ANNEX 1: Common Risk Assessment – Eastern Gas Supply Risk Group – Ukraine

Member States

The Ukraine Risk Group is composed of: Austria, Bulgaria, Croatia, Czech Republic, Denmark, Germany, Greece, Hungary, Italy, Luxembourg, Poland, Romania, Slovenia, Slovakia and Sweden.

Gas Storage Capacity in Member States

	Working gas volume in TWh	**Share of capacity in risk group in %**
AT	97,64	12,39%
BG	5,89	0,75%
CZ	44,67	5,67%
DE	252,40	32,02%
DK	9,85	1,25%
EL	0,00	0,00%
HR	4,77	0,61%
HU	67,70	8,59%
IT	195,20	24,77%
LU	0,00	0,00%
PL	37,54	4,76%
RO	33,86	4,30%
SE	0,10	0,01%
SI	0,00	0,00%
SK	38,55	4,89%
Total	**788,18**	**100,00%**

Source: AGSI+, 16.08.2023

Summary of the Common Risk Assessment

The Eastern gas supply risk group focused on Ukrainian gas supply route, after taking into account infrastructure and supply standards, protected customers definition for each involved Member State and the results of JRC analysis on the Russian supply disruption risk, found the following conclusions.

Infrastructure and supply standards, even if are theoretically sufficiently covered at a group level, may result into a situation where new infrastructures are needed in order to guarantee security of supply to the involved MSs considering the changing situation related to the geopolitical risk of the Russian gas supply routes.

Risk scenarios analysis conclusions.

WINTER VOLUME ANALYSIS

Best case-situation:

Short-term storage management strategy (0% of GIS at the end of 2023) with a cooperative approach leads the curtailment to around 6.3-6.6 bcm. In this case Germany, Romania and Hungary are the countries of the RG with the highest gas curtailment with 1 bcm on average, but there is a probability of 1/6 that Germany had unserved gas slightly higher than 4 bcm. In relative terms, unserved gas demand is kept below 20% for all countries belonging to the RG.

Best case-situation for Risk Group/Country:

Short-term storage management strategy - cooperative approach

Risk Group: Curtailment around 6.3-6.6 bcm.

Countries (in absolute terms): Germany, Romania and Hungary: 1 bcm on average; Germany: higher than 4 bcm with probability of 1/6.

Countries (in relative terms): below 20% for all countries belonging to the RG.

Worst case-situation:

Long-term storage management strategy (GIS at the end of 2023 equal to those observed at the end of 2021) with a non-cooperative approach leads the highest curtailment for the Risk Group: around 33-34 bcm. Czechia and Hungary have gas curtailment around 5.0-5.5 bcm; Austria, Poland, and Germany around 4.0 bcm on average; Germany and Italy have a probability of 1/6 to reach gas curtailment around 9-10 bcm. In relative terms, curtailments are higher than 70% of the corresponding demand in Sweden, Slovakia, Czechia, Hungary, Slovenia, Austria, and Bulgaria; around 40% in Denmark and Poland; 20% in Romania; curtailments below 10% in Germany, Croatia, Italy, Luxembourg, and Greece.

It's important to underline that under a cooperative approach the curtailment for the Risk Group decreases to 26-27 bcm, but is observed the highest curtailment in absolute terms in Germany (10 bcm), and Italy (6.5 bcm).

Worst case-situation for Risk Group:

Long-term storage management strategy – non-cooperative approach

Risk Group: Curtailment around 33-34 bcm.

Countries (in absolute terms): Czechia, Hungary: around 5.0 bcm on average; Austria, Poland, Germany around 4.0 bcm on average; Germany, Italy: around 9-10 bcm with probability of 1/6.

Countries (in relative terms): Sweden, Slovakia, Czechia, Hungary, Slovenia, Austria, Bulgaria: higher than 70%; Denmark, Poland: around 40%; Romania: 20%; Germany, Croatia, Italy, Luxembourg, Greece: below 10%.

Worst case-situation for Country:

Long-term storage management strategy – cooperative approach

Countries (in absolute terms): Germany 10 bcm; Italy 6.5 bcm.

WINTER PEAK ANALYSIS

Best case-situation:

As regard the analysis on a daily basis, short-term storage management strategy (0% of GIS at the end of 2023) with a cooperative approach leads the lowest values of peak gas curtailment. Germany around 110 mcm/d (20% of its peak demand); Italy around 74 mcm/d (19% of its peak demand). In general, the remaining countries keep their peak curtailments below 22 mcm/d in absolute terms, corresponding on average to 20% of its peak demand.

Short-term storage management strategy - cooperative approach

Countries (in absolute terms): Germany: 110 mcm/d; Italy: 74 mcm/d; remaining countries: below 22 mcm/d.

Countries (in relative terms): below 20% for all countries belonging to the RG.

Worst case-situation:

As regard the analysis on a daily basis, long-term storage management strategy (GIS at the end of 2023 equal to those observed at the end of 2021) with a non-cooperative approach leads the highest values of peak gas curtailment. Germany around 223 mcm/d (40% of its peak demand); Italy around 151-161 mcm/d (around 40% of its peak demand). In general, the remaining

countries keep their peak curtailments below 54 mcm/d in absolute terms. In relative terms, we identify curtailments up to 98% in Slovenia, 97% in Czechia or 84% in Slovakia.

Long-term storage management strategy – non-cooperative approach

Countries (in absolute terms): Germany: 223 mcm/d; Italy: 151-161 mcm/d; remaining countries: below 55 mcm/d.

Countries (in relative terms): Germany, Italy: around 40%; up to 98% in Slovenia, 97% in Czech Republic, 84% in Slovakia.

However, the Slovenian main supplier closed a new supply contract at the end of 2022 to reduce this exposure. Since the beginning of 2023 Slovenian customers have been supplied partly with North African gas which reduced the curtailments to around 70% in Slovenia in worst case.

Greece, Croatia, Italy and Poland have LNG terminals, but new LNG terminals come into operation in Germany at the beginning of 2023. LNG send-out flows are kept around 25 bcm regardless of the modelling assumptions. There is an increase in the LNG send-out flow from January 2023 onwards due to the new LNG terminals in Germany. The LNG send-out utilisation over winter in Croatia and Greece increases when resorting to cooperation mechanisms compared to the ones under a non-cooperative management strategy in order to keep the curtailment in all countries below a given threshold (i.e. 20%).

All countries in this RG except Greece, Luxembourg and Slovenia have underground gas storage facilities. When assuming a short-term storage management strategy, the aggregated filling level at the beginning of the heating season is slightly lower than 90%, however the storages are depleted over the winter thus arriving at 8% on 1 April 2023 on average. There are demand scenarios in which storages are exhausted and other scenarios in which filling level is kept just below 20% (cooperative strategy). Long-term storage management leads to higher curtailments, as stated previously, in order to prevent the use of gas in storage. In this case, the average filling level is kept around more than 40% on average on 1 April 2023 (cooperative strategy). There is a range of possible filling levels at the end of the heating season depending on the demand scenarios, thus arriving at either just below 50% or slightly lower than 40%. A non-cooperative strategy may lead to lower filling levels at the end of the winter.

Cooperation implies more intense use of transmission capacities. Per se, interconnection transmission capacities do not affect substantially the impact on curtailment. Moreover, it can be seen that higher flows go to countries with storages when assuming a long-term security of supply perspective. It should be noted that, under non-cooperation with a long-term storage management strategy, there are substantial exports to Ukraine via Slovakia (around 3 bcm during winter). The reason behind this behaviour relies on the operation of the aggregated Ukrainian storage, which must keep gas in storage for the next winter season.

Regarding the sensitivity analysis on demand reduction, it can be concluded that 5% reduction over the winter is enough to mitigate completely gas curtailments when storages could be used as much as possible during winter. However, if security of gas supply in the long-term (next

winter) were prioritised, the needed demand reduction would be 15%. Note that this reduction factor has been applied throughout the simulation horizon.

Regarding the additional risk events, the cold spell is the event leading to the worst gas curtailment (9.5 bcm on average for the RG). There is a probability of 1/6 that the cold spell causes unserved gas demand up to circa 18 bcm over the winter (11.1% of the worst-case gas demand scenario in the RG), but there is another probability of 1/6 to have a milder winter without any curtailment. Similar conclusions can be drawn from a total disruption of Algerian gas supplies for two months and a partial interruption of Transmed pipeline flows for five months. The remaining risk events do not affect substantially to the RG compared to the baseline scenario.

Description of the System

Bulgaria

The transmission system in Bulgaria consists of 3.276 km of pipelines. The Transmission network includes cross-border connection points with Romania (point Negru Voda 1 / Kardam and Ruse / Giurgiu), Greece (point Kulata / Sidirokastro), North Macedonia (Kyustendil/ Zidilovo), Turkey (Strandzha / Malkoclar and Strandzha 2/Malkoclar) and Serbia (Kireevo / Zaychar). There are also entry points in the transmission system from local production (GMS Dolni Dabnik) and coastal production (GMS Galata), as well as one connection point with the Underground Storage facility in Chiren.

Gas is currently a small component of the country's energy mix. It is primarily utilized by the industrial sector, with a modest role in power generation and very low consumption in the residential and commercial sectors.

Bulgaria's natural gas domestic market is only 3 bcm per year. However, the country has an extensive network of gas pipelines that serve Bulgaria's needs as well as those of neighbouring countries. Bulgaria is also a gas transit country, to North Macedonia, Turkey, Greece and Serbia, up to the rest of Europe.

Bulgaria, which for years has met over 90% of its gas needs with Russian imports through the Negru Voda entry point, has recently seen its gas deliveries extremely reduced, because of the changed politic situation due to Russian war of aggression on Ukraine. For this reason, it's now acting to reduce dependence on Russian supplies, increasing imports of gas volumes from other neighbouring countries.

The construction of the gas interconnector Greece-Bulgaria (IGB) was recently completed. The interconnector IGB connects the natural gas transmission network of Greece near the town of Komotini with the Bulgarian transmission network near the town of Stara Zagora, including approximately 31km running through Greece and 151km through Bulgaria. As part of the development of the Southern Gas Corridor, through IGB Bulgaria and its neighbouring countries will have access to alternative supplies from the Caspian region as well as from existing or planned LNG terminals. The interconnector Greece- Bulgaria will play a key role in meeting Bulgaria's objectives of diversifying energy sources, energy security and independence. Chiren UGS has a technical volume of 550 million cubic meters (1300 MSm3 of total gas volume minus 750 MSm3of cushion gas). To enhance the security of natural gas supply, the storage operator is working on a project to expand its capacity. It is planned to reach up to 1 billion cubic metres after the project is completed.

In 2021 natural gas consumption amounted to 3,4 bcm, against a domestic production of 0,7% of annual consumption; total storage capacity amount to 5,81 TWh.

	2021			2022		
	Real Data			Forecast		
	Protected customers		Non Protected Customers	Protected Customers		Non Protected customers
	Protected customers of solidarity	Rest		Protected customers of solidarity	Rest	
Gas consumption (bcm)	**3,4**			**3,55**		
Industrial	0.14		1.37	0.15		1.41
Electricity generation	0.04	0.21	0.45	0.04	0.23	0.47
District heating	0.075	0.13	0.67	0.08	0.16	0.68
Residential	0.095		0	0.11		0
Other	0.02		0.2	0.02		0.2
Peak demand (mcm/d)	**15,33 / 15.02.2021**			**16,0**		
Industrial	0.7		6.38	0.75		6.55
Electricity generation	0.75	0.48	1.7	0.75	0.5	1.75
District heating	0.2	0.83	2.35	0.2	0.9	2.5
Residential	0.7		0	0.7		0
Other	0.5		0.74	0.5		0.9

Croatia

Croatian gas transmission network has a total length of 2.694 km of transportation pipelines. The natural gas transmission network has cross-border interconnections with Slovenia (Rogatec) and Hungary (Dravaszerdahely) usually utilised to import gas. There are also 7 entry points from production plants and one interconnection with the underground storage facility of Okoli.

The upstream pipelines in the Adriatic Sea are used to export Croatian natural gas from the production platforms to Italy. Panon gas fields are connected by upstream pipelines to the transmission network and to the underground gas storage facility at the Okoli site.

The Okoli gas storage infrastructure (553 million cubic meters) is located at Okoliand and it is part of the Underground Gas Station d.o.o..

In 2020 Croatia completed the construction of the LNG terminal on the island of Krk, with a storage capacity from up to 265.000 m3 of LNG; nominal regasification capacity of 8 billion m3 of gas per year.

There were 33 companies for natural gas distribution in the Republic of Croatia in 2020. In total, the gas distribution network in Croatia is 18,429 km long. In 2021 natural gas consumption amounted to 31,70 TWh, against a domestic production of 8,08 TWh; total storage capacity amount to 5,22 TWh.

Czech Republic

The Czech natural gas transmission network is composed of 2 637 km of transit pipelines, 1 181 km of domestic pipelines, and is divided into four branches: the Northern and Southern branches, which run from Lanžhot to the Czech-German borders, the Western branch, which connects the Northern and Southern branches, and the Moravian branch which supplies the Moravian region (south-eastern part of the country) and connects with Poland.

The Czech distribution network consists of 72 914 km of high, medium and low-pressure pipelines. Industry is the largest user, followed by residential and electricity and heat generation.

Given the low domestic production of gas and, as a landlocked country, the lack of LNG terminals, the Czech Republic relies on imports for its domestic consumption, imported via pipeline interconnection points between the Czech Republic and neighbouring countries. The Czech gas transmission system also plays a key role in supplying gas to Europe, with the annual amount of gas transported through the country more than four times domestic consumption.

There are six cross-border interconnections, three with Germany (Hora Svaté Kateřiny, Brandov, Waidhaus), one with Poland (Cieszyn), one with Slovakia (Lanžhot) and one entry only point again from Germany (Olbernhau). Storage system is composed of eight sites (Tvrdonice, Dolní Dunajovice, Štramberk, Lobodice, Třanovice, Háje, Uhřice, Dambořice)

In 2021 natural gas consumption amounted to 100,77 TWh, against a domestic production of 2,17 TWh; total storage capacity amount to 35,99 TWh.

Germany

Germany has an extensive transmission system. The network of the transmission system operators (TSOs) is about 38 000 km long, has more than 110 compressor stations and is connected to the systems of neighbouring countries via a large number (>25) of cross-border interconnection points. The German gas transmission system is divided into an H-gas area and an L-gas area.

Some 34 underground storage facilities are operated in Germany now, but because some of them are used by more than one operator, 50 facilities are marketed. The maximum usable working gas volume in these underground storage facilities amounts to some 274.72 TWh, giving Germany the largest storage capacity in the European Union. Of the total usable working gas volume, 136.1 TWh are accounted for by cavern and 117.01 TWh by pore storage facilities (rest 21.71 TWh). Reflecting the structure of the German natural gas market, the majority of the storage facilities are used for the storage of H-gas (251.86 TWh for H-gas compared to 22.87 TWh for L-gas).

Against the background of the current geopolitical situation and its impact on the supply situation with natural gas and the current efforts to reduce Germany's dependence on Russian gas supplies, the expansion of the LNG infrastructure in Germany represents a central building block.

In addition to the five Floating Storage and Regasification Units (FSRUs) currently chartered by the federal government, which will be deployed in the short term - the first two federal FSRUs (RWE, Uniper) are scheduled to go into operation as early as winter 2022/2023 - there are other private-sector project sponsors planning both land-based and floating terminals (FSRUs).

In view of the reductions in German L-gas production and L-gas imports from the Netherlands, the relevant companies are already taking action to prevent any decline in the availability of L-gas negatively affecting security of supply. German L-gas producers, the network operators affected and storage system operators have set up a joint working group to develop a plan for the coordinated conversion from L-gas to H-gas. The companies involved are drafting a conversion plan that will include a schedule for converting the supply areas affected from L-gas to H-gas.

In 2021 natural gas consumption amounted to 995,17 TWh, against a domestic production of 47,78 TWh; total storage capacity amount to 241,92 TWh.

Gas demand structure in Germany

		2019	2020	2021	2022
TOTAL CONSUMPTION	Inland consumption [TWh]	977,18	964,00	995,17	
	Industry [TWh]	296,01	283,37		
	Electricity Generation [TWh]	60,82	72,16		
	Heat [TWh]	21,40	21,65		
	Combined Heat and Power [TWh]	155,99	154,49		
	Households [TWh]	289,19	281,00		
	Commercial and public services [TWh]	122,35	128,51		
	Transport [TWh]	10,12	6,11		

	Other [TWh]	21,30	16,71		
PEAK DEMAND	Dmax [GWh/d] (Historical Data)	6125,45			
	Dmax [GWh/d] (ENTSOG)	6010,85			
	Indicate D_{max} calculation methodology or date of historical peak demand day	11.02.2021			
HEATING SEASON	Season	2019-2020	2020-2021	2021-2022	2022-2023
	Heating Season Demand [TWh]	639,42	606,52	637,52	

Greece

The National Natural Gas System (NNGS) transports Natural Gas from the Greek-Bulgarian and Greek-Turkish borders, the Trans Adriatic Pipeline (TAP) as well as from the Liquefied Natural Gas (LNG) terminal located on the island of Revithoussa in the Megara bay, to consumers in the continental Greece.

The network has four entry points: three at the north and north-eastern borders, Sidirokastro, Nea Mesimbria and Kipi, connecting Greece with the Bulgarian and Turkish gas networks, and one in southern Greece, Agia Triada, linked to the LNG terminal.

The Greek NG system consists of:

- gas transmission network of 953.204 km;
- the border metering stations at Sidirokastro, near Serres, and at Kipi, near Evros river as well as the metering station at Agia Triada (related to the LNG terminal);
- the LNG terminal at Revithoussa;
- the Compression Station at Nea Messimvria, Thessaloniki;
- the Control and Dispatching Centers at Patima Elefsinas and at Nea Messimvria, near Thessaloniki;
- 6 Operation & Maintenance Centers of Sidirokastro, Eastern Greece, Northern Greece, Central Greece, Southern Greece and the Peloponesse;
- 2 offshore pipelines each with diameter of 24 inches and length 620 m and 630 m, connecting the Revithoussa LNG Station to the NNGTS.

The three pipeline entry points have a total capacity of 171 GWh/d. The Greek-Turkish interconnector at Kipi brings gas mainly from the Middle East and the Caspian region into Greece. The interconnector with Bulgaria (Sidirokastro) allows gas flows from the Russian Federation via Turkish Steam-Bulgaria. The interconnector at Nea Mesimbria brings gas from Azerbaijan through Turkey.

The biggest natural gas infrastructure of Greece is the LNG terminal located at Revithoussa island. The terminal has a maximum send out capacity of 224.59 GWh/d and a storage capacity of 225.000 m3.

The upgrade of the terminal of Revithoussa Station has been completed at the end of 2018. The project includes:

- The construction of a 3rd LNG tank of 95,055 m3
- The upgrading of gasification rate (from 150,000 MWh/d to 224,593 MWh/d)
- The increase of the gasification capacity to 1,400 m3 LNG/h from 1,000 m3 LNG/h
- The upgrading of marine environment to accommodate larger ships (allowing the reception of LNG carriers with a capacity of up to 260,000 m3 from 140,000 m3)
- The upgrading of Agia Triada metering station

In 2021 natural gas consumption amounted to 69,96 TWh.

	2021			2022		
	Real Data			Forecast		
	Protected customers		Non Protected Customers	Protected Customers		Non Protected customers
	Protected customers of solidarity	Rest		Protected customers of solidarity	Rest	
Gas consumption (bcm)	**6,08**			**5,52**		
Industrial		0,15	1,08		0,14	
Electricity generation			4,19			3,18
District heating	0,02			0,01		
Residential	0,55			0,56		
Other	0,09			0,09		
Peak demand (mcm/d)	**27,08** / 18.01.2021					
Industrial		NA	NA		NA	NA
Electricity generation	NA		NA	NA		
District heating	NA			NA		
Residential	NA			NA		
Other	NA			NA		

Hungary

Hungarian gas transmission network has a total length of 5.889 km of transportation pipelines. The natural gas transmission network has cross-border interconnections with Ukraine (Beregdaróc), with Slovakia (Balassagyarmat), with Austria (Mosonmagyaróvar)1, with Croatia (Drávaszerdahely), with Romania (Csanádpalota) and with Serbia (Kiskundorozsma). Thus, the Hungarian natural gas system is connected to all of the adjacent networks except for Slovenia.

The 2 pipeline interconnections with Ukraine have been operating as a single virtual interconnection point since 1 May 2020, where the clearing of inbound and outbound deliveries is netted.

With the commissioning of a new Hungarian-Serbian interconnector on 1 October 2021, Hungary is able to receive and transport a significant amount of natural gas (up to 8.5 bcm per year) from Serbia.

Natural gas plays an important role in the electricity generation with a share of around 25% and it is forecasted to remain a crucial energy carrier also in the coming years. In 2021 36% of the natural gas was consumed by the households, 27% by power generation, 16% by the industry and 15% by other sectors (e.g. services, agriculture, transport) respectively and 6% was consumed for non-energy purposes.

In 2021 natural gas consumption amounted to 117.83 TWh against a domestic production of 13.36 TWh; total storage capacity amount to 69.4 TWh (5 storage sites combined).

	2017	**2018**	**2019**	**2020**
	Real data	**Real data**	**Real data**	**Real data**
Inland Gas consumption (TWh)	**110,44**	**106,97**	**109,44**	**113,32**
Industrial	24,80	24,80	24,49	24,90
Electricity - CHP	19,36	17,92	20,88	21,96
Heating	7,10	6,72	6,43	6,60
Residential	38,40	36,58	36,09	39,11
Commercial and public services	15,12	14,25	13,69	13,73
Transport	0,85	1,01	1,07	0,79
Other	4,80	5,71	6,79	6,23

[1] The Austrian interconnection is unidirectional towards Hungary.


Lanzhot
45
59
Kuty
Zvolen
Jablonov
Nad Turňou
Košice
218
Uzhgorod
71
Budince
Veľké Kapušany
Lakšárska Nová Ves
Láb
CZ/AT
Baumgarten
46
60
VIENNA
Nitra
Ivánka Pri Nitre
BRATISLAVA
Veľké Zlievce
Beregdaróc
231
Beregovo
VIP BEREG
Selešťany
Balassagyarmat
75
EASTRING
Kittsee
HAG
47
414
CEGH
Mosonmagyaróvár
Győr
Szada
Tekovo
Satu Mar
Hajduszoboszlo
TAG
BUDAPEST
EASTRING
Graz
Siófok
Murfeld
HUNGARY
Városföld
25
Tornyiszentmiklós
Pince
Nagykanizsa
413
MGP
Kidričevo
30
Zabok
Kozármisleny
Kiskundorozsma
57
48
Csanadpalota
Nadlac
Arad
Floria
Subotica
Petrovaselo
Drávaszerdahely
ZAGREB
Lučko
58
Donji Miholac
Sombor
Osijek
Mokrin
EASTRING
Karlovac
Hateg

Italy

Italian gas transmission network extends for more than 32.000 km. Snam Rete Gas (SRG), part of the Snam Group, is Italy's main gas Transmission System Operator (TSO). SRG operates a nationwide pipeline network and supplies around 95% of the Italian market. All pipelines have reverse flow capability.

The national network has cross-border interconnection points with Austria (Tarvisio/Arnoldstein), Slovenia (Gorizia/Sempeter) and with Switzerland (Griess Pass). Italy is also supplied through three offshore interconnectors: Transmed (with Tunisia and Algeria – entry point in Mazara del Vallo), Greenstream (Libya – entry point in Gela) and Trans Adriatic Pipeline (Azeri gas from Caspian Sea Region to Italy at Melendugno entry point). There are four entry points from the regasification terminals (Panigaglia, Livorno, Cavarzere and the newly operational Piombino), as well as another new point under construction in Ravenna, where the FSRU BW Singapore is expected to moor and become operational within the beginning of 2024 .There are also twelve entry exit point from storage plants. Stogit, controlled by Snam, is the most significant operator of natural gas storage in Italy. Local production shows a historical decreasing trend due to the decline of domestic sources, not sufficiently offset by new production developments.

Natural gas is a critical energy source, accounting for almost half of electricity generation. It will continue to play a central role in power generation in the coming decade, particularly as coal-fired capacity is being phased out. Currently nearly 44% of gas consumption comes from the distribution network demand, 38% from power generation demand and 18% from the industrial demand.

In 2022 natural gas consumption amounted to 724,49 TWh, against a domestic production of 35,05 TWh; total storage capacity amount to 197,52 TWh.


SWITZERLAND
HUNGARY
LJUBLJANA
SLOVENIA
ZAGREB
BOSNIA AND HERZEGOVINA
CROATIA
ITALY
SARAJEVO
Ligurian Sea
Adriatic Sea
MONTENEGRO
PODGORICA
CORSICA
ROME
SARDINIA
Tyrrhenian Sea
Ionian Sea
TUNIS

Luxembourg

The natural gas transmission system of Luxembourg comprises 277,2 km of high-pressure pipeline. The transmission gas infrastructure is owned and operated by Creos Luxembourg. The gas supply of Luxembourg is ensured by mainly 3 physical entry points, two from Belgium, in Bras and Pétange, and one in Remich from Germany. The two entry points with Belgium ensure a total capacity of 180.000 Nm3/h. The booked capacity at the German IP REMICH is 31 GWh/h. A minimum of 90.000 Nm3/h is necessary to fulfil the N-1 obligation.

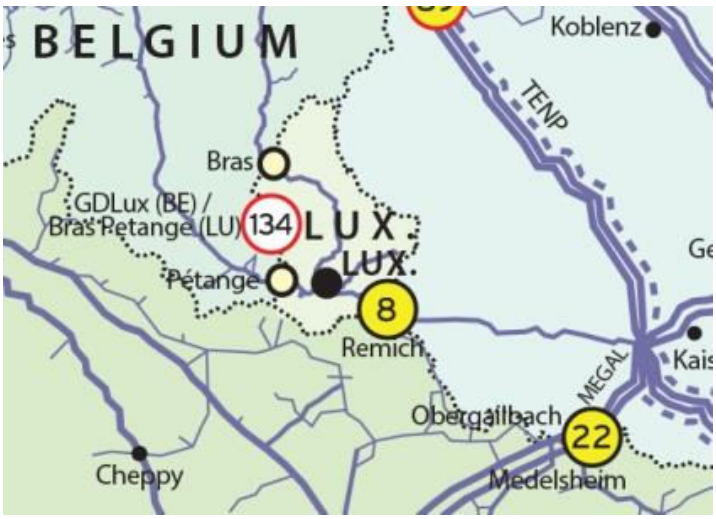
The total capacity of the transmission system amounts to 330.000 Nm3/h.

The transmission system transports natural gas to 62 pressure-reduction substations (distribution system and customers). No infeed or storage are connected to the transmission system.

The main peak load registered in the last ten years dated from 2012 and amounts to 296,550 Nm3/h. However due to the decommissioning in July 2016 of a CCGT gas power plant with a capacity of 375 MWel, the peak load decreased significantly to 196.003 Nm3/h in 2021.

Due to the market integration and the shutdown of the CCGT in Luxembourg, more gas volumes are currently delivered from Belgium than from Germany to Luxembourg. In 2021 79 % of the flows were delivered from the Belgium entry points.

In 2021 natural gas consumption amounted to 8,71 TWh, whereas approximately 31 % of the consumption can be attributed to the residential sector, 38 % to the professional sector, 25 % to the industrial sector and approximately 6 % of the gas consumption to the combined electricity and heat production in CHP plants.



Poland

G Gas transmission system in Poland consists of pipelines with the total length of 11 394 km. There are two types of gas transported in the network operated by GAZ-SYSTEM S.A.: H-gas and L-gas. In addition, there is the Yamal-Europe Pipeline with the length of 684 km.

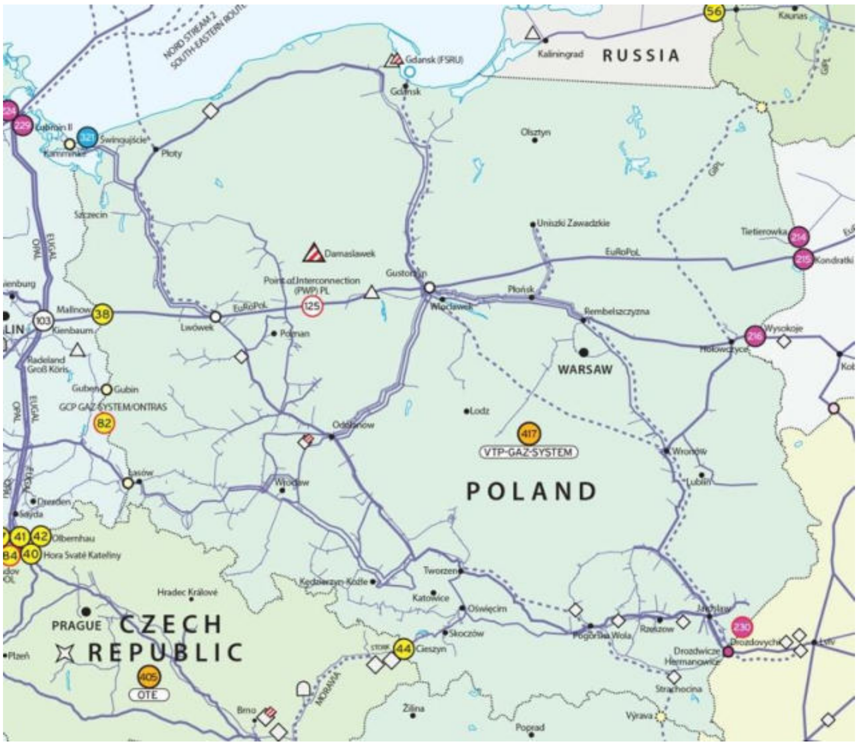
There are seven cross-border entry points into the transmission network that are located in GCP GAZ-SYSTEM/UA TSO (formerly Drozdowicze - Ukraine), Point of Interconnection (Lwówek and Włocławek on the Yamal-Europe Pipeline), GCP GAZ-SYSTEM/Ontras (Germany), Cieszyn (Czech Republic), Vyrava (Slovakia), Santaka (Lithuania), FAXE (Denmark – Baltic Pipe). As of June 2016, the transmission system in Poland can also be supplied via the LNG Terminal in Świnoujście (7,2 bcm/y). Local production (4 bcm/y in 2021) shows a historical decreasing trend due to the decline of domestic sources, not sufficiently offset by new production developments. Storage system is composed of seven facilities with a total working gas volume of 3,231 bcm. In 2021, natural gas consumption (high-methane gas) amounted to 20,8 bcm (including gas export and storage injection) and it is expected to rise in the following years (excluding 2022).

Due to historical circumstances, the Polish transmission system was focused on gas supplies from the Eastern direction, and the supplies from Russia were clearly dominant in the import structure. Currently, the situation has changed thanks to investments in the transmission system and the expansion of cross-border connections such as PL-LT, PL-SK, PL-DK(Baltic Pipe).

Completed by GAZ-SYSTEM and ENERGINET in October 2022 Baltic Pipe project provides Poland with a direct access to Norwegian supplies. Baltic Pipe, in conjunction with the expansion of the domestic transmission infrastructure and the construction of two new cross-border interconnections with adjacent systems (SK, LT) provides the basis for a secure and competitive gas market in the CEE and Baltic regions.

Currently, Polish main priorities are the expansion of the LNG Terminal in Świnoujście and construction of FSRU Terminal in Gdańsk region. The LNG Terminal will be upgraded in order to increase the regasification capacity and provide a wider range of LNG services.

The purpose of the FSRU Terminal project is to create an infrastructure that will enable the off-take of additional volumes of liquefied natural gas delivered by sea, their subsequent regasification and delivery to the National Transmission System. The investment involves the location of a floating FSRU (Floating Storage Regasification Unit) in the Gdańsk region. FSRU Terminal could be designed to provide regasification capacity at the level corresponding to about 6.1 bcm of gaseous fuel per year. In addition, at this stage it is still assumed that the regasification capacity can be increased depending on market development and growth in demand for natural gas in the country and region. As part of the program, the expansion of the national transmission system is also planned, which will enable effective distribution of gas from the Gdańsk region to customers in Poland and in the region. For the capacity of the new terminal to be fully utilized, the construction of new gas transmission pipelines is required.


RUSSIA
POLAND
WARSAW
CZECH REPUBLIC
PRAGUE
VTP-GAZ-SYSTEM
OTE
EuRoPoL
Gdansk (FSRU)
Gdansk
Kaliningrad
Olsztyn
Damaslawek
Point of Interconnection (PWP) PL
Wloclawek
Plonsk
Rembelszczyzna
Tietierowka
Kondratki
Wysokoje
Mallnow
Lwówek
Gubin
GCP GAZ-SYSTEM/ONTRAS
Lodz
Lublin
Hradec Králové
Katowice
Oświęcim
Skoczów
Cieszyn
Drozdowicze
Strachocina
Poprad
Žilina
Brno

Romania

The National Transmission System (NTS) was conceived as an interconnected radial-ring system, being developed around and starting with the large natural gas deposits in Transylvania Basin, Oltenia and then East Muntenia (south of the country). Destined were the large consumers in the Ploiesti area - Bucharest, Moldova, Oltenia, as well as the central (Transylvania) and northern parts of the country.

Subsequently, natural gas flows have undergone significant changes due to the decline of sources in the Transylvanian Basin, Moldova, Oltenia and the emergence of other sources (imports, OMV-Petrom, concessions made by third parties, etc.), given that the natural gas transmission infrastructure remained same.

The main components of the National Gas Transmission System as of 31.12.2021:

- 14,209.55 km main transport pipelines and natural gas supply connections, out of which 183.5 km international natural gas pipelines (T3);
- 1141 measuring stations for measuring natural gas (SRM) - (1,237 247 measuring directions);
- 58 valve control stations (SCV, NT);
- 7 gas measuring stations for import and export;
- 2 measuring stations located on the international natural gas pipelines (SMG);
- 8 natural gas compressor stations (SCG), with an installed power of approx. 70.2 MW;
- 1,045 cathodic protection stations (SPC);
- 1,026 natural gas odorous stations (SOG).

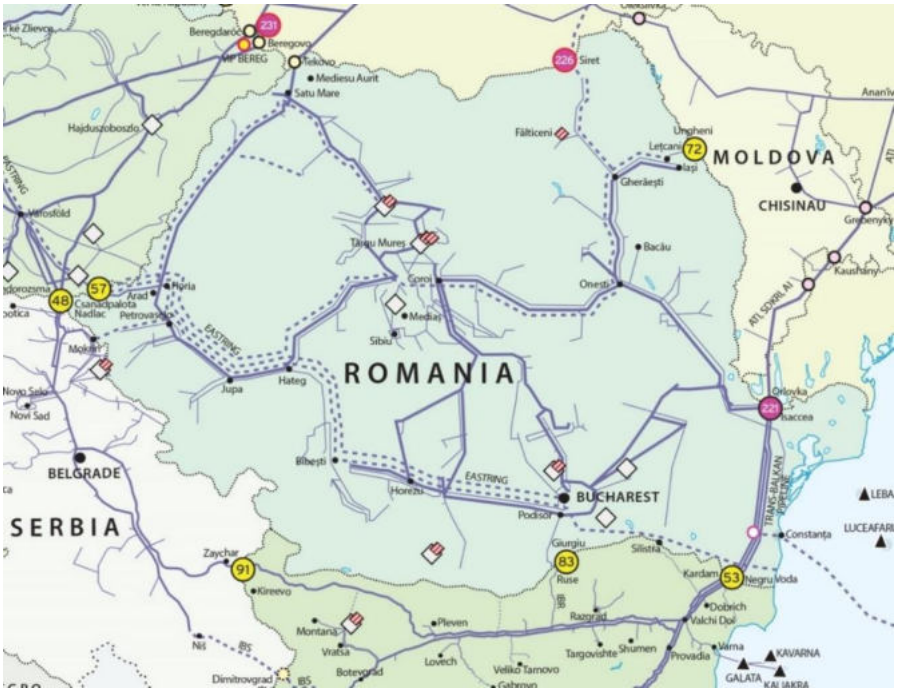
The National Transmission System is represented by the set of main pipelines, as well as their installations, equipment and endowments, used at pressures between 6 bar and 63 bar, which ensures the taking over of natural gas extracted from the production perimeters or those coming from import and their transport in order to be delivered to the participants on the internal market of natural gas, export, international transport, etc.

At the end of 2020, the modernization of the measuring stations Isaccea I (new station) and Negru Vodă I was completed, giving the possibility of a bidirectional flow of natural gas on the T1 international transport pipeline. At the same time, the connection of the T1 pipeline to the NTS (through Isaccea) was completed, thus being possible both the delivery of natural gas from the T1 pipeline to the NTS and the delivery of natural gas from the NTS to the T1 pipeline at a maximum level of 6.3 Mil Sm3 / day , which will be offered in concurrent capacity (not all conditions are currently met in order to offer this concurrent capacity).

At the end of 2021, the modernization of the measuring stations Isaccea II and Negru Vodă II was completed, giving the possibility of the bidirectional flow of natural gas on the T2 international transport pipeline. At the same time, the connection of the T2 pipeline with the T1 pipeline and implicitly to the NTS (through Isaccea) was completed, thus making it possible to deliver natural gas from the T2 pipeline to the NTS. The national network has cross-border interconnection points with Moldova (Ungheni), with Ukraine (Orlovka/Isaccea and Mediesul Aurit/Tekovo), with Bulgaria (Negru Voda/Kardam and Giurgiu/Ruse) and with Hungary (Csanapadlota/Nadlac).

In 2021 natural gas consumption amounted to 129,33 TWh, against a domestic production of 93,52 TWh; total storage capacity amount to 32,97 TWh.

	2021		
	Actual data		
	Protected customers		Non protected customers
	Protected customers of solidarity	Rest	
Gas consumption (bcm)	**11,33**		
Residential	3,18	-	-
Commercial	0,78	-	
District heating	1,05	-	
Industrial sector (electrical and thermal)	-	-	2,05
Chemical industry	-	-	1,02
Other industrial customers	-	-	0,52
Other secondary customers	-	1,53	
Third party suppliers	-	-	0,36
Technological consumption related to the gas sector activities	-	-	0,85
Energy consumption related to the gas sector activities	-	-	0,004
Peak demand (mcm/d)	**72**		
Residential	16,69	-	-
Commercial	4,88	-	
District heating	6,03	-	
Industrial sector (electrical and thermal)	-	-	10,57
Chemical industry	-	-	9,06
Other industrial customers	-	-	4,96
Other secondary customers		8,51	
Third party suppliers	-	-	4,30
Technological consumption related to the gas sector activities	-	-	6,98
Energy consumption related to the gas sector activities	-	-	0,02



Slovakia

The total gas transmission, for the total length of the gas transmission network of almost 2,270 km, amounts to 60.6 bcm. Due to the amount of transported gas eustream remains one of the most important TSO based on the volume of gas transported within the EU.

Five compressor stations are part of the transmission network – Veľké Kapušany, Jablonov nad Turňou, Veľké Zlievce and Ivanka pri Nitre and Lakšárska Nová Ves – which provide a pressure differential needed for the flow of gas with a total output of 600 MW. The total transmission capacity of the network is more than 90 bcm per year. Natural gas from the transmission network in the defined territory gets through intrastate stations into the distribution networks and is transported to the final customers. On 30 November 2011 implementing measures were completed that allow reverse flow within the transmission network in Slovakia. In this mode it is possible to transport in the west – east direction the amount of gas that is higher than the highest consumption in Slovakia in the winter months. Slovakia interconnection with neighboring countries on the level of transmission networks currently exists with Austria [border point Baumgarten], Czech Republic [border point Lanžhot], Hungary [border point Veľké Zlievce] and Ukraine [border point Veľké Kapušany and border point Budince]. Interconnection with the Czech Republic since 2009 and with Austria since 2010 are prepared so that it will be possible in case of crisis situation (emergency level respectively) to ensure physical reverse flow of gas to Slovakia. Since November 2022 the Slovak – Polish interconnector started its commercial operation. Slovakia is now connected to all neighboring countries and their transmission systems.

Slovakia has in its territory several geological formations which are suitable for construction of underground gas storage facilities. Currently there are two companies active on the market, that are storage system operators - NAFTA a.s., Bratislava and POZAGAS a.s., Malacky. Total storage capacity in Slovakia is 3.66 bcm, which represents more than 65% (based on 2021 data) of total consumption . The facilities are located in the southwestern part of the country near the border with Austria and the Czech Republic.

According to the available data the share of natural gas in the electricity production was 15 % in 2021.

In 2021 natural gas consumption amounted to 58,81 TWh, against a domestic production of 0,63 TWh; total storage capacity amount to 41,53 TWh.


STORK
44
Cieszyn
MORAVIA
Brno
Žilina
Poprad
Drozdwicze
Hermanowice
Strachocina
Výrava
SLOVAKIA
Dolní Bojanovice
59
Břeclav
Lanžhot
45
Kúty
Zvolen
Jablonov
Nad Turňou
Košice
218
Uzhgorod
Budince
71
Veľké Kapušany
Lakšárska Nová Ves
Láb
60
46
Nitra
Ivánka Pri Nitre
Veľké Zlievce
231
Beregdaróc
BRATISLAVA
Selešťany
75
Balassagyarmat
Kittsee
VIP BEREG
47
Mosonmagyaróvár
Győr
Szada
EASTRING
Hajduszoboszlo

Slovenia

The Slovenian transmission network has cross-border interconnections with Austria (Murfeld/Ceršak interconnection point), with Italy (Gorizia/Šempeter) and with Croatia (Rogatec).

Slovenian gas system has no storage facilities nor any local gas production. The gas network was put into use 1978 and further developed over its lifetime. Slovenia uses approximately between 0.9 and 1 billion cubic meters of natural gas annually, accounting for about 13 percent of the country's final energy consumption. Most of gas was supplied on a short-term basis from Central European Gas Hub. A minor portion was supplied through a long-term contract from Russia until early 2022. Slovenian companies depend on infrastructure in Austria, Italy and Croatia. Slovenia has expressed interest in securing LNG sources via terminals in Krk, Croatia, or Rovigo, Italy, to diversify its supply away from Russia. Various projects and investments are planned to develop the gas network. Two corridors are envisaged, one of them Croatia – Slovenia – Austria, which would enable gas transport from enlarged LNG terminal at Krk. In Slovenia this project requires investments into both interconnectors, Rogatec and Ceršak, and an enlargement of Kidričevo compressor station. The second corridor connects Hungary – Slovenia – Italy. The pipeline would run from Kozármisleny to Nagykanizsa, Tornyiszentmiklós, Lendava, Kidričevo, Ajdovščina, Šempeter, Gorizia. It is listed in 10-year natural gas development plans for Slovenia and Hungary. In Slovenia the gas interconnector consists of two sections: repurposing of Šempeter-Vodice Gas Pipeline and building a new gas pipeline Pince-Lendava-Kidričevo. Both corridors would be hydrogen ready.

In 2021, the total natural gas consumption amounted to 10,13 TWh, out of which 8,20 TWh by the non-household customers, i.e. industry and services which are not protected customers. Protected customers consumed 1,95 TWh of gas. Household consumption was 1,31 TWh. The structure of gas consumption in the year 2021 is representative.

Use of gas in the electricity mix is very specific. Both larger gas fired power plants are only used for peak power production and auxiliary services for the electricity system. In addition, they both have fuel switching capability which they efficiently utilise. They play a very important role for the operation of electricity, system, for which they consume very small gas volumes. The largest gas power plant consumed only 4,63 mcm of gas in that year, the others even less.

Sweden

There is no extraction of natural gas in Sweden and the entire volume of consumed natural gas is imported from Denmark via pipeline. The Swedish transmission system for natural gas begins in Dragør in Denmark, crosses the Öresund strait via the Öresund pipeline to Klagshamn south of Malmö, from where the trunk pipeline heads northward to Stenungsund. The technical capacity of the Öresund trunk line is 8.6 mcm/d and the technical capacity of the entry point of Dragør (in Denmark) is 8.6 mcm/d. The natural gas network consists of approximately 620 km of transmission lines and roughly 2 700 km of distribution lines. Branch pipes lead off from the trunk pipeline to various consumption areas.

Sweden has a biogas production and small volumes of biogas with a quality equal to natural gas is injected into the distribution systems. The total production of biogas in Sweden is around 2 TWh per year and amounted to 2.2 TWh in 2021. The produced biogas is mainly consumed in transportation where over half is used. Sweden is also a world leader in liquefied biogas technology (LBG), although this is still represented by very low figures of production in pilot plants.

The gas flow in the Öresund pipeline is one-way from Denmark to Sweden. Today it is not technically possible to reverse the flow so that gas flows from Sweden to Denmark. Sweden has no natural gas production or any significant gas storage, nor is network connected biogas production significant, although network connected biogas production will gradually increase according to decisions and plans.

Sweden has an exemption from the N-1 infrastructure criteria in the regulation as well as the criteria for reverse flows. Despite the exemption from the N-1 criteria the Swedish Energy Agency still preforms the calculation to give an indication of the supply situation in case of an N-1 event. The calculated area is the geographic area supplied with gas through the Swedish natural gas system. For Sweden, the result is 15.8 per cent due to limited domestic biogas production, one small storage facility and a single route of supply.

The Swedish natural gas market is relatively small when compared to other European markets. During the gas year 2021/2022, the final consumption of natural gas in the western Swedish natural gas system was 8 097 GWh and corresponds to roughly 2 per cent of total energy demand in Sweden.

The maximum demand for gas in Sweden is estimated to be 7,2 MNm3/day on a cold winter day (-15 degree Celsius). Furthermore, the maximum demand for a month is estimated to be 124 MNm3. Gas demand in summer is significantly lower than winter demand. Household use about 2 per cent of the gas. Industries or other similar activities (including district heating and transports) are the main consumers.


NORWAY
SWEDEN
OSLO
STOCKHOLM
Karlstad
Örebro
Västerås
Fredrikstad
Stokke
Rafnes
Marlestad
Lidköping
Linköping
Norrköping
Mjölby
Lysekil
Uddevalla
Strömstad
Skagerrak
Göteborg
Jönköping
Gnosjö
GOTLAND
Kattegat
Varberg
Halmstad
Ljungby
Kalmar
DENMARK
COPENHAGEN
Kristianstadt
Helsingborg
Malmö
Trelleborg
Ystad
Baltic Sea
BALTIC PIPE
NORD STREAM 2
NORTH-WESTERN ROUTE

Infrastructure Standard

As provided for by article 5.5 of the Regulation, the competent authorities of relevant Member States may agree to provide the calculation of the N – 1 formula at regional level in the common risk assessment (art. 7), following the provisions of point 5 of Annex II of the Regulation.

The N – 1 formula describes the ability of the technical capacity of the gas infrastructures to satisfy total gas demand in the calculated area in the event of disruption of the single largest gas infrastructure during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years (Dmax).

As provided for by Annex II of the Regulation, for the calculation of the "N – 1 formula at regional level", the single largest gas infrastructure of common interest shall be used; the single largest gas infrastructure of common interest for the Eastern gas supply risk group Ukraine is Uzhgorod interconnection point.

The formula used for the calculation of the "N – 1 formula at regional level" is the one provided by the point 4 of Annex II "Calculation of the N – 1 formula using demand-side measures":

$$N-1[\%]=\frac{EP_m+P_m+S_m+LNG_m-I_m}{D_{\max}-D_{eff}}\times 100, N-1\geq 100\%$$

The terms of the formula have been calculated as follows:

EP_m	*Technical capacity of entry points (in GWh/d), other than production, LNG and storage facilities covered by Pm, LNGm and Sm, means the sum of the technical capacity of all border entry points capable of supplying gas to the calculated area.*
P_m	*Maximal technical production capability (in GWh/d) means the sum of the maximal technical daily production capability of all gas production facilities which can be delivered to the entry points in the calculated area.*
S_m	*Maximal technical storage deliverability (in GWh/d) means the sum of the maximal technical daily withdrawal capacity of all storage facilities which can be delivered to the entry points of the calculated area, taking into account their respective physical characteristics.*
LNG_m	*Maximal technical LNG facility capacity (in GWh/d) means the sum of the maximal technical daily send-out capacities at all LNG facilities in the calculated area, taking into account critical elements like offloading, ancillary services, temporary storage and re-gasification of LNG as well as technical send-out capacity to the system.*
I_m	*Technical capacity of the single largest gas infrastructure (in GWh/d) with the highest capacity to supply the calculated area. When several gas infrastructures are connected to a common upstream or downstream gas infrastructure and cannot be separately operated, they shall be considered as one single gas infrastructure.*

D_{max}	*The total daily gas demand (in GWh/d) of the calculated area during a day of exceptionally high gas demand occurring with a statistical probability of once in 20 years.*
D_{eff}	*The part (in GWh/d) of Dmax that in the case of a disruption of gas supply can be sufficiently and timely covered with market-based demand-side measures.*

Tables below are calculated taking into account the following hypothesis:

- interruption of Velké Kapušany-Uzhgorod entry point as the single largest infrastructure (Im) as requested by the SOS regulation;
- total disruption of Russian gas. Even if not requested by the Regulation, this is the relevant scenario which we may incur in;
- forthcoming LNG regasification plants sensitivity

As provided by the Regulation, the N-1 formula has been computed taking into account the 100% of underground storage working gas volume.

Even If in each case the index results far above the 100%, given the actual rerouting of the main gas supply flows following the February 2022 invasion of Ukraine by Russia, the result doesn't mean that regional gas infrastructures are properly dimensioned in order to cover maximum demand of the involved Member States.

However, N-1 index doesn't take into account possible existence of internal bottlenecks or problems induced by malfunctioning of internal interconnection points or due to lack of available capacity to attract gas. All these risks are evaluated in the following risk analysis.

The following tables summarise the data set used for N-1 formula calculation.

Table 1: N-1 calculation and results

					With forthcoming LNG			
	2022	**2022-09**	**No RU* 2022**	**No RU* 2022-09**	**2022**	**2022-09**	**No RU* 2022**	**No RU* 2022-09**
N-1	**189,7%**	**189,7%**	**166,7%**	**166,4%**	**194,6%**	**194,7%**	**171,7%**	**171,4%**
D_{max}	14554,31	14554,31	14554,31	14554,31	14554,31	14554,31	14554,31	14554,31
EP_m	13692,60	13702,00	10352,70	10310,90	13692,60	13702,00	10352,70	10310,90
P_m	729,09	729,09	729,09	729,09	729,09	729,09	729,09	729,09

S_m	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61	14022,61
LNG_m	1072,29	1072,29	1072,29	1072,29	1794,66	1794,66	1794,66	1794,66
I_m	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60	1913,60
D_{eff}	0	0	0	0	0	0	0	0

* In this particular case, capacities of IPs that carried mostly Russian gas and no longer have physical flow (Greifswald, Kondratki, Tieterowka, Wysokoje, Orlovka) were removed and they were not considered as the largest regional infrastructure. It should be noted that the Drozdovichi (UA-PL) and Uzgorod-Velké Kapušany (UA-SK) points still show flows. Velké Kapušany remains the largest capacity infrastructure.