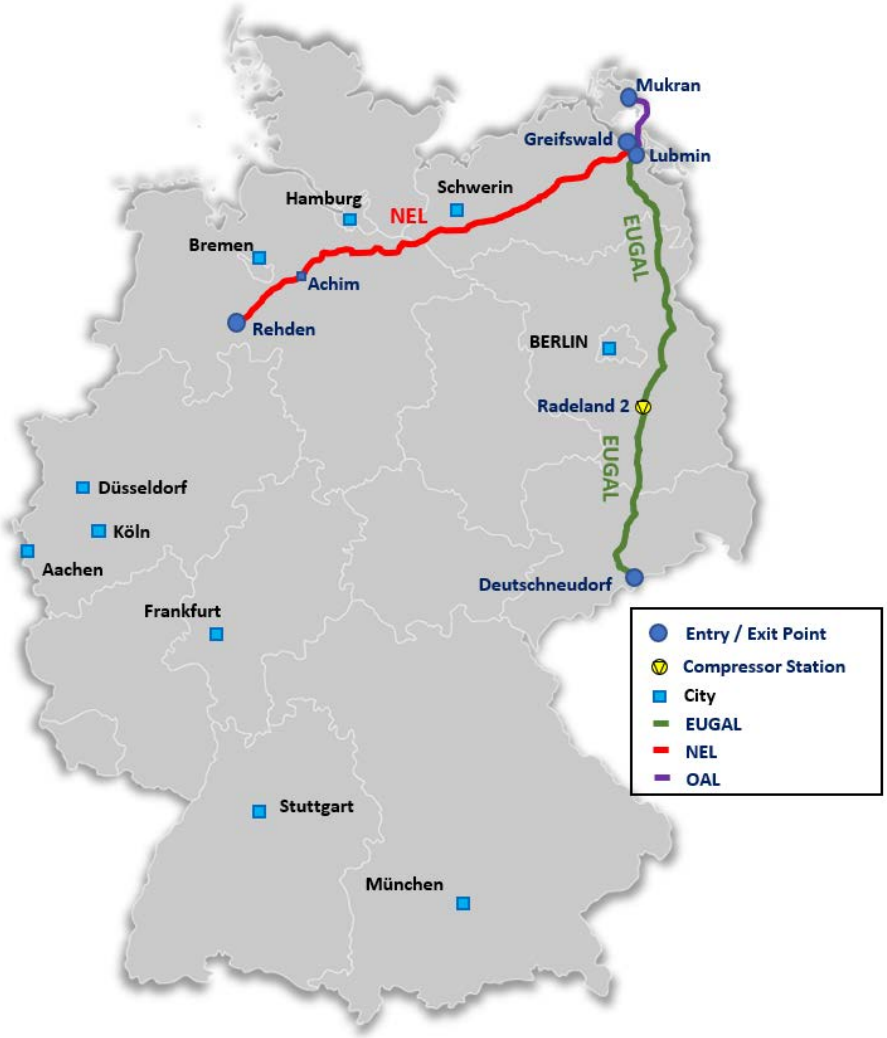

Figure 3: The course of the NEL, EUGAL and OAL, entry and exit points and the compressor stations along the route of the pipeline.

Gas network calculation

Calculation tool

The “SIMONE” simulation program is used to calculate the corresponding transportation capacities of the transmission system.

Determination capacities

Determination of freely allocable capacity (FZK)

The aim of determining the FZK is to maximize the technical capacities, i.e., the bookable firm capacities at entry and exit points. An optimization problem is solved for this purpose.

As already mentioned in the introduction, the determination of FZK assumes, that entry and exit points are always equal in amount. This assumption is reflected in the gas network access model in the requirement that balancing groups must be balanced. Injections and withdrawals therefore always match each other; increasing use of entry capacities leads to increased withdrawals and vice versa. The reduction in the use of an entry (i.e., the capacity rights there) will lead to an increase in the use of another entry or a reduction in the use of an exit (i.e., the capacity rights marketed there) if the development of the grid states is considered.

Accordingly, it is sufficient to map bottlenecks in the transmission network via entry or exit points. The gas volume at a bottleneck will always be at most the minimum of the entry capacities marketed before the bottleneck and the exit capacities marketed after the bottleneck by balancing entry and exit.

Taking congestion into account at the same time when determining entry and exit capacities would lead to excessive restrictions and therefore unreasonable limitations.

Once capacities have been marketed, it is no longer possible to change the consideration of a congestion from entry to exit or vice versa. An initial mapping of congestion maximizes the sum of marketable FZK. No factors were used to weight entry and exit capacities at different grid points. The capacities were also not assessed according to the type of grid point involved (market area-internal grid interconnection point, grid connection point, cross-border interconnection point, market area interconnection point).

Determination of dynamically allocable capacities (DZK)

Allocation restrictions are possible in all situations where it is not possible to transport volumes of gas because of bottlenecks in the transmission system, but a shipper is already interested in a shorter transportation distance. An allocation restriction makes it possible to continue utilising the capacity of sections of the network that are not fully utilised while, at the same time, taking into consideration the restrictions of the transport system.

Determination of bottlenecks

The precondition for determining the technical capacities is the identification of bottlenecks in the transmission system. In some cases, these bottlenecks are not relevant to determining the technical capacity because it is possible for one bottleneck to overlap another. However, this only becomes apparent in later stages of the method described here. Bottlenecks can fundamentally be divided into one of the following three categories.

Technical station capacities

The technical station capacity depends upon the technical design of the individual components of a station. It should be derived partly by taking the design pressure and planning and approval documentation into account and/or should be reconciled with the network interconnection contracts.

Bottlenecks in the pipeline system

Bottlenecks in the pipeline system occur as a result of the pressure loss during gas transport and the associated boundary conditions. The contractually agreed handover and acceptance pressures set forth in the network interconnection contracts serve as the boundary conditions for determining bottlenecks in transmission systems.

To determine the bottlenecks in the NEL, EUGAL and OAL transmission systems it is only necessary to take one transport direction into consideration, under the assumption of a limiting load scenario.

The respective load scenarios to be used were planned such that the maximum transit shipment is achieved within the prescribed boundary conditions (contractual pressures on the entry and exit of gas quantities, withdrawals along the pipeline).

Compressor bottlenecks

The capacities of compressor stations are mainly influenced by the respective design of the compressor units. This concerns the input and output pressure of compressors (compression ratio) and the size of the units – and, therefore, the volume of gas that can be transported. The redundant compressors serve as technical replacements in the event of failure and their use is not planned for increasing marketable capacities. For compressor design purposes inlet temperatures of up to 20°C and air temperatures of up to 35°C are assumed, to cover all eventualities in a restrictive manner.

Due to the varying nature of the respective input pressures and the required output pressures, the compressor capacities are dependent on the transport directions and may therefore vary in volume for different transport scenarios.

Maintenance measures

Maintenance work is essential at regular intervals to permanently guarantee the availability of capacities in the NEL, EUGAL und OAL systems. Such work may include safety checks at compressor stations, but expansion measures may also be required to ensure supply security for end users.

Once the planning for a measure has been concluded, the measure is communicated to the market and a so-called individual assessment carried out to calculate the effect on capacities.