



NETWORK CODE ON INTEROPERABILITY AND DATA EXCHANGE RULES

5TH IMPLEMENTATION MONITORING REPORT

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1 INTRODUCTION

ENTSOG was created in December 2009 as part of the implementation of the European Union's Third Energy Package. Thereafter, ENTSOG was mandated under Regulation (EU) 2024/1789 (as part of the Hydrogen and Decarbonised Gas Market Package), along with other relevant legislation, to undertake specific tasks to support EU energy security, the internal energy market, and decarbonisation.

ENTSOG's main tasks until 2024 were based on Regulation (EC) 715/2009 and included the development and implementation monitoring of network codes, development of its Ten-Year Network Development Plans (TYNDP) and assessment of European security of supply, through preparation of Summer Supply Outlook and Winter Supply Outlook reports. Many of these same tasks are also required by Regulation (EU) 2024/1789, while now also accounting for the analysis, monitoring and reporting of renewable and low carbon gases, such as biomethane.

The Regulation also tasks ENTSOG to elaborate any network codes requested by the European Commission. ENTSOG will continue to actively participate in the further development of the established Network Codes and Guidelines through the Functionality Process as well as through any formal regulatory amendment process and any task given via new legislation, including a potential amendment of the Interoperability and Data Exchange Network Code. Additionally, ENTSOG continuously monitors the implementation and functionality of published CNOTs (Common Network Operation Tools for coordination of network operation in normal and emergency conditions) and will update or develop new CNOTs, if required.

Specifically on this document that represents the 2025 edition of the Implementation Monitoring Report (IMR), as required by Art. 26.7 of Regulation (EU) 2024/1789 (previously Art. 8.8 of Regulation (EC) No 715/2009) and by Art. 25 of Regulation (EU) 2015/703 (network code on interoperability and data exchange rules – INT NC), ENTSOG is tasked to monitor and analyse the INT NC implementation and report its findings to ACER. The INT NC enables the necessary harmonisation of interconnection agreements, EU-wide units for communication and publication, gas quality management and monitoring, and data-exchange solutions, therefore leading to effective market integration.

ENTSOG has published four editions of the IMR to date: the first in October 2016, the second in June 2018, the third in August 2020 and the fourth in August 2022. To complement the analysis, annexes were added to the third and fourth IMRs in August 2021 and July 2023 respectively.

Results from these previous exercises show that TSOs' compliance with the INT NC provisions is very high, with many Articles reaching near-full implementation. In particular, for the areas relevant to the current IMR, gas quality and data exchange, compliance levels are extremely high, approaching 100 % for most Articles.

For this reason, and as requested by ACER, this year's IMR adopts a different analytical perspective compared with previous editions as described in the next chapter.



Picture courtesy of Gasgrid Finland

2 GENERAL CONSIDERATIONS

2.1 2025 IMR APPROACH

In line with the evolving regulatory landscape, the 2025 Madrid Forum formally requested an assessment of the need to revise the INT NC. This request reflects the Forum's recognition of new challenges and opportunities arising from recent legislative developments, including the completion of the work of CEN to develop the European standard EN 16726, as well as those arising from market developments, (e. g. the shifts in supply patterns, including the anticipated higher injection of low-carbon gases and the technological developments in the area of data exchange)

The 2025 Madrid Forum's conclusion on this topic are as follows:

"The Forum welcomes the imminent completion of the work of CEN to develop common standards under the so-called European standard EN 16726 "Gas infrastructure – Gas quality – Group H" and highlights the importance of this work as part of the removal of any barriers to the free flow of natural gas in the internal energy market. The Forum invites the Commission, following the adoption of the CEN standard, to consider carrying out a public consultation, or designating ACER to carry out such consultation, for the purpose of identifying the exact need, timing, and scope of a potential amendment of the Interoperability Network Code."

ACER in its work to prepare the initial consultation on whether a revision of the INT NC is needed has requested ENTSOG for support and to contribute to the knowledge base for subsequent stages of the revision process. The aim was to obtain, through ENTSOG's IMR, a more accurate overview of the implementation status of the various provisions relevant to the INT NC, in order to support more informed decisions regarding the situation and the potential need to amend any of its provisions.

To facilitate the work, ACER asked ENTSOG to circulate a questionnaire among its members and provide responses on three key areas:

- 1. Gas quality**
- 2. Data exchange**
- 3. Liabilities in cases of off-spec gas quality**

The questionnaire included questions related to these three areas on 1) the current implementation of the INT NC and 2) on expectations for a potential INT NC revision. The analysis presented in the 2025 edition of the IMR of the INT NC focus on the answers provided for 1) the current implementation of the INT NC.

Indeed, regarding the INT NC, Regulation (EU) 2024/1789 indicates that the EC may adopt implementing acts establishing network codes for interoperability rules for the natural gas system, including addressing areas that are not included in the current Network Code. The inclusion of these new areas in the INT NC require that the revision of the NC is considered.

With this in mind, as mentioned before, ACER's questionnaire also included questions on expectations for a potential INT NC revision in the three areas indicated. These questions were explored in an internal technical workshop jointly hosted by ENTSOG and ACER to explore topics related to the INT NC that may be considered for future revisions. The workshop brought together ENTSOG, ACER, TSOs, NRAs, and the European Commission. The primary goal of the workshop was to support ACER in preparing the initial consultation on whether a revision of the INT NC is needed and to contribute to the knowledge base on the topics discussed.

Regarding "liabilities in case of off spec gas quality", while it is not a topic included in the INT NC or explicitly listed in Art. 71.2 a) of the Gas and Hydrogen Regulation 2024/1789, ACER has requested ENTSOG and its members, the EU gas TSOs, to respond to questions on this topic to help to build understanding on the matter and assess it as potential point to include in the INT NC.

ENTSOG's analysis of the issue is then included in an additional chapter to this INT NC Implementation Monitoring Report.



Picture courtesy of Gas Connect Austria

2.2 DESCRIPTION OF THE EXERCISE

As noted in the first chapter, the preparation of this report has benefited from the constructive cooperation and strong engagement of ENTSOG Members in responding to ACER's questions regarding the current implementation of the INT NC. This collaborative effort has also supported the inclusion of an additional chapter on liabilities in cases of off-spec gas quality, enabling ENTSOG and the TSOs to provide a shared analysis and to contribute, as effectively as possible, to the continuous improvement of the functioning of the EU gas system.

The assessment carried out across all sections of this report focused largely on identifying provisions included in Interconnection Agreements (IAs) that are not explicitly mandated by the INT NC.

It is important to recall that Chapter III of the INT NC defines the rules governing IAs. Under this chapter, adjacent TSOs must ensure that every IA covering an interconnection point (IP) contains at least the elements required by Articles 6 to 12 of the network code.

These mandatory components include:

- ▲ rules for flow control
- ▲ measurement principles for gas quantities and gas quality
- ▲ rules for the matching process
- ▲ rules for the allocation of gas quantities
- ▲ communication procedures applicable in exceptional events
- ▲ settlement of disputes arising from the IA
- ▲ the process for amending the IA

Accordingly, a first step in this assessment was to determine whether the provisions under analysis, although not mandated by EU regulation, are commonly included in IAs in practice.

The analysis presented throughout this report has been developed in an aggregated manner in order to highlight general practices across the EU gas system, rather than to refer to or characterise individual TSOs or specific bilateral situations.

It should also be noted that not all TSOs responded to all questions, and therefore some findings reflect the information available at the time of the assessment.

3 EXECUTIVE SUMMARY

In line with ENTSOG's Annual Work Programme 2026 and following the request by ACER to assess whether further analysis on the implementation of the INT NC is required, ENTSOG conducted a comprehensive survey among its members. A total of 36 gas TSOs (including Trans Adriatic Pipeline) of 22 Member States contributed to this year's monitoring exercise, sharing detailed information through a questionnaire jointly developed by ACER and ENTSOG. Their input forms the backbone of this IMR.

3.1 OVERALL FINDINGS

The 2025 monitoring exercise confirms that implementation of the INT NC regarding the areas analysed, gas quality and data exchange, remains robust, stable, and highly interoperable across the European gas transmission system. TSOs continue

to collaborate effectively, both bilaterally and at EU level, ensuring seamless cross-border operations despite evolving technical, regulatory, and market conditions.

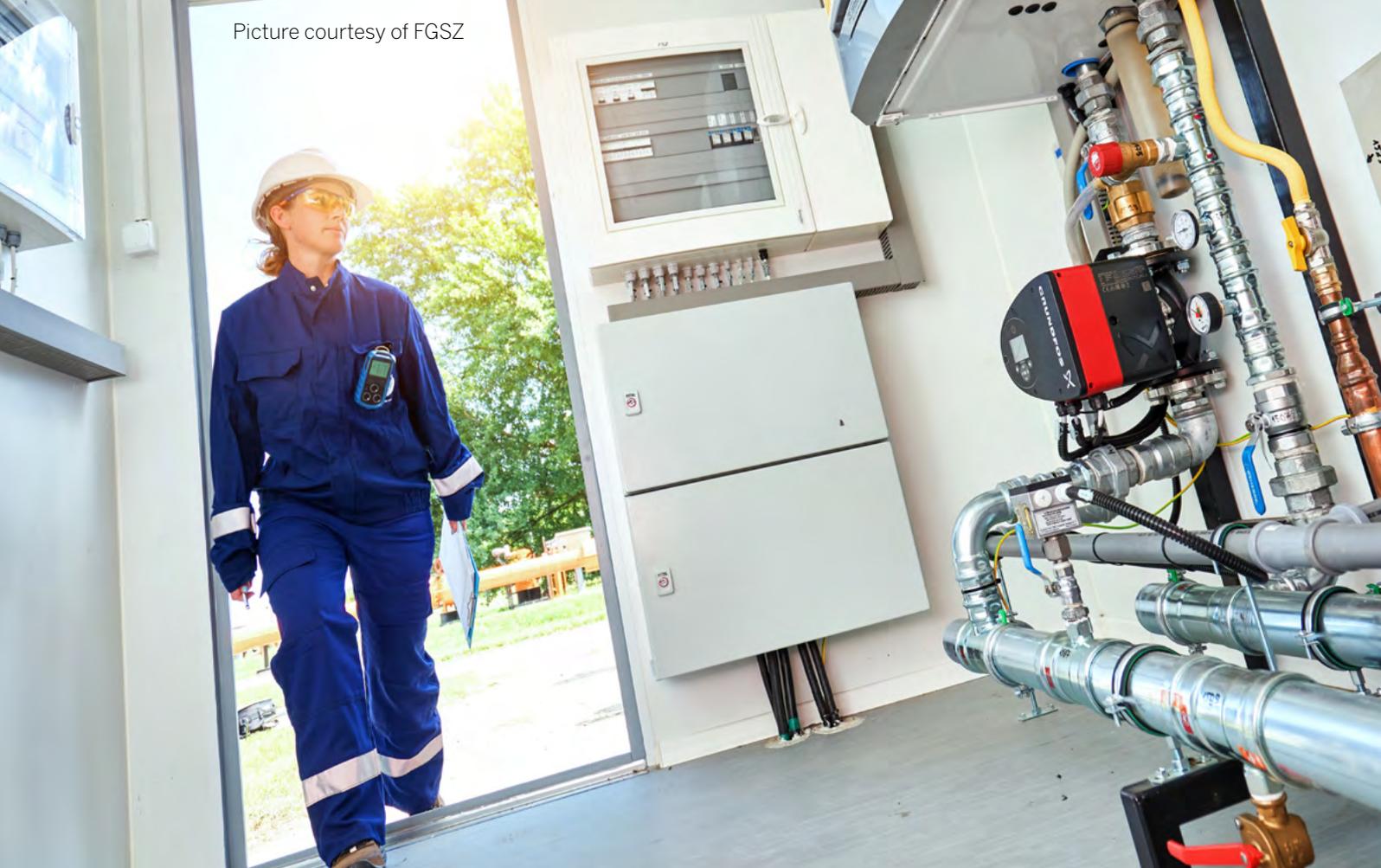
3.2 GAS QUALITY

The survey results show that most IAs include explicit gas quality parameters, even though the INT NC does not make these a mandatory element. In practice, these arrangements have proven effective: TSOs cooperate to prevent flow restrictions and manage cross-border gas quality differences, including cases where limits differ by flow direction. Only a small number of TSOs reported risks of cross-border flow restrictions due to gas quality discrepancies, all of which were resolved through bilateral coordination.

The results also reveal that the limits for Wobbe Index, sulphur and oxygen indicated in the IAs are generally adjusted to the local circumstances (e. g. supply sources, presence of sensitive users, odourisation practices, etc.), with values that can differ depending on the specific IP.

Where disagreements arise, TSOs may rely on the procedural framework under Article 21 of Regulation (EU) 2024/1789, which offers a structured basis for identifying and implementing solutions. At the time of drafting this report, no TSO has indicated having used Article 21 to resolve such disagreements. Examples of relevant cases, along with the solutions applied, are provided in Chapter 5.

About the implementation of Article 17 of the INT NC, half of the respondents have established criteria and protocols to make eligible a list of parties receiving indicative information on gas quality variation. The number of parties depends on the number of eligible connections (i.e. final customers directly connected to TSOs' networks, DSOs, SSOs) and the type of users connected to the grid, as the latter can determine the user sensitiveness to gas quality variation. Additionally, while Article 17 has proved beneficial for certain users connected to TSOs, it is not universally required in all cases, reflecting the adaptability and practical approach taken by the sector.



3.3 DATA EXCHANGE

TSOs report that data-exchange processes remain mature, fully interoperable, and compliant with the INT NC. The pairing of Edig@s with AS4 continues to serve as the sector's foundation for secure, automated, machine-to-machine communication, in line with Articles 21–24 of the INT NC.

Extending similar data-exchange protocols to national infrastructure operators were non-committal. While some respondents recognise potential benefits, they also highlight there could be financial impact and no common mandate for broadening the framework exists.

Key observations include:

- ▲ Standardisation: Edig@s 5.1 combined with AS4 (ENTSOG 3.6) remains the dominant setup, confirming consistent alignment across Europe.
- ▲ Automation trend: Document-based and AS4-based solutions are widely preferred for their reliability, security, and scalability.
- ▲ Flexibility where needed: Interactive exchanges (GUIs, web portals) persist for user-facing processes.
- ▲ Legacy presence: Some formats (Edig@s 4, AS2, proprietary) remain in use in outlier, older implementations.

3.4 CONCLUSIONS

The assessment for 2025 reaffirms the strong and consistent implementation of the INT NC across the EU gas system regarding the areas analysed, gas quality and data exchange. Gas quality cooperation

remains effective and pragmatic, while data exchange processes continue to demonstrate high interoperability, system resilience, and technical maturity.

4 SURVEY PARTICIPANTS

A total of 36 responses were received from the following European gas TSOs members of ENTSOG, who participated in the survey:

Country	TSO
Austria	Gas Connect Austria GmbH
	TAG GmbH
Belgium	Fluxys Belgium S.A.
	Interconnector Limited
Bulgaria	Bulgartransgaz EAD
	ICGB AD
Croatia	Plinacro
Czech Republic	NET4GAS, s.r.o.
Denmark	Energinet
Finland	Gasgrid Finland Oy
France	TERÉGA
Germany	bayernets GmbH
	Fluxys TENP GmbH
	GASCADE Gastransport GmbH
	Gasunie Deutschland Transport Services GmbH
	Gastransport Nord GmbH
	Nowega GmbH
	ONTRAS Gastransport GmbH
	Open Grid Europe GmbH
	terranets bw GmbH
Thyssengas GmbH	
Greece	DESFA S.A.
Hungary	FGSZ Natural Gas Transmission
Ireland	Gas Networks Ireland
Italy	Snam Rete Gas S.p.A.
	Infrastrutture Trasporto Gas SpA (received through Snam Rete Gas S.p.A.)
	Società Gasdotti Italia S.p.A. (received through Snam Rete Gas S.p.A.)
Latvia	Conexus Baltic Grid
Lithuania	AB Amber Grid
Netherlands	BBL Company V.O.F.
	Gasunie Transport Services B.V.
Poland	Gas Transmission Operator GAZ-SYSTEM S.A.
Portugal	REN-Gasodutos, S.A.
Romania	Transgaz S.A.
Slovakia	eustream, a.s.
Slovenia	PLINOVODI d.o.o.
Spain	ENAGÁS TRANSPORTE S.A.U
Switzerland	Trans Adriatic Pipeline AG (ENTSOG Associated Partner)
Luxembourg	Creos Luxembourg S.A. received a derogation from Art. 60 of Regulation (EU) 2024/1789

Table 1: Survey Participants

5 GAS QUALITY

One objective of this assessment is to evaluate whether gas quality provisions are commonly included in IAs. Even though adjacent transmission system operators shall agree on measurement principles for the gas quality parameters that shall be measured, no parameter is mandatory and gas quality ranges are not a compulsory requirement to be included in the IAs under the INT NC.

According to the survey conducted for the IMR, approximately 100 IAs specify gas quality ranges, while only about 15 IAs do not contain gas quality ranges or no information was provided.

This section also investigates the Wobbe Index (WI) ranges and limits for oxygen and sulphur included in the IAs of TSOs who replied to the survey.

5.1 WOBBE INDEX LIMITS

Different WI ranges exist in Europe. The Figure below, taken from the informative Annex E of the revised EN16726, shows the national WI ranges in 27 countries related to October 2024.

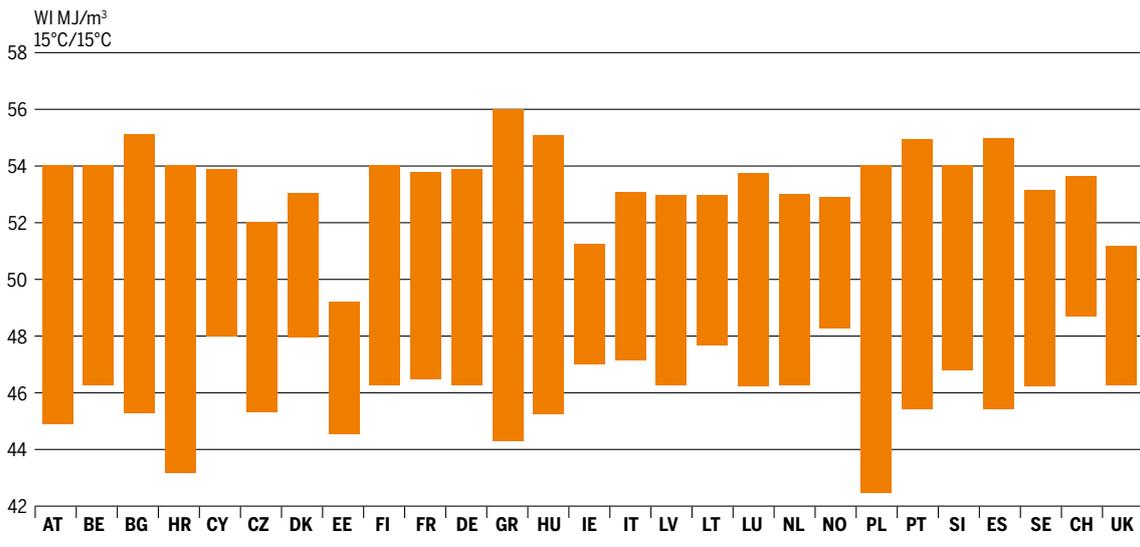


Figure 1: National WI ranges as in Annex E revised EN16726 (October 2024)

In the context of the IMR, the analysis focused on the WI limits indicated in the Interconnection Agreements.

The graph below shows the WI ranges in the reported IAs. For reading the graph, some information needs to be considered:

- ▲ The x-axis indicates the IPs included in the IAs between TSOs (TSOs have analysed around 100 IAs and this information has been included in this IMR).

- ▲ For each point of the x-axis, the maximum (orange dot) and minimum (blue dot) WI limit of the IA are indicated.

- ▲ The full lines indicate the recommended WI range from the revised standard EN16726.

Note: the implementation of the new version of the EN 16726 has not yet been adopted by MS, additionally, its application is not mandatory. Moreover, the WI range included in the latest revision of the standard is a recommendation.



Picture courtesy of GAZ-SYSTEM

The main findings are:

- ▲ In most IAs, the WI range falls inside the recommended range from the standard.
- ▲ Around 10 IAs allow the flow of gas with a maximum limit of WI above the recommended maximum limit from EN 16726, while around 20 IAs foresee minimum WI limit below the recommended minimum from EN16726:
- ▲ Some WI ranges fall below the WI range of the standard (for example point 20). Those points refer to IAs including WI ranges for L-gas.

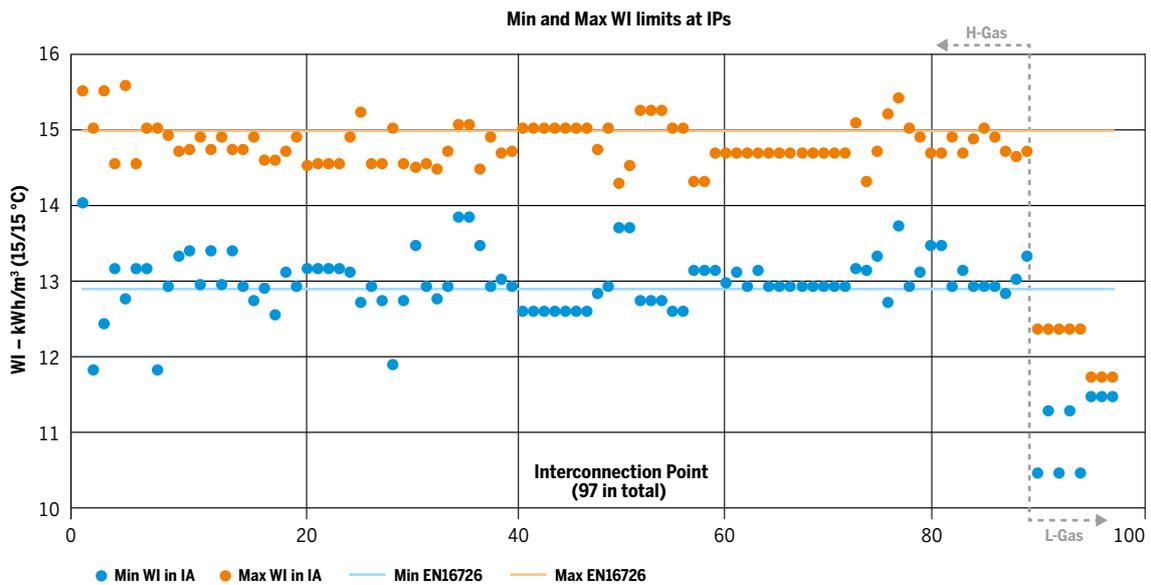


Figure 2: WI ranges at IPs

5.2 OXYGEN LIMITS

This section focuses on the oxygen content limits defined in the IAs.

The survey reveals that for half of IAs, the maximum allowed oxygen content is set at 100 ppm or lower. However, the limits vary across IAs, reflecting different national practices (due to, for example choices of supply sources, presence of sensitive users, among other reasons). Specifically, 24 % of the respondents report O₂ limits of 10 ppm included in their IAs, while 21 % indicate a limit of 200 ppm.

In EN 16726:2025 the maximum limit for oxygen concentration is 1 %, unless an assessment for oxygen-sensitive installations requires lowering the limit (e. g., to 0,01 % or 0,001 %).

The results show that the oxygen limits indicated in the IAs are different depending on the IP. In some cases, even IAs concluded by the same TSO figure different limits. There are also situations where different values are indicated in the IA of the same IP depending on the flow direction.

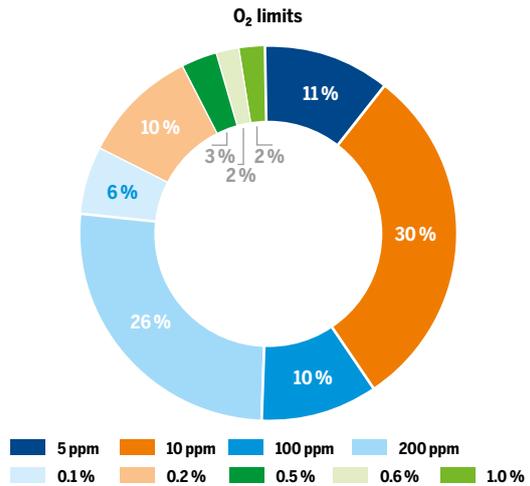


Figure 3: Oxygen limits at IPs

Note for the reader: 5 ppm, 10 ppm, 100 ppm and 200 ppm are equal to, respectively, 0.0005 %, 0.001 %, 0.01 % and 0.02 %.

5.3 SULPHUR LIMITS

In this section, the limits on total sulphur are analysed. The results of the survey are summarised in the plot below which indicates the number of IAs, on the vertical axis, and the maximum limit for total sulphur, on the horizontal axis.

The survey reveals that most IAs contains limits for sulphur equal to 20 mgS/m³ (41 IAs) and 30 mgS/m³ (39 IAs). One possible explanation may be that these limits are the ones defined in the gas quality standard EN16726.

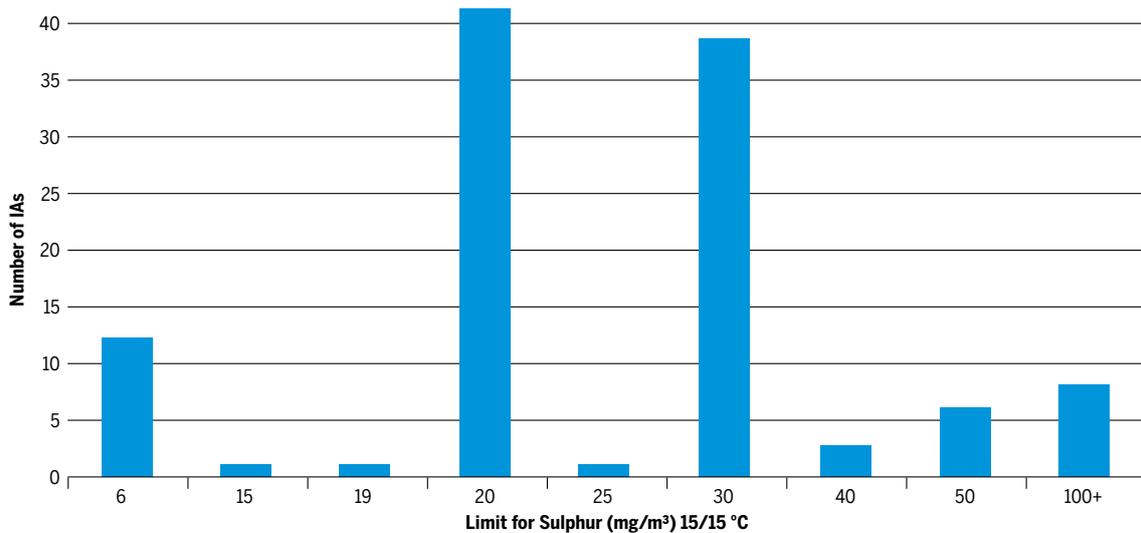


Figure 4: Sulphur limits at IPs

It's worth noting that several IAs also contain other sulphur limits for specific situations, and they are not illustrated in the graph. For example, in case of odorised gas, the second higher limit usually indicated in the contracts is 30 mgS/m³.

Higher tolerance is also consented in unusual conditions but for a short period of time. In these circumstances, the higher limits span from 30 to 300 mgS/m³.

5.4 CROSS-BORDER FLOW RESTRICTIONS DUE TO GAS QUALITY

Very few cross-border flow restrictions due to gas quality differences happened in the last decades. For this assessment, three situations were reported by ENTSOG members at operational level. In the case of Gascade, some restrictions related to gas quality were experienced and these were solved through exchanges between the involved TSOs that resorted to operational and commercial tools (for example reduction of flows, or swaps) to resolve the situation.

Restrictions were also reported by Transgaz and the solution was to include Addenda to two IAs in May 2025 agreeing on minimum gas quality requirements for a limited period of time.

Interconnector reported that contaminated gas was delivered to it at the UK Bacton interconnection point on multiple occasions in 2022 to 2025 from the Great Britain system. As necessary, capacity was temporarily limited or flows curtailed to prevent delivery of contaminants into the EU.

Two additional examples of how asymmetrical technical gas quality requirements at IPs were dealt by TSOs were provided in the ENTSOG Gas Quality Monitoring Report and are reported below:

- ▲ In Denmark, Energinet is currently using a double piping system to face the oxygen limit of 0.001 %mol at the Danish-German border, using one pipeline for exporting natural gas with limited amount of oxygen, while the other pipeline handles biomethane delivery to Danish consumers in that area.
- ▲ At the IP Medelsheim, flow of odorised gas from France to Germany was made possible through regulatory provisions in Germany in 2022 and throughout the more serious period of the energy crisis that resulted from the war in Ukraine.

For further details on these two cases, the reader is invited to consult the referenced Gas Quality Monitoring Report¹.

5.5 IMPLEMENTATION OF ART. 17 OF THE INT NC

While contracts, standards, or technical or regulatory documents define the allowed quality of gas flowing in the transmission grid, the INT NC aims to ensure cross-border interoperability by establishing common rules for monitoring and exchanging gas quality data. Regarding Art. 17 of the INT NC, it addresses the information provision from TSOs on short-term variations in gas quality towards other points on transmission networks where the gas quality is measured. This requirement ensures that, beyond the standard contractual ranges and limits, some stakeholders can receive relevant information on gas quality variations that could impact their operations.

This section focuses on the implementation of Art. 17 of the INT NC among TSOs and the approach followed to identify parties entitled to receive indicative gas quality information.

The survey revealed that approximately half of TSOs have identified specific parties requiring indicative information on gas quality under the scope of Art. 17. The number of parties identified varies by TSO:

- ▲ Most TSOs report having fewer than 10 parties receiving gas quality information
- ▲ Five TSOs have between 10 and 30 parties receiving such information
- ▲ One TSO has more than 100 parties being provided with gas quality information on short-term variation

¹ [ENTSOG Gas Quality Monitoring Report – First Edition – December 2024](#)



Picture courtesy of TAP

In most of the cases, there is no specific process to select parties, but a case-by-case analysis is performed to identify parties that receive information. For instance, some TSOs identify sensitive users through public consultations, others through bilateral discussions or under request from users.

In a few cases, all connected end-users, DSOs and SSOs are considered eligible to receive information related to Art. 17.

Gas quality information is often provided on the TSO website, a platform or a document accessible to users.

Half of respondents do not have parties requiring gas quality information for several reasons:

- ▲ Customers did not request additional info on gas quality
- ▲ Gas quality is not measured along the network but only at IPs
- ▲ Interconnectors² are not connected to final customers

5.6 CONCLUSIONS

The survey carried out for the current Implementation Monitoring report reveals that most IAs include specific gas quality parameters, while a few IAs do not. Despite the fact that no parameter is mandatory and gas quality ranges are not a compulsory requirement to be included in the IAs under the INT NC, the arrangements in place have generally functioned effectively: TSOs collaborated to minimise cross-border flow restrictions by managing gas quality even in situations of asymmetrical agreements (different gas quality limits depending on the flow direction). Indeed, only a few cases of risk of cross-border flow restrictions due to gas quality differences have been reported by TSOs. In those few cases, the situation was solved bilaterally among the concerned TSOs.

It's worth noting that in situations where disagreements arise, Art. 21 of the Regulation EC 2024/1789

can serve as a framework for identifying and implementing appropriate solutions.

The results also reveal that the limits for Wobbe Index, sulphur and oxygen indicated in the IAs are generally adjusted to the local circumstances, with values that can differ depending on the specific IP.

About the implementation of Art. 17, half of the respondents have selected a list of parties receiving indicative information on gas quality variation. The number of parties depends on the number of eligible connections (final customers directly connected to TSOs' networks, DSOs, SSOs) and the type of users which determines its sensitiveness to gas quality variation. Additionally, while Art. 17 has proved beneficial for certain users connected to TSOs, it is not universally required in all cases, reflecting the adaptability and practical approach taken by the sector.

2 Definition of Interconnectors from Article 2 of the DIRECTIVE (EU) 2024/1788: 'interconnector' means a transmission line which crosses or spans a border between Member States for the purpose of connecting the national transmission system of those Member States or a transmission line between a Member State and a third country up to the territory of the Member States or the territorial sea of that Member State.

6 DATA EXCHANGE

6.1 IMPLEMENTATION OF THE COMMON DATA EXCHANGE SOLUTIONS

Implementing EDI, document-based data exchange, is a significant undertaking for any business. Its application can positively affect business relationships between market stakeholders that work in the gas value chain. For this reason, the gas sector (European TSOs) is required to apply standardised data formats and communication protocols that adhere to the INT NC (Chapter V). Where ENTSOG has the obligation to monitor and report the implementation and adherence to these rules, regular analysis are produced for ACER, and the following section reflects the status of data exchange for TSOs.

The common data exchange solutions are prescribed in the INT NC Art. 21 which provides the TSOs with three main data exchange types/paradigms: Document-based data exchange, integrated data exchange and interactive data exchange. Each method has dedicated data formats and communication options primarily Edig@s XML and ENTSOG AS4.

In line with the IMR research framework, this section, after a brief explanation of the data exchange solutions the INT NC specifies, reports how the existing EU data-exchange regulations, standards, and communication protocols defined under the INT NC and accompanying CNOTs, are adopted across European TSOs.

6.2 DATA EXCHANGE TYPES

Art. 21 of the INT NC establishes three data exchange types that TSOs may apply depending on the nature of the information exchanged and the business process concerned. These data exchange solutions define the protocol, the data format and

the network (the network being the internet). In all three cases, the objective is to ensure interoperability, secure information transfer and harmonised practices across EU gas transmission networks.

DOCUMENT-BASED DATA EXCHANGE

Under document-based, data is wrapped into a file and exchanged automatically between the IT systems of the involved parties. This model supports machine-to-machine communication and is typically used for structured, standardised, and recurrent processes (e. g. nominations, matching, allocations, gas quality reporting).

Document-based data exchange supports high-volume operational processes and forms the cornerstone of the European gas system's cross-border interoperability.

According to Article 21(2)(a) of the INT NC:

- ▲ Protocol: AS4
- ▲ Data Format: Edig@s-XML or an equivalent ENTSOG-published format

INTEGRATED DATA EXCHANGE

Integrated data exchange concerns direct application-to-application communication between the IT systems of two counterparties. This model supports automated business processes requiring synchronous or near-real-time interactions.

This method is suitable for business processes that depend on process-integrated, system-driven interactions rather than batch file exchange.

Article 21(2)(b) of the INT NC requires:

- ▲ Protocol: HTTP/S-SOAP
- ▲ Data Format: Edig@s-XML or an equivalent ENTSOG-published format

INTERACTIVE DATA EXCHANGE

Interactive data exchange refers to user-driven interactions via a web interface, where information is accessed or submitted manually through browser-based tools. It is often used as a fallback procedure, or for cases where human validation is necessary.

It ensures that counterparties have a secure, standardised method for manual data exchange when automated channels are insufficient or unavailable.

Article 21(2)(c) of the INT NC establishes:

- ▲ Protocol: HTTP/S

6.3 COMMUNICATION PROTOCOL: ENTSOG AS4 PROFILE

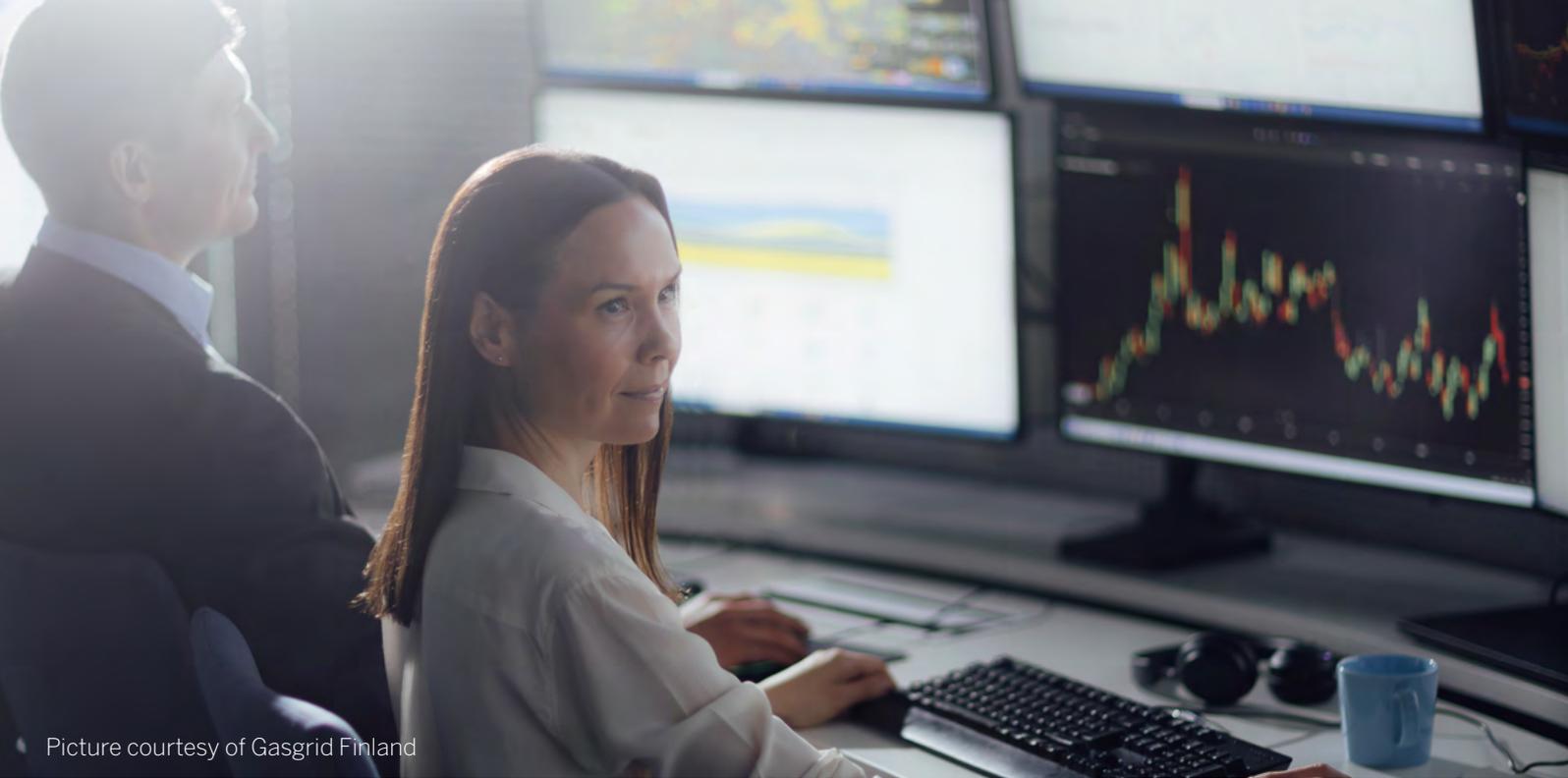
The INT NC specifies that “The following common data exchange solutions shall be used [for the communication] protocol: AS4” for document-based exchanges. Art. 21 in the INT NC, whilst prescribing AS4, does not specify a specific version and it should be noted that several versions of ENTSOG AS4 can coexist as valid implementations. Additionally, versions are not mutually exclusive i. e. TSOs may apply all versions in various connections.

Version 4.0 is the first major update of the ENTSOG AS4 profile³, released in May 2025, since the last version 3.6, which was published in 2018. It retains all the core functionality of the last version 3.6. The main changes relate to the message layer security section, where some selected algorithms have been replaced by more state-of-the-art secure

algorithms. These changes intend to enable continued secure use of ENTSOG AS4 in the coming years. These changes also provide continued alignment of ENTSOG AS4 with the version 2.0 of the European Commission’s eDelivery AS4 profile, published on 5 December 2024. Due to the changes in algorithms, ENTSOG AS4 version 4.0 is not compatible with ENTSOG AS4 3.6.

Whilst the new version 4.0 profile is set to replace the successful ENTSOG 3.6 (adopted by ~85 % of TSOs as per the assessment conducted for this report), there will be substantial, ongoing activity and support over the next few years by ENTSOG and EASEE-gas to facilitate the TSOs migration to the latest ENTSOG AS4 version 4.0.

3 [ENTSOG AS4 PROFILE Version 4.0 – 2025](#)



Picture courtesy of Gasgrid Finland

6.4 DATA FORMAT: ENTSOG EDIG@S® XML

Edig@s is the harmonised European data-exchange standard for commercial and operational gas-market processes. Within the ENTSOG framework, Edig@s provides the semantic and structural foundation for data exchanged between TSOs, shippers, DSOs, storage operators and other gas-market actors. With reference to INT NC compliance, Edig@s assures that:

- ▲ Cross-border interoperability is maintained across all market participants,
- ▲ Data exchange requirements in the INT NC (e. g. CAM, BAL, Transparency) are mapped to standardised messages, in a consistent, machine-readable format.

Edig@s acts as the technical enabler for harmonised business processes underpinning the EU internal gas market and its implementation warrants regular review. Such a review has been undertaken with the corresponding analysis presented in the following section. Art. 21 in the INT NC, whilst prescribing Edig@s, does not specify a specific version and as a result, multiple Edig@s versions currently coexist as valid implementations. Moreover, these versions are not mutually exclusive, as TSOs may apply different Edig@s versions across various connections.

6.5 OVERVIEW OF RESULTS: IMPLEMENTATION OF THE COMMON DATA EXCHANGE SOLUTIONS

The survey demonstrates that data-exchange practices across European TSOs remain highly harmonised and aligned with the technical options in Art. 21 INT NC. Document-based, machine-to-machine exchange using Edig@s XML and the AS4 (ENTSOG Profile 3.6) protocol continues to form the backbone of cross-border interoperability.

The implementations across TSO–TSO, TSO–network user and TSO–VTP exchanges show consistent adherence to the INT NC, with no significant divergence in the application of formats or communication protocols.

Overall, the data confirm that implementation practices are mature, interoperable, and stable, ensuring the reliability and predictability of cross-border data exchange.

6.6 OVERVIEW ON DATA EXCHANGE DIMENSIONS USAGE

The usage of the Data Exchange solutions by TSOs (i.e. % of TSOs stating they offer a certain dimension in at least one use case) is presented in Table 2 below.

Dimension	Category	Usage of dimension by TSOs	Notes
Data exchange type	Document-based	~90 %	– Predominant method of Data exchange
Data exchange type	Integrated (SOAP/HTTPS)	~25 %	
Data exchange type	Interactive (GUI/manual/API)	~20 %	
Communication protocol	ENTSOG AS4 Profile	~85 %	– Currently adopted version is 3.6
Communication protocol	AS2	~5 %	– Legacy communication protocol – Remains in use in outlier, older implementations
Data format	Edig@s XML 5.1	~90 %	– Predominant Edig@s version – Long-established production use
Data format	Edig@s XML 6.1	~10 %	– Increasingly adopted, particularly when installing new or upgraded systems
Data format	Edig@s 4	~35 %	– Legacy message format – Remains in use in outlier, older implementations

Table 2: Overview on Data Exchange Dimensions Usage

Note: Figures include both production usage and formally declared migration intentions. Additionally, versions are not mutually exclusive i.e. TSOs may apply all versions in various connections.

6.7 CONCLUSIONS

Overall, the TSOs' assessment of the implementation of the data exchange provisions of the INT NC in the European gas sector is positive. The findings reaffirm that data-exchange practices are stable, interoperable, and compliant with the INT NC. The pairing of Edig@s and AS4 continues to provide a reliable technical foundation and Articles 21–24 remain fit for purpose. In more detail:

- ▲ **Standardisation:** The majority of exchanges conform to Edig@s 5.1 with AS4 (ENTSOG 3.6), indicating strong harmonisation across parties.
- ▲ **Automation trend:** Document based and AS4-based setups dominate, showing preference for secure, machine-to-machine communication.
- ▲ **Flexibility:** Interactive exchanges (web portals, GUIs) are still used for user-oriented data tasks.
- ▲ **Legacy presence:** Some formats (Edig@s 4, AS2, proprietary) remain in use in outlier, older implementations.

7 COMPLEMENTARY ANALYSIS: LIABILITIES IN CASE OF OFF SPEC GAS QUALITY

As mentioned in chapter 2 “General considerations” of this report, “Liabilities in case of off spec gas quality” is not a topic included in the INT NC or explicitly listed in Art. 71.2 a) of the Gas and Hydrogen Regulation 2024/1789. However, ACER has requested ENTSOG and its members, the EU gas TSOs, to respond to questions on this topic to help to build understanding on the matter and assess it as potential point to include in the INT NC.

ENTSOG’s analysis of the issue is then included in this additional chapter to this INT NC IMR.

7.1 GENERAL CONSIDERATIONS

Off spec gas quality can occur within EU gas systems; however, such cases remain infrequent. To ENTSOG’s knowledge, and at the time of drafting this report, during the period under analysis (2025) these occurrences have not led to disputes over liability nor compensation for damages nor any interruptions of transport. Instances involving cross-border situations are even more uncommon as illustrated in the gas quality part of this report, demonstrating that the current situation is not an issue nor a barrier to cross-border trade.

As a result of the aforementioned rare occurrence and the high costs for building and operating gas treatment facilities, TSOs currently do not have, in most cases, the capability of adjusting the quality of off-spec gas. The potential for such capability is deemed inefficient due to its disproportionate costs to both the system and its users in relation to the minimal benefits it offers. TSOs would need to invest in and operate large facilities for gas treatment, that are most of the time not needed, with consequences for the tariffs and network users.

Based on this common understanding and with the background knowledge that already in 2018 liability discussions were extensively deliberated upon during the development of the GT&C template⁴ within

ENTSOG, this chapter sums up the consequences, namely that it is necessary to keep the liability questions out of the scope of the INT NC. Especially in the GT&C template, developed by ENTSOG and submitted to ACER for their opinion, it was decided not to include liability provisions in this EU level document due to the substantial differences in national civil law principles with various consequences. However, although the template does not include a chapter on liabilities, it actually indicates responsibilities regarding gas quality:

- ▲ **Rights/Obligations of the TSO:** Responsibility for fulfilling the gas quality specifications at the exit point of the national transmission system subject to the country and the TSO’s network specific conditions of any sort (statutory and contractual conditions, operational constraints, etc.)
- ▲ **Rights/Obligations of the Network User:** Responsibility for fulfilling the gas quality specifications at the entry point of the national transmission system

These discussions also highlighted that liability regimes are very closely linked to national law and resolutions of NRAs: either general liability princi-

⁴ [ENTSOG Template Contract of Main terms and conditions](#) for the offer of bundled capacity products in accordance with article 20 of Commission Regulation (EU) 2017/459 establishing a network code on capacity allocation mechanism in gas transmission systems (“CAM NC”)



ples of civil law (as defined by law and interpreted by the case law) or sometimes sector specific legislations. Liability rules, their legal preconditions and consequences and especially possibilities of liability limitations vary from one country to the other. Given the significant differences and requirements in national civil law principles, TSOs that include liability provisions in IAs apply varying approaches and examples of these approaches can be found later in this report.

As part of the GT&C template work, a public report has been published by ENTSOG in January 2018⁵ and, chapter 13, brings forward all relevant argumentation that reasons why EU alignment on liability would be questionable since the report demonstrated that they are affected by fundamental great variety of clauses and regimes. A detailed analysis of this chapter is included in the next section of this report.

It is also noteworthy that, given the gas quality requirements among Member States upon entry into the EU and that in the vast majority of cases

TSOs lack a direct commercial relationship with producers, TSOs knowledge of varying gas quality requirements across MSs necessitate reliable measuring methods, information exchange and monitoring mechanisms.

In fact, as owners of the gas commodity itself, shippers are the entities that hold contracts with producers, TSOs, and end users. Chapter § 8a of the “General Agreement Concerning The Delivery And Acceptance Of Natural Gas” by EFET, now Energy Traders Europe, says:

- ▲ **Seller’s Obligation:** In respect of an Individual Contract, the Seller shall procure that Natural Gas delivered at the Delivery Point conforms to the Transportation Requirements.

The same chapter also presents obligations in terms of notifications, rights of the buyer, underdelivery due to off spec gas, indemnity, and payment for off spec gas.

Accordingly, shippers play a key role in ensuring that the gas they source complies with the specifications of the system through which it flows.

5 [ENTSOG Report on Transport Contracts Main Terms and Conditions Differences](#) – January 2018

7.2 ENTSOG'S PAST ANALYSIS ON LIABILITIES

Several observations and conclusions could be drawn from the GT&C template development exercise by ENTSOG in 2018. Some of the points taken directly from this exercise are the following:

- ▲ Liability clauses have as object to define the principles of the liabilities of the parties (between them and as the case may be towards third parties) for damages or personal injuries, possible limits of such liabilities in terms of fault degree, type of damages or financial compensations.
- ▲ In fact, contractual arrangements regarding liabilities in the EU vary significantly across Member States, as they depend on national rules and civil law principles. As mentioned before, it was decided not to include liability provisions (among others, including but not limited to hardship, termination or Price and Tariffs) in the template due to the substantial differences in national civil law principles as mentioned above – a situation that remains unchanged.
- ▲ Liability regimes are very closely linked to national law and resolutions of NRAs: either general liability principles of civil law (as defined by law and interpreted by the case law), or sometimes sector specific legislations. Liability rules and especially possibilities of liability limitations vary from one country to the other. The liability regime is a country-specific topic. This provision is affected by fundamental differences in principles of national law and jurisprudence.
- ▲ In fact, the comparison done at the time (still valid currently) revealed a great variety of clauses and regimes:
 - For example, conditions for liability limitations vary from one country to the other.
 - Exemption clauses are mostly subject to a restrictive interpretation (“contra proferentem” rule).
 - Some countries prohibit contractual amendments of the extra-contractual liability regime whereas other countries allow them
 - Differences are also due to the contractual freedom of the parties, who can amend to some extent the legal provisions and even adopt terms and definitions at their own discretion
- Whereas for example provisions reducing the indemnification obligation pertaining to a damage caused by the fault of a given party (for instance by excluding from the indemnification certain types of damages, such as e. g. indirect damages) are common practice, the definition of indirect damages may vary from country/contract to country/contract.
- Most of the contracts contain detailed liability clauses governing both contractual and extra-contractual liabilities. Some, however, contain no specific liability clauses (national civil laws are thus applicable) and some explicitly refer to national legal regimes with or without amendments to this regime.
- Although the general principle would be that parties are liable by civil law towards each other for damages resulting out of a fault, the detailed liability regimes vary on many different topics
- Generally speaking, the fact that a contract does not explicitly govern some of these topics, does not mean that they are not regulated in the relevant jurisdiction: the silence of the contract is an invitation to apply national law.
- Indeed, liability regimes are very closely linked to national law and resolutions of NRAs: either general liability principles of civil law (as defined by law and interpreted by the case law), or sometimes sector specific legislations. Liability rules and especially possibilities of liability limitations vary from one country to the other. The liability regime is a country-specific topic. This provision is therefore affected by fundamental differences in principles of national law and jurisprudence.

When ENTSOG developed the GT&C template in 2018 – later submitted to ACER for opinion – it was decided to deliberately not include liability provisions, due to the substantial differences in national civil law principles across Member States. This context remains unchanged today and should be valid all the more since liability for gas quality is only a small part of the topic.

The full in-depth analysis is included in [ENTSOG's January 2018 Report on Transport Contracts Main Terms and Conditions Differences](#).

7.3 LIABILITIES IN CASE OF OFF SPEC GAS QUALITY – ENTSOG’S ANALYSIS

As outlined in Chapter 2 of this report, ACER requested ENTSOG to circulate a questionnaire among its members to gather insights on the implementation of the INT NC and to explore expectations for a potential revision in three key areas: gas quality, liabilities in cases of off spec gas quality, and data exchange.

Although “liabilities in case of off spec gas quality” is not currently a topic covered by the INT NC, ACER asked ENTSOG to analyse this issue to support a better understanding of existing practices and to consider whether it could be addressed in a future revision. The results of this analysis are presented in this chapter.

A first step in this assessment is to determine whether liability provisions, although not mandated by EU Regulation, are commonly included in IAs.

Moreover, Art. 7 of the INT NC sets out the measurement principles for both gas quantity and gas quality. However, it is evident that liability, whether understood in general terms or specifically in relation to gas quality, is not addressed within the INT NC. The explanations provided earlier in the report can also be valid for the INT NC.

It also remains established practice that shippers are responsible for ensuring that the gas they introduce into TSO systems meets the applicable gas quality specifications. TSOs, in turn, can accept off spec gas at entry points under certain circumstances, though such action can have implications for system operation and security of supply.

Because liability is not regulated at EU level through the INT NC, TSOs retain discretion to decide whether to include liability provisions in their IAs with neighbouring TSOs. This formed the starting point of ENTSOG’s assessment, from which several conclusions emerged.

DO IAs CONTAIN LIABILITY CLAUSES FOR GAS QUALITY ISSUES?

As observed in the chart below, approximately 65 % of TSOs indicated that at least one of their IAs contains a clause addressing liabilities. The remaining TSOs reported that none of their IAs include liability-related provisions.

Based on ENTSOG’s previous assessments – and given the significant differences and requirements in national civil law principles – those TSOs that do include liability provisions apply varying approaches. Examples of approaches identified, which may be specific to certain contracts or appear in several, include, for example:

- ▲ A general liability clause, without any specific/ additional provisions related to failure to meet required gas quality specifications.
- ▲ Requirements for operational or informational actions to be undertaken.
- ▲ Liability limits, which vary across contracts.
- ▲ Clauses in which TSOs are liable in cases of gross negligence or wilful misconduct.
- ▲ Context-specific factors, such as security-of-supply events or unknown gas quality, which may influence liability attribution.

Do IAs contain liability clauses for gas quality issues?

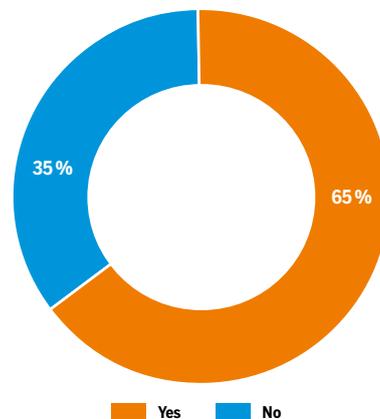


Figure 5: Do IAs contain liability clauses for gas quality issues?

ARE LIABILITY RULES BETWEEN TSOS AND OTHER ENTITIES (E.G., SHIPPERS) ESTABLISHED BY NATIONAL LEGISLATION OR BY CONTRACTUAL AGREEMENTS?

As with the diverse landscape observed regarding the inclusion of liability clauses in IAs, the rules governing liability between TSOs and other entities vary across the EU.

According to the responses collected (see chart referenced below):

- ▲ 58 % of TSOs report that liability rules are set both in national legislation and in contractual agreements between TSOs and other entities.
- ▲ 15 % rely exclusively on national legislation for liability governance.
- ▲ 85 % of TSOs confirm that liability provisions in TSO-shipper relationships are typically defined in the General Terms and Conditions for Transmission Network Access, even if national legislation also applies.

Examples of approaches identified (these approaches may be specific to individual contracts or appear across several):

- ▲ Liability for gas quality between TSOs and shippers defined directly in Network Access Rules.
- ▲ National civil law principles providing the overarching legal framework, with specific liability terms and limitations further detailed contractually.
- ▲ A hybrid liability framework, combining national legislation/regulatory requirements with contract-specific provisions, with the balance varying depending on the counterparty.
- ▲ TSOs bearing responsibility for gas quality measurement and monitoring at both entry and exit points.

- ▲ If injection conditions pose a severe risk to expected gas flows due to off-spec gas, the TSO is entitled to interrupt the injection.
- ▲ Shippers being financially liable for all costs and expenses resulting from delivering off-specification gas into the TSO network.
- ▲ If off-spec gas is delivered by a TSO at an exit point even when compliant gas is received at entry, the TSO must notify the interested parties (e. g. adjacent TSO, shippers, end-users), who then have the right to refuse the off-spec gas.
- ▲ Except in certain circumstances (e. g. SoS crises) a TSO who decides to accept to receive off spec gas at the entry point is responsible for ensuring compliant gas at the exit point.

Coverage of liability rules between TSOs and other entities

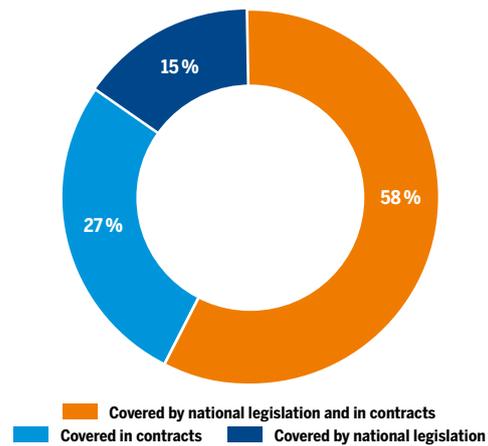


Figure 6: Coverage of liability rules between TSOs and other entities

7.4 CONCLUSIONS

When ENTSOG developed the GT&C template in 2018 – later submitted to ACER for opinion – it was decided to deliberately not include liability provisions, due to the substantial differences in national civil law principles across Member States. This context remains unchanged today and should be valid all the more since liability for gas quality is only a small part of the topic. Despite the absence of harmonised rules at EU level, the existing arrangements have consistently proven effective, with liability matters appropriately addressed at national or regional level and currently not being an issue for cross border trade under current arrangements. Regional issues, in particular, should continue to be addressed as local matters.

It is also important to note that liabilities cannot be harmonised through EU legislation, including network codes, as this does not fall within EU legislative competence. Any attempt to modify national liability frameworks individually would risk negatively affecting domestic market structures. At the same time, importantly, ENTSOG believes that the responsibilities currently assigned to actors in the pan European gas system remain fit for purpose and do not require adaptation.

Given these considerations, ENTSOG strongly recommends that liability provisions continue to be governed at national level, the status quo is kept and changes for the INT NC can create legal complexities trying to solve a non-existing issue. The significant differences in legal principles and jurisprudence across Member States make EU-level harmonisation highly complex, while offering only limited benefits. The current framework has demonstrated its robustness and suitability, and further harmonisation would risk imposing additional costs on TSOs and, ultimately, end users.

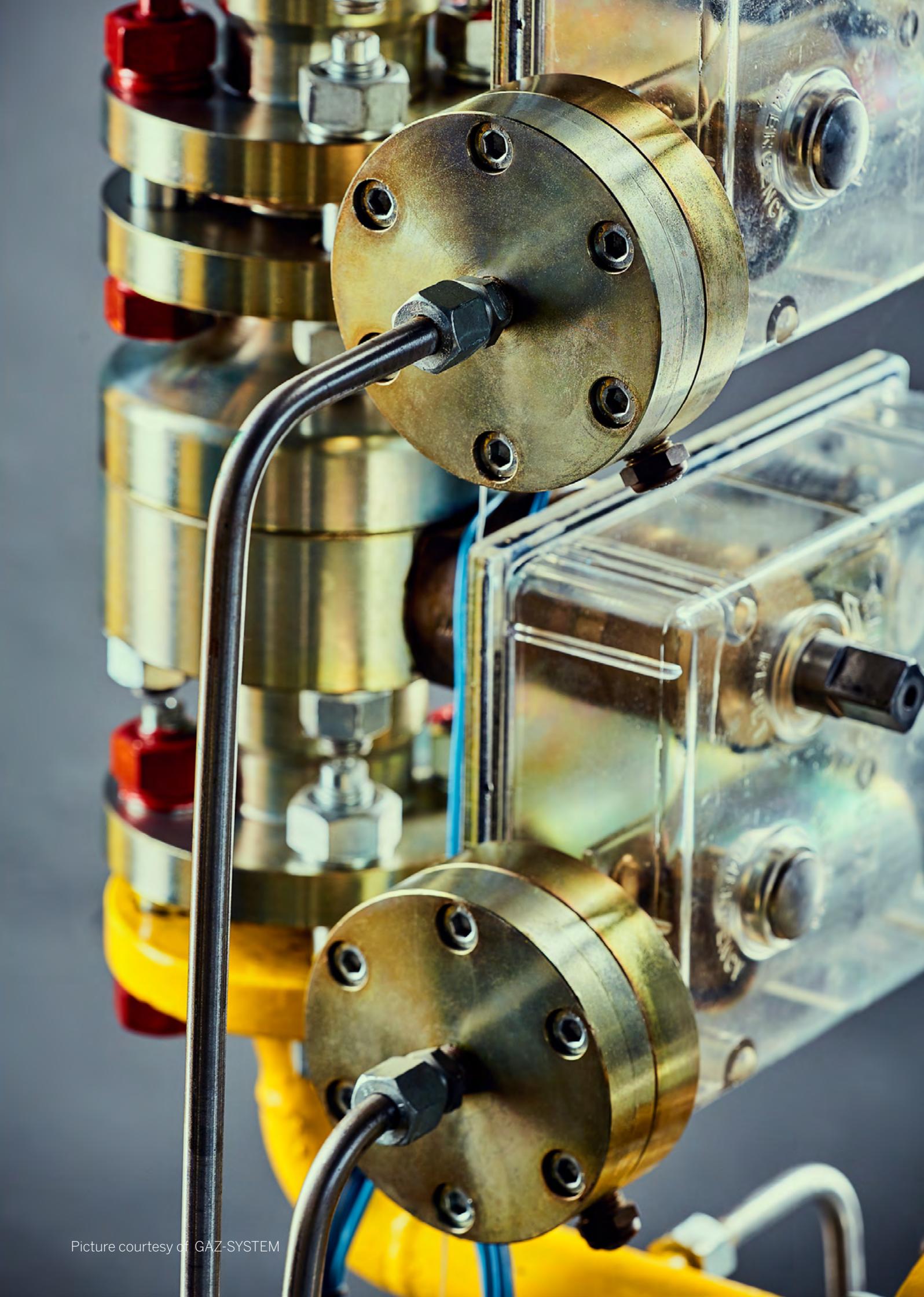
Additionally, maintaining the current allocation of responsibilities is essential. Altering this balance, for example, by altering shipper liability, would diminish incentives for compliance with gas quality specifications, heighten operational risks for TSOs, and could ultimately jeopardise security of supply. TSOs generally lack the capability to

correct off specification gas once it has entered the system and although they monitor key gas quality parameters at entry points they can, in certain circumstances, accept off spec gas to not negatively affect security of supply. It is appropriate that shippers are responsible and liable for the quality of the gas delivered into a TSO's network, as the owner of the gas commodity itself. In addition to this, the shipper will have the necessary contractual arrangements upstream, whereas TSOs lack contractual relationship with producers. This contractual chain represents the situation in most member states today and this works effectively.

One possible solution could be introducing large scale gas treatment capabilities at TSOs but this would be highly inefficient and disproportionate, requiring significant investments that would rarely be utilised and would ultimately raise tariffs for network users.

In fact, it is key to keep acknowledging that varying gas quality requirements across MSs necessitate robust information exchange and monitoring mechanisms. For this system to function effectively, it is crucial that responsibilities along the chain remain appropriately distributed. ENTSOG and the TSOs believe that responsibilities for complying with gas quality requirements and the associated liabilities in cases of off spec gas must continue to be shared between TSOs and shippers. Altering existing responsibility allocations could trigger unforeseen and undesirable impacts on the gas system, as illustrated in this assessment, whilst at the same time the current responsibility allocations are not deemed to be an issue today and are not a barrier to cross-border trade.

Finally, because TSOs are regulated entities, the discussed modification of liability schemes, with TSOs having more liability, would require compensation through tariff adjustments. Any shift that increases TSO responsibilities or potential liabilities must therefore be reflected in the tariffs charged, which would, in turn, increase costs for end users.



ABBREVIATIONS

ACER	Agency for the Cooperation of Energy Regulators established by Regulation (EC) No 713/2009
CEN	Comité Européen de Normalisation (European Committee for Standardisation)
CNOTs	Common Network Operation Tools for coordination of network operation in normal and emergency conditions
DSO	Distribution System Operator
EC	European Commission
ENTSOG	European Network of Transmission System Operators for Gas
EU	European Union
GT&C	General Terms and Conditions
IA	Interconnection Agreement
IMR	Implementation Monitoring Report
INT NC	Network Code on Interoperability and Data Exchange Rules
IP	Interconnection Point, as defined by Article 2(63) of the DIRECTIVE (EU) 2024/1788
MS(s)	Member State(s)
NRA	National Regulatory Authority
SSO	Storage System Operator
TSO	Transmission System Operator
WI	Wobbe Index

COUNTRY CODES (ISO)

AT	Austria	LU	Luxembourg
BE	Belgium	LV	Latvia
BG	Bulgaria	MT	Malta
CH	Switzerland	NL	Netherlands, the
CY	Cyprus	NO	Norway
CZ	Czechia	PL	Poland
DE	Germany	PT	Portugal
DK	Denmark	RO	Romania
EE	Estonia	SE	Sweden
ES	Spain	SI	Slovenia
FI	Finland	SK	Slovakia
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GR	Greece		
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HU	Hungary		

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