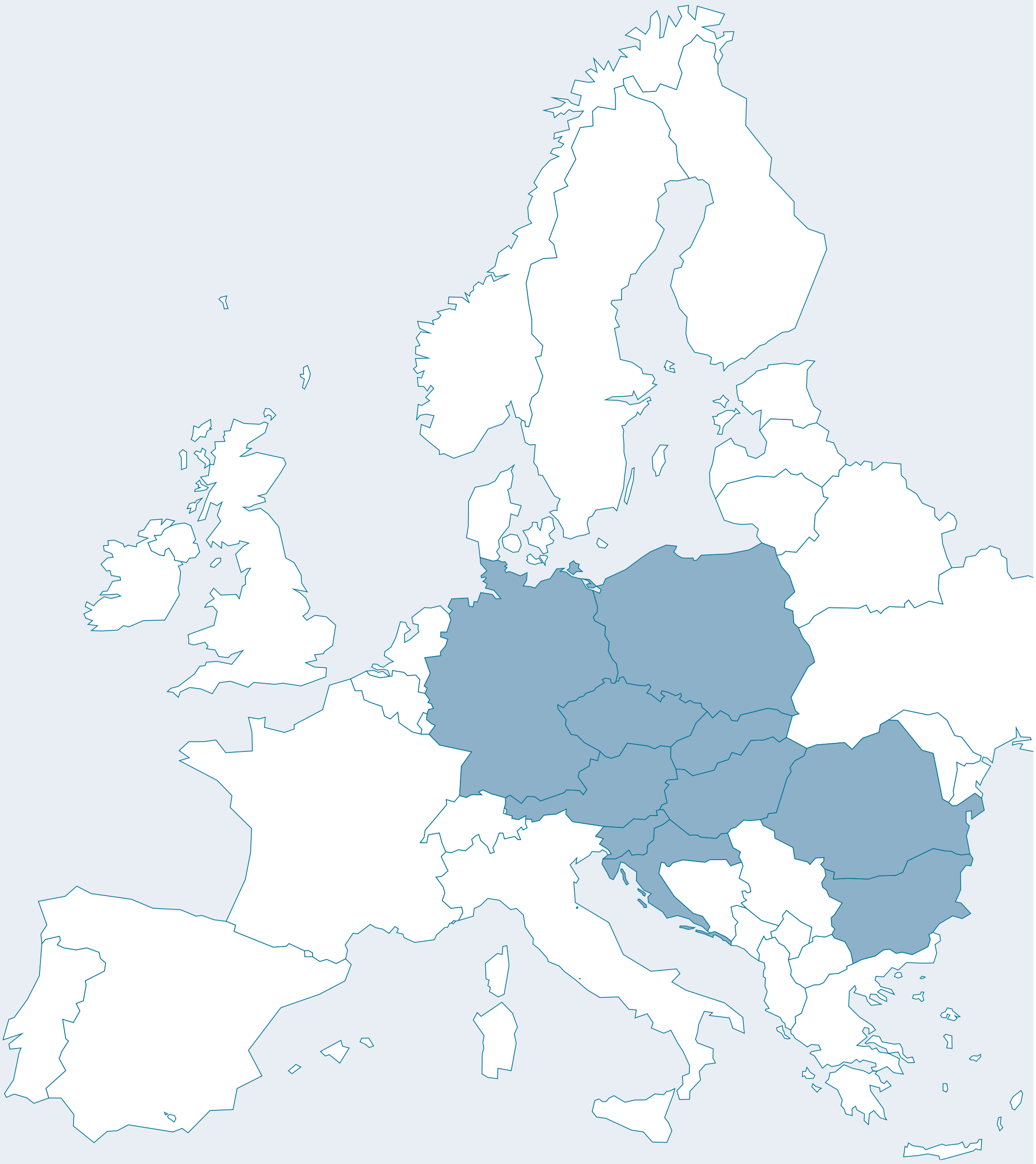
CENTRAL-EASTERN EUROPE GAS REGIONAL INVESTMENT PLAN

2021

CENTRAL-EASTERN EUROPE

Cover picture courtesy of eustream



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FOREWORD

Dear reader,

It is a pleasure for us to present you the outcome of the co-operation of involved transmission system operators in the Central and Eastern Europe, the fifth edition of the regional investment plan.

We are facing the climatic challenges voiced via European Commission's program of European Green Deal. The transmission system operators are ready to take their part in the decarbonisation process by means of introducing new type of infrastructure projects.

The current edition of the CEE GRIP builds on the previous CEE GRIPs editions and also on the ENTSOG TYNDP 2020 providing an overview of infrastructure projects in the region that are either planned or under construction.

The region is still exposed to some security of supply risks, but over the years significant improvements in this respect have been achieved as many planned projects have already been commissioned. The development of the gas infrastructure has significantly encouraged the market integration within the region.

Special emphasis of the document is put on the role of the decarbonisation efforts in the CEE region and role of gas infrastructure. This topic is important especially in time when European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy is getting under its way. We do think that gas and the gas infrastructure in the countries of the CEE region will still play the important role in the upcoming decades in order to support the energy transition.

The coordination of this document was facilitated by eustream, a.s. (Slovakia). As this document is the outcome of common work, we would like to thank all colleagues from participating TSOs involved in the CEE GRIP process for their beneficial support and active work.

The CEE GRIP working group will be launching a post-publication consultation on the CEE GRIP and that is why we would like to encourage all stakeholders and other interested parties to provide their proposals and comments in the upcoming open public consultation process.

Coordination team of eustream, a.s.

EXECUTIVE SUMMARY

Planning and development of gas infrastructure are vital for meeting the obligations under EU Directive 2009/73/EC, and these are further detailed in Regulation (EC) 715/2009. The fifth edition of the Gas Regional Investment Plan for Central and Eastern Europe (CEE GRIP) is strongly linked with the EU-wide Ten-Year Network Development Plan 2020 (TYNDP 2020). A harmonised data set is used for developing both reports in parallel. The CEE GRIP supports and complements the TYNDP 2020. The CEE GRIP is presented based on analyses in light of the possible evolution of gas infrastructure with a focus on specific regional matters.

The CEE region consists of 10 countries (Austria, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia).

The following summary sets out key outputs of this CEE GRIP. The findings are provided in three main sections, depending on the subject of analysis:

Infrastructure projects in the CEE region

- In total, there are 109 gas infrastructure projects planned for implementation in the CEE region in the upcoming decade. For the first time new sort of projects is being introduced – energy transition related projects ([ETR]; hydrogen, reduction of methane emissions).
- 24 projects have already reached a final investment decision (FID) and 85 projects are at an earlier stage of development (non-FID).
- There are 15 projects that have been commissioned in the CEE countries since the release of the fourth edition of the CEE GRIP. These projects contributed to the improved diversification of gas supply sources and infrastructure integration.
- Majority of the projects are transmission pipelines projects – 77, others are 5 LNG projects, 8 UGS projects and 19 ETR projects.

CEE GRIP Regional N-1 Analysis

- The CEE GRIP Regional N-1 analysis covers gas supply disruption cases through Ukraine and Belarus for the winter and summer periods. The assessment is based on the N-1 methodology according to Regulation (EU) 2017/1938, which was adjusted to enable the application to be used for the CEE GRIP purposes.
- In the winter period 2021/2022 under the Ukrainian gas route disruption case Poland does not meet the basic N-1 criterion (the result has to be equal to or greater than one) due to increased daily maximum demand by more than 1/3 between years 2017 and 2021. The implementation of planned infrastructure projects in upcoming years can solve this situation.
- Due to geographical reasons, the disruption of supplies via Belarus only affects Poland, but the assessment indicates a decreasing dependency over the entire time span for both winter and summer periods.
- Almost all countries in the CEE region obtain satisfactory N-1 calculation results in the summer period, as each country is able to cover its own gas demand and meet the injection requirements of underground storage facilities when the two analysed disruption cases are considered. With regard to the main findings, we can enumerate the following situations:

  – For Hungary and Austria during the Ukraine disruption scenario in summer 2021, such a disruption could cause a lack of filling the underground storage facilities, in case the disruption lasts longer than 66 days (Hungary) or 150 days (Austria).

  – All these identified problems would be fully solved by the commissioning of the planned projects in the following years.

Decarbonisation in the CEE Region

- In most cases, due to their transit character and historical circumstances, countries of the CEE region have natural gas in their energy mixes. For decades, in the vast majority of cases, it has been complementary to the fuel dominating in the national economy such as coal or nuclear energy.

- Natural gas will be a transitional fuel in the process of transition to the zero-carbon economy, and at the same time, it can lead to both improved energy efficiency and lower energy efficiency costs compared to other conventional technologies.

- The countries of the CEE region see the need to use new low-carbon gases, recognising that their scale-up will vary depending on national conditions and the different starting points regarding each country's energy mix. Many countries are in the process of defining their pathways toward the final goal – decarbonisation of the energy economy. There are being developed the fundamental political/strategic documents that recognise the hydrogen and other low carbon gases as a future energy carrier.

- Many countries in the CEE region already developed strategies how to implement hydrogen into their decarbonised future, existing infrastructure after needed adaptation should be part of the success story.


Picture courtesy of Gas Connect Austria

1 INTRODUCTION

The Gas Regional Investment Plans (GRIPs) are being prepared as requirements to promote regional cooperation, which is enshrined in EU Directive 2009/73/EC, Article 7 and further detailed by REG 715/2009, Article 12. This report represents the fifth edition of the Gas Regional Investment Plan for Central and Eastern Europe (CEE GRIP) and provides a specific regional view of supply, demand, and capacity developments in the CEE region for the upcoming decade.

The aim of this report is to support and add to the previously published EU-wide TYNDP 2020 prepared by the European Network of Transmission System Operators for Gas (ENTSOG). The goal is to provide additional information focusing on the CEE region and to emphasize the regional gas infrastructure outlook by assessing the basis for identification of potential future gas infrastructure needs in the region. This CEE GRIP edition is fully based on a harmonised data set, as was used for developing the TYNDP 2020. This ensures consistency between these two reports. Due to the fact that the CEE GRIP is published after the TYNDP 2020, the transmission system operators (TSOs) contributing to the CEE GRIP took the opportunity to present the updated commissioning years of the infrastructure projects planned in this region. If any modifications to the source data from the TYNDP 2020 were used in this report, they are clearly explained in the text of specific chapters and annexes. The difference between the TYNDP 2020 and the CEE GRIP is also in the time period analysed. While the TYNDP 2020 looks 20 years ahead due to REG 347/2013, the CEE GRIP focuses on a 10-year timeline to provide more precise information about the near future.

Beyond the TYNDP 2020, the CEE GRIP provides an additional overview of broader gas market dynamics by looking at aspects linked to supply scenarios, market integration, and the security of supply (SoS) on the regional level. The key analysed areas which formed the main focus of this report are:

- The future development of gas transmission infrastructure in the CEE region
- CEE GRIP Regional N-1 analysis up to a 10-year time frame
- A detailed focus on the decarbonisation efforts in the CEE region

The general methodological approach used in the CEE GRIP is based on the one used in the TYNDP 2020. For analyses and results carried out beyond the focus of the TYNDP 2020, the description of the specific methodology used is detailed in the respective chapters concerned. The status and all data used in the report reflect the best information available at the moment of collection. Through the present document, the CEE TSOs support the exchange of valuable information and analysis for all implied actors and assist the market in assessing gas infrastructure needs in the CEE region.

TSOs CONTRIBUTING TO THE CEE GRIP

The CEE GRIP region covers 10 countries, with the involvement of 17 TSOs. The complete list of countries and TSOs contributing to the CEE GRIP is presented in the table below.

Country	TSO(s)	
Austria	GAS CONNECT AUSTRIA GmbH	GAS CONNECT AUSTRIA
	Trans Austria Gasleitung GmbH	TAG Trans Austria Gasleitung
Bulgaria	Bulgartransgaz EAD	BULGARTRANSGAZ
Croatia	Plinacro d.o.o.	plinacro
Czech Republic	NET4GAS, s.r.o.	NET4GAS
Germany	Fluxys TENP GmbH	fluxys TENP
	GASCADE Gastransport GmbH	GASCADE
	Gasunie Deutschland Transport Services GmbH	gasunie Transport Services
	GRTgaz Deutschland GmbH	GRTgaz Deutschland
	ONTRAS Gastransport GmbH	ONTRAS
	Open Grid Europe GmbH	OGE
	terranets bw GmbH	terranets bw
Hungary	FGSZ Ltd.	FGSZ
Poland	Gas Transmission Operator GAZ-SYSTEM S.A.	GAZ system
Romania	Transgaz S.A.	TRANSGAZ MAGISTRALA ENERGIEI
Slovakia	eustream, a.s.	eustream SLOVAK GAS TSO
Slovenia	PLINOVODI d.o.o.	Plinovodi Connected through energy

Table 1.1: The list of TSOs contributing to the CEE GRIP

Work on this edition of the CEE GRIP was coordinated by eustream, a.s.

The CEE GRIP document was approved by following TSOs contributing to the CEE GRIP: GAS CONNECT AUSTRIA GmbH, Trans Austria Gasleitung GmbH, Bulgartransgaz EAD, Plinacro d.o.o., NET4GAS, s.r.o., Fluxys TENP GmbH, GASCADE Gastransport GmbH, GRTgaz Deutschland GmbH, ONTRAS Gastransport GmbH, Open Grid Europe GmbH, FGSZ Ltd., Gas Transmission Operator GAZ-SYSTEM S.A., Transgaz S.A. and PLINOVODI d.o.o.

2 INFRASTRUCTURE PROJECTS IN THE CEE REGION

The present chapter focuses on the infrastructure level and provides a comprehensive summary of projects that have been commissioned since the publication of the last edition of the CEE GRIP.

The chapter also gives an overview of gas projects planned for implementation in the upcoming decade. For the first time new group of projects is introduced – ETR projects. These projects are defined by TYNDP 2020 as projects which facilitate the integration of renewables, the achievement of decarbonisation and efficiency targets, reduction of air pollutants, sector coupling initiatives and, more generally, all projects specifically aimed at the energy system transformation for reaching sustainability goals. In order to reach the widest group of project promoters, the data set has been based on the process run by ENTSOG for the purpose of the TYNDP 2020. This ensures the full involvement of all relevant stakeholders, including the TSOs, SSOs, LSOs, and third-party project promoters in the region.

The EU energy policy aims to support the development of an internal energy market that guarantees secure, competitive, sustainable and affordable sources of energy for customers. Actions to support this policy are being undertaken in the gas sector. They focus on putting in place an appropriate regulatory framework and the adequate level of necessary infrastructure for both the present and the future. In relation to infrastructure activity, significant developments have taken place in the CEE region in recent years. This was primarily done by improving cross-border integration between individual countries, reinforcing internal network grids, and increasing physical diversification of gas supplies in the region.

Progress towards achieving a well-functioning and fully competitive gas market in the Central-Eastern Europe was made, but it is not yet complete. The region continues to be strongly dependent on Russian gas as its major gas supply source, and the north-south gas corridor is still under development nevertheless significant improvements were accomplished. The CEE TSOs also look for possibilities to contribute to the decarbonisation efforts in order to enhance the CEE regional gas markets in terms of a high level of security, competition, and liquidity.

Table 2.1 summarises investment projects that were included in the CEE GRIP 2019 and have been commissioned since the release of the last CEE GRIP report in January 2020.

Promoter	Name	Code
eustream	Capacity increase at IP Lanžhot entry	TRA-F-902
NET4GAS, s.r.o.	Capacity4Gas – DE/CZ	TRA-F-752
	Capacity4Gas – CZ/SK	TRA-F-918
Plinacro Ltd	CS 1 at the Croatian gas transmission system	TRA-F-334
	LNG evacuation pipeline Omišalj – Zlobin (Croatia)	TRA-F-90
LNG Croatia	LNG Terminal Krk	LNG-N-82
SNTGN Transgaz S.A.	Interconnection of the NTS with the DTS and reverse flow at Isaccea	TRA-F-139
	Development on the Romanian territory on the NTS (BG-RO-HU-AT Phase 1)	TRA-F-358
	Romania – Serbia Interconnection	TRA-A-1268
Trans Austria Gasleitung GmbH	TAG Reverse flow	TRA-F-954
FGSZ Ltd.	Romanian-Hungarian reverse flow Hungarian section 1st stage	TRA-F-286
Magyar Gáz Tranzit Zrt.	Development of Transmission Capacity at Slovak-Hungarian interconnector	TRA-N-636
GASCADE Gastransport GmbH	NOWAL – Nord West Anbindungsleitung	TRA-F-291
Gasunie Deutschland Transport Services GmbH	Embedding CS Folmhusen in H-Gas	TRA-A-951
bayernets GmbH, Open Grid Europe GmbH	CS Wertingen	TRA-F-340

Table 2.1: Investment projects commissioned after the publication of the CEE GRIP 2019

TSOs and other project promoters submitted a total of 109 investment projects within the geographical coverage area of the CEE GRIP in the TYNDP 2020. Comparing to the previous edition the number of projects increased by 19, mainly ETR projects. The CEE GRIP 2021 projects are planned to be commissioned in the upcoming decade.

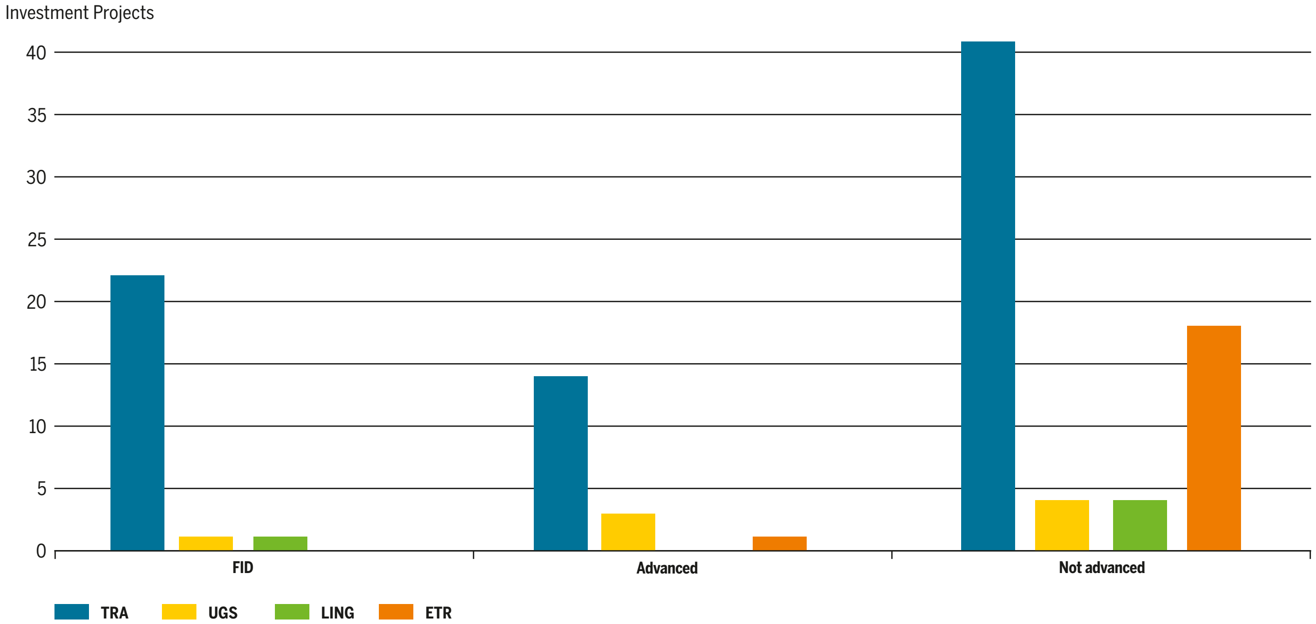


Figure 2.1: Investment projects included in the CEE GRIP by type and implementation status

Figure 2.2 displays more detailed split of the non-FID projects by their maturity status as defined by TYNDP 2020 – advanced status projects and non-advanced status projects

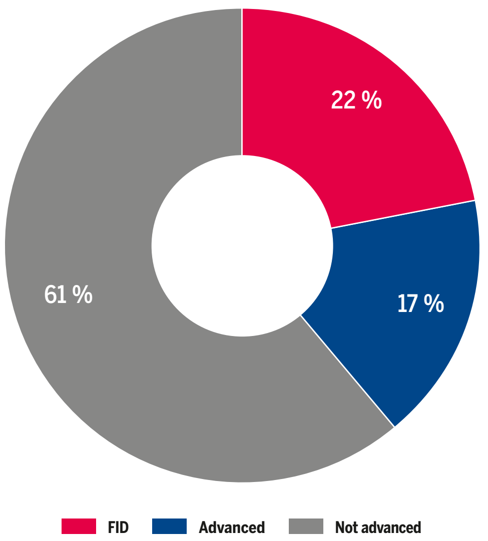


Figure 2.2: CEE GRIP – Project progress details

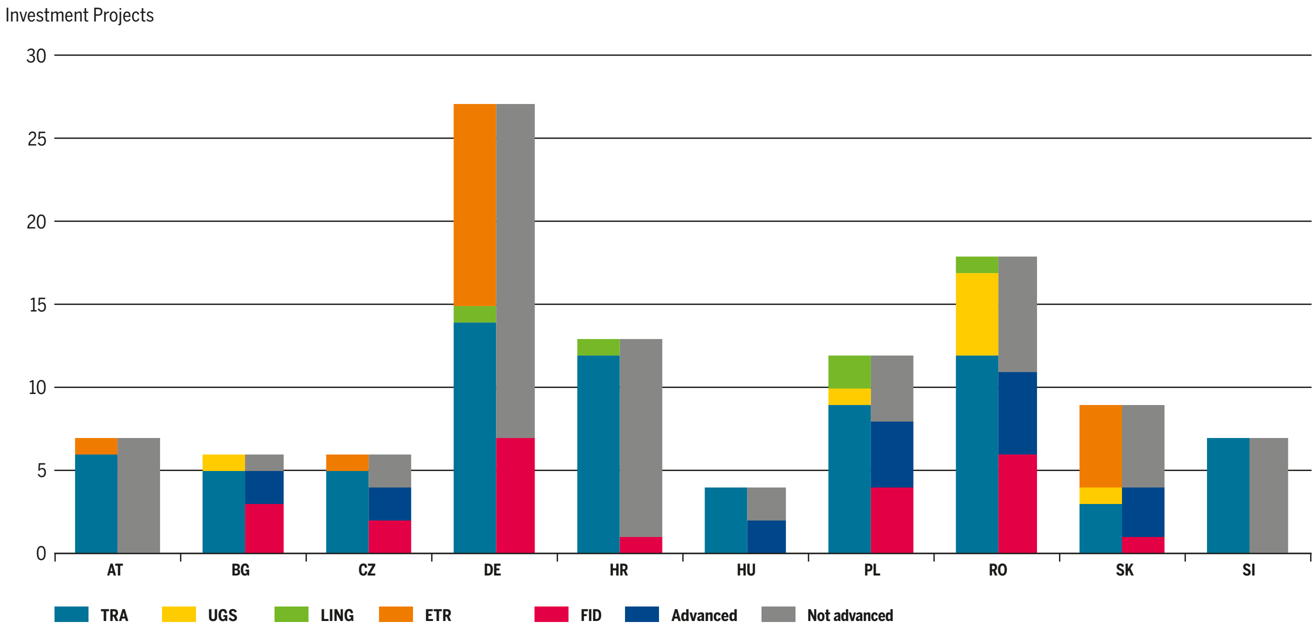


Figure 2.3: Investment projects included in the CEE GRIP by type and implementation status by country
Note: For Germany are counted only the projects promoted by the CEE GRIP participating TSOs.

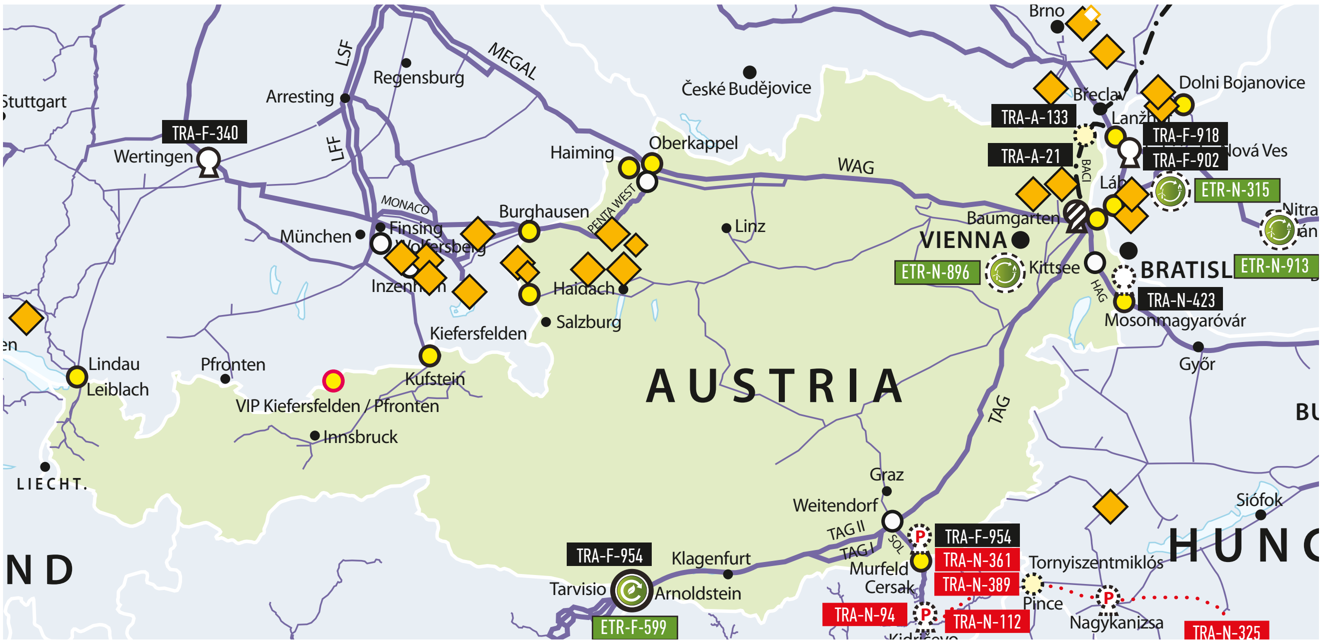
The following tables present the main information on the projects within the geographical coverage area of the CEE GRIP 2021. The current edition of the Gas Regional Investment Plans shall be based on the data used in the TYNDP 2020. However, the involved TSOs in the preparation of the CEE GRIP were given the opportunity to update the information about their projects submitted to the TYNDP 2020.

For the sake of clarity, the presented updates as of 1 July 2021 are incorporated to the assessments and analysis provided in the following chapters in this report.

More detailed data concerning these projects is available in the TYNDP 2020 Annex A.1.

AUSTRIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.



TYNDP 2020 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-N-954	TAG Reverse Flow	Trans Austria Gasleitung GmbH	2020	see Austrian Coordinated Network Development plan 2020**	No
TRA-N-361	GCA 2015/08: Entry/Exit Murfeld	GAS CONNECT AUSTRIA GmbH	2023	see Austrian Coordinated Network Development plan 2020**	Yes
TRA-N-021	Bidirectional Austrian-Czech Interconnector(BACI)	GAS CONNECT AUSTRIA GmbH	2024	see Austrian Coordinated Network Development plan 2020**	No
TRA-N-423	GCA Mosonmagyaróvár	GAS CONNECT AUSTRIA GmbH	2024	see Austrian Coordinated Network Development plan 2020**	No
ETR-N-896	P2G4A	GAS CONNECT AUSTRIA GmbH	Unknown	see Austrian Coordinated Network Development plan 2020**	No
N/A	Czech-Austrian Interconnector (CZATi)[a)]	GAS CONNECT AUSTRIA GmbH	–	see Austrian Coordinated Network Development Plan 2020**	No
N/A	GCA 2015/04: Entry Mosonmagyaróvár - Minimum[b)]	GAS CONNECT AUSTRIA GmbH	–	see Austrian Coordinated Network Development Plan 2020**	No

* Update of expected commissioning year reflects a situation as of 1 July 2021. ** German version available here

Table 2.2: List of projects in Austria

Notes:

a) A new project which reacts on a non-binding capacity demand received by companies GAS CONNECT AUSTRIA and NET4GAS in 2019 during the market demand assessment process for incremental capacity realized based on the Commission Regulation (EU) 2017/459.

b) A new project which reacts on a non-binding capacity demand received by companies GAS CONNECT AUSTRIA and FGSZ in 2019 during the market demand assessment process for incremental capacity realized based on the Commission Regulation (EU) 2017/459.

BULGARIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.

TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-N-137	Interconnection Bulgaria – Serbia	Bulgartransgaz EAD	2022	–	Yes
TRA-F-378	Interconnector Greece-Bulgaria (IGB Project)	ICGB a.d.	2022	–	Yes
TRA-F-298	Rehabilitation, Modernization and Expansion of the NTS	Bulgartransgaz EAD	2024	–	Yes
TRA-A-654	Eastring – Bulgaria	Bulgartransgaz EAD	2030	–	No
UGS-A-138	UGS Chiren Expansion	Bulgartransgaz EAD	2025	2024	Yes
TRA-F-592	Necessary expansion of the Bulgarian gas transmission system	Bulgartransgaz EAD	2022	2021	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.3: List of projects in Bulgaria

CROATIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.

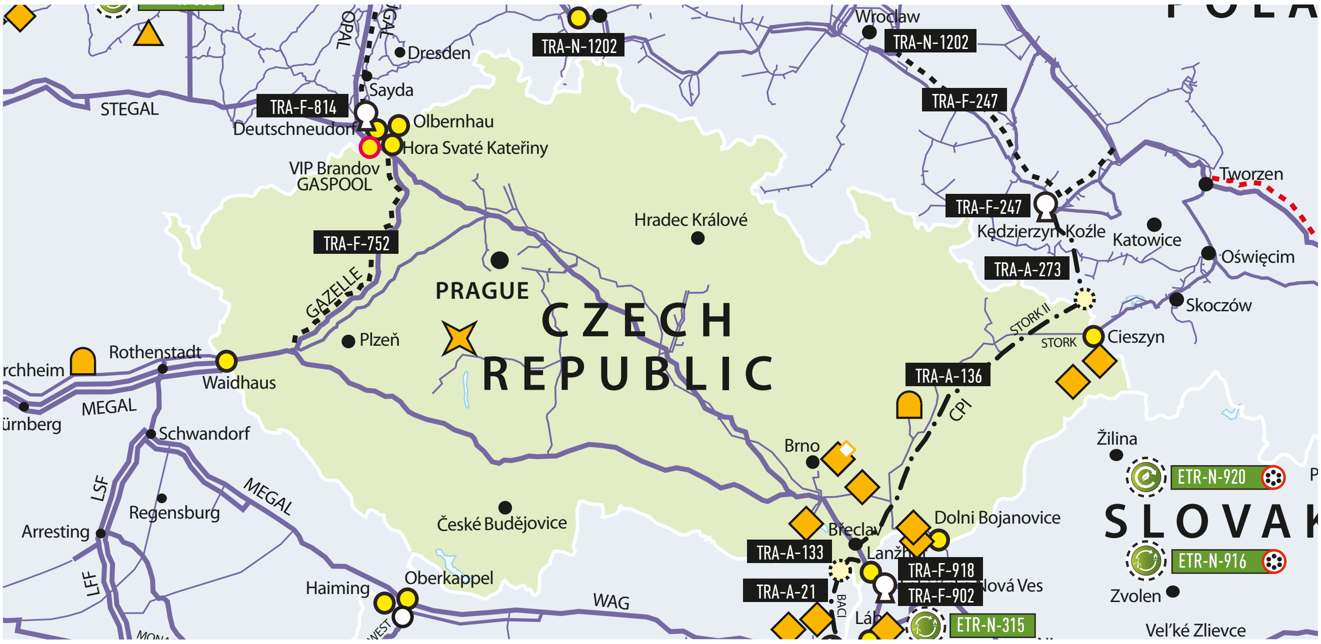
TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-F-334	Compressor station 1 at the Croatian gas transmission system	Plinacro Ltd	2019	–	Yes
LNG-N-82	LNG terminal Krk	LNG Hrvatska d.o.o.	2023	2020	Yes
TRA-N-90	LNG evacuation pipeline Omišalj – Zlobin (Croatia)	Plinacro Ltd	2019	2020	Yes
TRA-N-86	Interconnection Croatia/Slovenia (Lučko – Zabok – Rogatec)	Plinacro Ltd	2021	2026	Yes
TRA-N-66	Interconnection Croatia –Bosnia and Herzegovina (Slobodnica- Bosanski Brod)	Plinacro Ltd	2020	2026	No
TRA-N-75	LNG evacuation pipeline Zlobin-Bosiljevo-Sisak-Kozarac	Plinacro Ltd	2020	2028	No
TRA-N-1057	Compressor stations 2 and 3 at the Croatian gas transmission system	Plinacro Ltd	2022	2030	Yes
TRA-N-302	Interconnection Croatia-Bosnia and Herzegovina (South)	Plinacro Ltd	2021	2024	No
TRA-N-68	Ionian Adriatic Pipeline	Plinacro Ltd	2023	2025	No
TRA-N-70	Interconnection Croatia/Serbia (Slobdnica-Sotin-Bačko Novo Selo)	Plinacro Ltd	2023	Phase 1: 2025 Phase 2: 2028	No
TRA-N-1058	LNG Evacuation Pipeline Kozarac-Slobodnica	Plinacro Ltd	2023	2028	No
TRA-N-303	Interconnection Croatia-Bosnia and Herzegovina (west)	Plinacro Ltd	2027	2027	No
TRA-N-336	Interconnection Croatia/Slovenia (Umag-Koper)	Plinacro Ltd	2027	2030	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.4: List of projects in Croatia

THE CZECH REPUBLIC

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.



TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-A-136	Czech-Polish Gas Interconnector (CPI)	NET4GAS, s.r.o.	2023	on hold	No
TRA-F-752	Capacity4Gas (C4G) – DE/CZ	NET4GAS, s.r.o.	Phase 1: 2019 Phase 2: 2021	completed	No
TRA-F-918	Capacity4Gas (C4G) – CZ/SK	NET4GAS, s.r.o.	2019	completed	No
TRA-A-133	Bidirectional Austrian Czech Interconnection (BACI)	NET4GAS, s.r.o.	2024	on hold	No
ETR-N-306	Greening of Gas (GoG)	NET4GAS, s.r.o.	2023	–	No
N/A	Czech-Austrian Interconnection[a)]	NET4GAS, s.r.o.	–	2028	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.5: List of projects in the Czech Republic

Notes:

a) A new project which reacts on a non-binding capacity demand received by companies NET4GAS and GAS CONNECT AUSTRIA in 2019 during the market demand assessment process for incremental capacity realized based on the Commission Regulation (EU) 2017/459.

GERMANY

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.

TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-F-814	Upgrade for IP Deutschneudorf et al. for More Capacity	ONTRAS Gastransport GmbH	2023	–	No
ETR-N-562	Energy Park Bad Lauchstädt	ONTRAS Gastransport GmbH	2023	–	No
TRA-F-208	Reverse Flow TENP Germany	Fluxys TENP GmbH, Open Grid Europe GmbH	2018	2021	No
TRA-F-1271	Compressor Station Krummhoern	Open Grid Europe GmbH	2022	2022	No
TRA-F-763	EUGAL - Europäische Gasanbindungs-leitung (European Gaslink)	GASCADE GmbH/Fluxys Deutschland GmbH/GUD GmbH&Co.KG/ONTRAS GmbH	2020	2022	No
TRA-N-951	Embedding CS Folmhusen in H-Gas	Gasunie Deutschland Transport Services GmbH	2020	2026	No
TRA-N-808	Additional transport of gas volumes to the Netherlands	Gasunie Deutschland Transport Services GmbH	2025		No
TRA-F-329	ZEELINK	Open Grid Europe GmbH and Thyssengas GmbH	2023	2023	No
TRA-F-755	CS Rimpar	GRTgaz Deutschland GmbH and Open Grid Europe GmbH	2023	2023	No
TRA-N-809	Reallocation H-Gas towards NL: Bunde/Oude to Zone Oude Statenzijl H	Gasunie Deutschland Transport Services GmbH	2020	2022	No
TRA-N-955	GUD: Complete conversion to H-gas	Gasunie Deutschland Transport Services GmbH	2030		No
LNG-N-1198	LNG Terminal Brunsbüttel	Gasunie Deutschland Transport Service GmbH	2021	2024	No
TRA-N-1199	LNG Terminal Brunsbuettel - Grid Integration	Gasunie Deutschland Transport Service GmbH	2021	2024	No
TRA-N-1200	Expansion MS Hetlingen	Gasunie Deutschland Transport Service GmbH	2022	2024	No
TRA-F-1254	CS Elten	Open Grid Europe GmbH and Thyssengas GmbH	2022	2022	No
TRA-N-402	TENP Security of Supply	Fluxys TENP GmbH & Open Grid Europe GmbH	2024	2024	No
ETR-N-452	Element Eins	Thyssengas GmbH, Gasunie Deutschland Transport Services GmbH, Tennet TSO GmbH	–	–	No
ETR-N-616	Renewable Methane according to NEP2020 [a)]	Gasunie Deutschland Transport Services GmbH	2025	–	No
ETR-N-622	Renewable Hydrogen according to NEP2020 [b)]	Gasunie Deutschland Transport Services GmbH	2030	–	No
ETR-N-903	Conversion of Natural Gas pipelines to Hydrogen	Gasunie Deutschland Transport Services GmbH	2030	–	No
ETR-N-904	Hydrogen import via Oude [c)]	Gasunie Deutschland Transport Services GmbH	2030	–	No
ETR-N-406	hybridge - gas grid infrastructure	Open Grid Europe GmbH	2023	2023	No
ETR-N-633	GET H2-ETR 1	Nowega GmbH & Open Grid Europe GmbH	2022	2022	No

TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
ETR-N-911	Zevenaar (NL)/ Elten (DE) Capacity of Hydrogen according to the NDP	Thyssengas GmbH and Open Grid Europe GmbH	2029	2029	No
ETR-N-939	H2morrow Steel	Open Grid Europe GmbH; Thyssengas GmbH	2026	2026	No
ETR-N-948	New hydrogen pipeline projects of german gas NDP 2020–2030	Nowega GmbH; Open Grid Europe GmbH; Thyssengas GmbH	2030	2030	No
ETR-N-952	Hydrogen pipeline system conversion projects of german gas NDP 2020–2030	Open Grid Europe GmbH	2030	2030	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.6: List of projects in Germany[1]

Notes:

a) The NDP will include two concrete scenarios for the integration of renewable gas:

- For 2025 a market survey was performed by the German TSOs to collect concrete projects for the supply of renewable gas from the use of P2G. Projects could either provide directly hydrogen or methane via an additional methanation process.
- For 2030 a total of 7.5 GW_el of P2G will be considered. The German TSOs see large need for P2G installations for an efficient path towards 2050. This scenario should support the ramp up of the development.

This project is covering the renewable methane infeed from P2G as envisioned in the NDP 2020. It covers in the "market survey"-path the total supply from renewable gas projects, that have not been put individually into the TYNDP.

b) The NDP will include two concrete scenarios for the integration of renewable gas:

- For 2025 a market survey was performed by the German TSOs to collect concrete projects for the supply of renewable gas from the use of P2G. Projects could either provide directly hydrogen or methane via an additional methanation process.
- For 2030 a total of 7.5 GW_el of P2G will be considered. The German TSOs see large need for P2G installations for an efficient path towards 2050. This scenario should support the ramp up of the development.

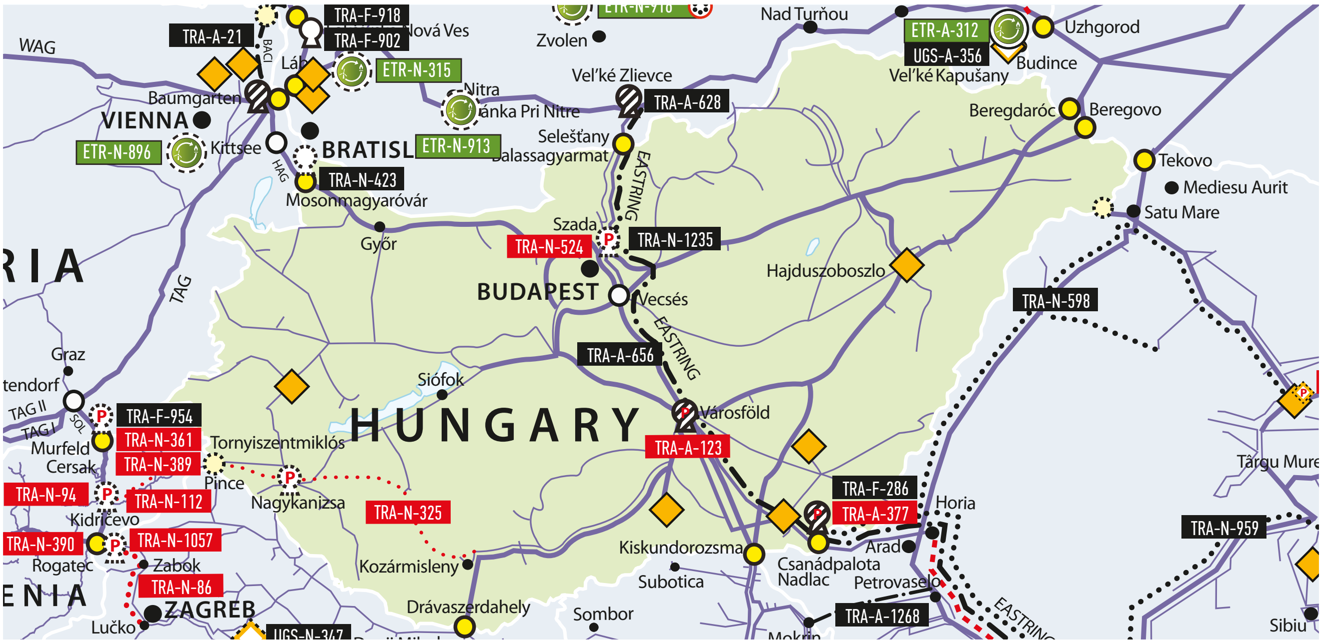
This project is covering the hydrogen infeed as envisioned in the NDP 2020. It covers in the "market survey"-path the total hydrogen supply from renewable gas projects, that have not been put individually into the TYNDP. The "towards 2050"-path is including the (additional) P2G installations considered in the NDP2020 for the 2030 scenario.

c) This project is the German part of a hydrogen interconnection point between Germany and the Netherlands as planned by the German national development plan.

1 Only projects of TSOs participating in the CEE GRIP have been included. The full project table can be found on ENTSOG's webpage.

HUNGARY

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.



TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-N-524	Enhancement of Transmission Capacity of Slovak-Hungarian interconnector	FGSZ Ltd	2022	Depends on market demand.	Yes
TRA-N-325	Slovenian-Hungarian interconnector	FGSZ Ltd.	Phase 1: 2022 Phase 2: 2023	Depends on market demand.	Yes
TRA-A-656	Eastring - Hungary	FGSZ Ltd.	2028	–	No
TRA-A-377	Romanian-Hungarian reverse flow Hungarian section 2nd stage	FGSZ Ltd.	2022	Depends on market demand.	Yes

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.7: List of projects in Hungary

POLAND

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.

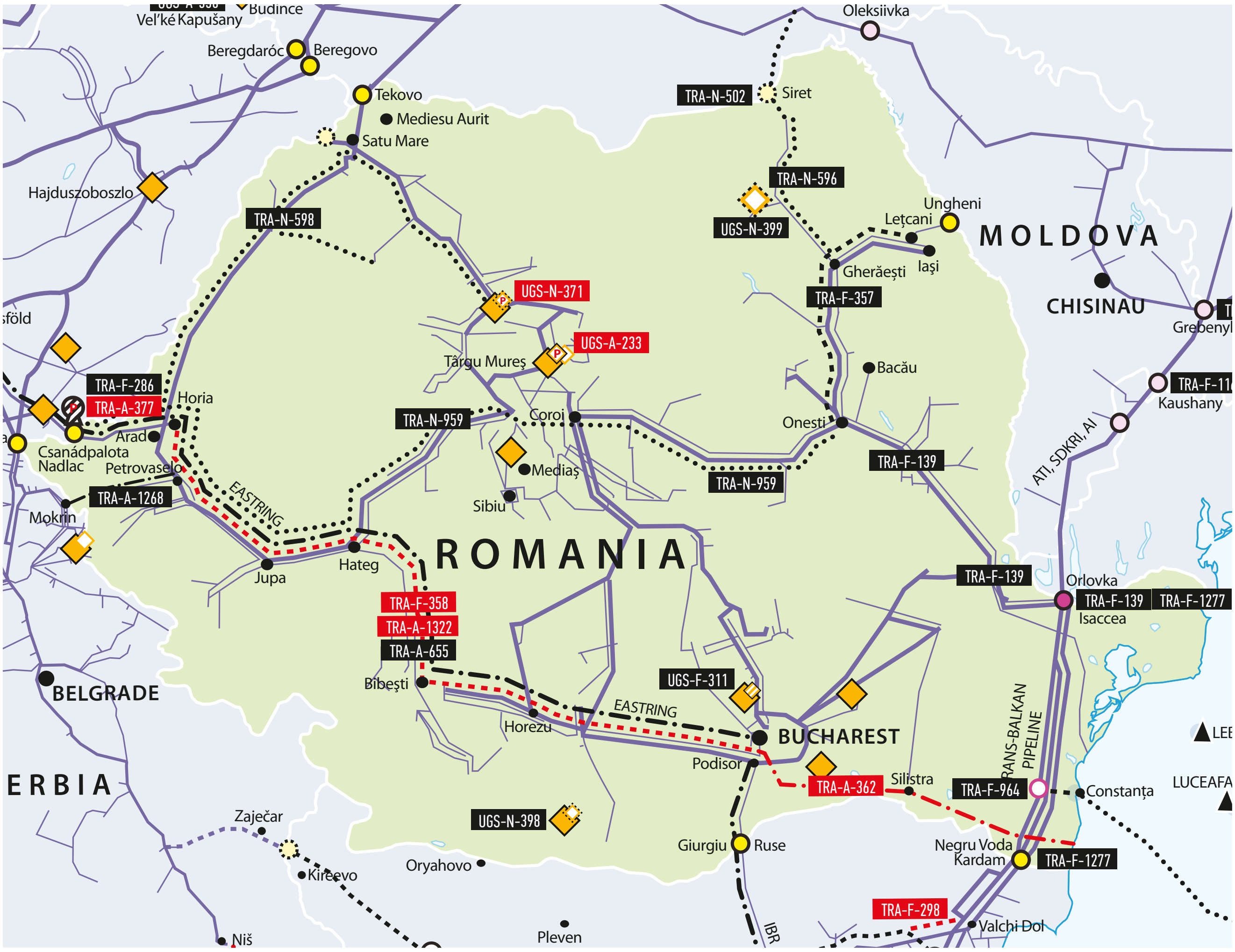
TYNDP 2020 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-F-212	Gas Interconnection Poland–Lithuania (GIPL) – PL section	GAZ-SYSTEM S.A.	2021	2022	Yes
TRA-F-247	North-South Gas Corridor in Western Poland	GAZ-SYSTEM S.A.	2021		No
TRA-A-273	Poland – Czech Republic interconnection (PL section)**	GAZ-SYSTEM S.A.	2023	on hold	No
TRA-F-275	Poland – Slovakia interconnection (PL section)	GAZ-SYSTEM S.A.	2021	2022	Yes
LNG-F-272	Upgrade of LNG terminal in Świnoujście	GAZ-SYSTEM S.A.	2023		No
TRA-A-621	Poland – Ukraine Gas interconnection (PL section)	GAZ-SYSTEM S.A.	2022	on hold	No
LNG-N-947	FSRU Polish Baltic Sea Coast	GAZ-SYSTEM S.A.	2025	2026	Yes
TRA-A-271	Poland – Denmark interconnection (Baltic Pipe) – PL section	GAZ-SYSTEM S.A.	2022		Yes
TRA-N-245	North-South Gas Corridor in Eastern Poland	GAZ-SYSTEM S.A.	2029		Yes
UGS-N-914	UGS Damaslawek	GAZ-SYSTEM S.A.	2026	2030	No
TRA-A-1173	Poland – Denmark interconnection (Baltic Pipe) – onshore section in Poland	GAZ-SYSTEM S.A.	2022		Yes
TRA-N-1202	GCP GAZ-SYSTEM/ONTRAS – incremental capacity project	GAZ-SYSTEM S.A.	2023	terminated**	No

* Update of expected commissioning year reflects a situation as of 1 July 2021. ** The project was terminated due to negative results of an economic test carried out as part of the incremental capacity process 2019–2021. More information is available under the following link.

Table 2.8: List of projects in Poland

ROMANIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.



TYNDP 2020 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-F-357	NTS developments in north-east Romania	SNTGN Transgaz S.A.	2021	2021	No
UGS-A-233	Depomures	Engie Romania S.A.	Phase 1: 2021 Phase 2: 2024	Phase 1: 2023	Yes
TRA-F-139	Interconnection of the NTS with the DTS and reverse flow at Isaccea	SNTGN Transgaz S.A.	2020	Commissioned	Yes
TRA-F-964	New NTS developments for taking over gas from the Black Sea shore	SNTGN Transgaz S.A.	2021	2021	Yes
TRA-F-358	Development on the Romanian territory of the NTS (BG–RO–HU–AT Phase 1)	SNTGN Transgaz S.A.	2020	Commissioned	Yes
TRA-A-1322	Development on the Romanian territory of the NTS (BG–RO–HU–AT Phase 2)	SNTGN Transgaz S.A.	2022	2023	Yes
TRA-A-362	Development on the Romanian territory of the Southern Transmission Corridor	SNTGN Transgaz S.A.	2020 2021	2021 2022	Yes

TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-A-655	Eastring Romania	SNTGN Transgaz S.A.	Phase 1: 2025 Phase 2: 2030	Phase 1: 2027 Phase 2: 2030	Yes
UGS-N-371	Sarmasel undeground gas storage in Romania	SNGN Romgaz SA – Filiala DE Inmagazinare Gaze Naturale Depogaz Ploiesti SRL	2024	2026	Yes
TRA-N-959	Further enlargement of the BG—RO—HU—AT transmission corridor (BRUA) phase 3	SNTGN Transgaz S.A.	2023	2026	Yes
LNG-N-376	Azerbaijan, Georgia, Romania Interconnector - AGRI	AGRI LNG Project Company SRL (RO)	2026		Yes
TRA-A-1268	Romania-Serbia Interconnection	SNTGN Transgaz SA	2020	2023	No
TRA-F-1277	Upgrading GMS Isaccea 1 and GMS Negru Voda 1	SNTGN Transgaz SA	2019 2021	2021	No
TRA-N-596	Interconnection between the RO and the UA gas transmission systems	SNTGN Transgaz SA	2025	2026	No
TRA-N-598	NTS developments in north-west Romania	SNTGN Transgaz SA	2026	2026	No
UGS-F-311	Bilciuresti daily withdrawal capacity increase	SNGN Romgaz SA – Filiala DE Inmagazinare Gaze Naturale Depogaz Ploiesti SRL	2025	–	No
UGS-N-398	Ghercesti underground gas storage in Romania	SNGN Romgaz SA – Filiala DE Inmagazinare Gaze Naturale Depogaz Ploiesti SRL	2026	–	No
UGS-N-399	Falticeni UGS	SNGN Romgaz SA – Filiala DE Inmagazinare Gaze Naturale Depogaz Ploiesti SRL	2029	–	–

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.9: List of projects in Romania

SLOVAKIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.

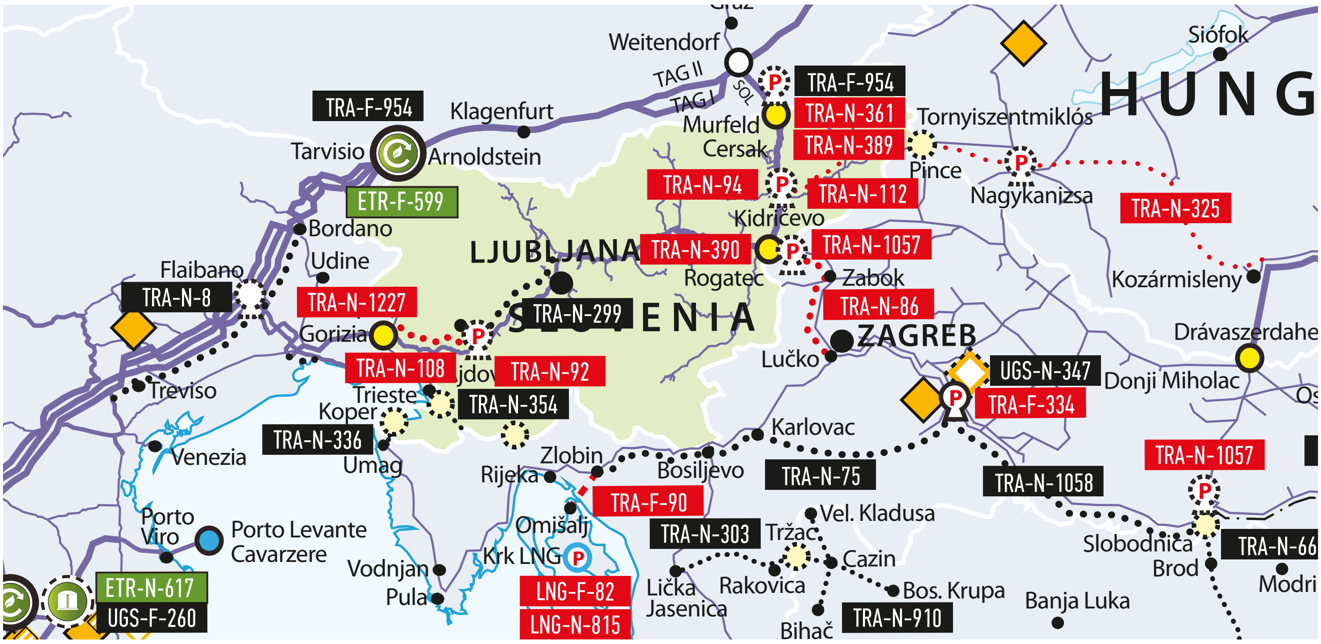
TYNDP 2020 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-F-190	Poland-Slovakia interconnection	eustream, a.s.	2021	2022	Yes
TRA-A-628	Eastring Slovakia	Eastring B.V.	2030	–	No
TRA-N-1235	Firm transmission capacity increase at the IP Veľké Zlievce	eustream, a.s.	2022	–	Yes
UGS-A-356	Underground Gas Storage Velke Kapusany	NAFTA a.s. (joint stock company)	2023	–	No
ETR-A-312	P2G Velke Kapusany	NAFTA a.s. (joint stock company)	2023	–	No
ETR-N-315	G2F – Gas to Future	NAFTA a.s. (joint stock company)	2025	–	No
ETR-N-913	Modification of NP23 MW turboset to a H_2-ready low emissions at CS04	eustream, a.s.	2023	–	No
ETR-N-916	Measures for achieving H_2 blending readiness of the transmission system	eustream, a.s.	2024	–	No
ETR-N-920	Measures for the reduction of methane emissions	eustream, a.s.	2024	–	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.10: List of projects in Slovakia

SLOVENIA

Map of projects in the specified country based on the ENTSOG TYNDP 2020 MAP.



TYNDP 2020 Code	Name	Promoter	Expected commiss-ioning year (according to TYNDP 2020)	Update of expected commissioning year *	PCI (4th list)
TRA-N-390	Upgrade of Rogatec interconnection (M1A/1 Interconnection Rogatec)	Plinovodi d.o.o.	2023	2026	Yes
TRA-N-94	CS Kidričevo, 2nd phase of upgrade	Plinovodi d.o.o.	2023	2026	Yes
TRA-N-108	M3 pipeline reconstruction from CS Ajdovščina to Šempeter/Gorizia	Plinovodi d.o.o.	2025	2025	Yes
TRA-N-112	R15/1 Pince - Lendava - KidričevPlinovodi d.o.o.	Plinovodi d.o.o.	2023 2025	2025	Yes
TRA-N-389	Upgrade of Murfeld/Ceršak interconnection (M1/3 Interconnection Ceršak)	Plinovodi d.o.o.	2023	2026	Yes
TRA-N-92	CS Ajdovščina, 1st phase of upgrade	Plinovodi d.o.o.	2025	2025	Yes
N/A	Transmission system upgrade project for achieving readiness for hydrogen blending and renewable gases	Plinovodi d.o.o.	N/A (project not included in the TYNDP 2020)	after 2023	No

* Update of expected commissioning year reflects a situation as of 1 July 2021.

Table 2.11: List of projects in Slovenia

Picture courtesy of Plinovodi

3 CEE GRIP REGIONAL N-1 ANALYSIS

3.1 GENERAL NOTE

The countries in the CEE region are exposed to gas supply disruptions, in the current supply situation primarily from the eastern supply. Projects completed in the past have improved the situation in this respect, nevertheless some challenges remain. Therefore, the participating TSOs decided to prepare the CEE Regional N-1 Analysis in the CEE GRIP, to highlight the potential impact of reduced supply on the focused perimeter of Central Eastern Europe region.

The assessment covers the gas supply disruption cases through the most significant supply corridors – Ukraine and Belarus.

The assessment is based on the capacities at interconnection points (IP) and the resulting residual capacities for neighbouring countries through supply corridors within the CEE region. The supply corridors and the results for each country in the analysed CEE region are described below. The analysis is calculated for periods until winter period 2030/2031. Special focus is put on the winter periods in the years 2021/2022, 2025/2026 and 2030/2031 and the summer periods in the years 2021, 2025 and 2030.

If not stated otherwise, all input data for the analysis are in line with the TYNDP 2020. The capacity data reflects currently existing infrastructure and FID and non-FID projects planned to be commissioned before 2030.

3.2 SUPPLY CORRIDORS

The CEE region analysed consists of nine countries: Austria, Bulgaria, Croatia, the Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia. Germany is not part of this analysis because not all German TSOs are involved in the CEE GRIP. The following paragraphs comprise a brief description of supply corridors for each country from the analysed region; only interconnection points which are relevant to the analysis are described.

3.2.1 AUSTRIA (AT)

The gas supply corridors in the following picture show the main supply corridor for Austria, which under normal conditions runs through Slovakia and through IP Baumgarten (at the figure marked AT1). Other gas supply corridors in case of a supply disruption through Ukraine, but also under normal conditions, are through Germany (marked AT2) and through Italy (AT3). Two new supply corridors for Austria can be used by commissioning two projects, which are planning to create a reverse flow capability between Slovenia and Austria, and Hungary and Austria, respectively. The remaining gas in Austria under a Ukraine disruption scenario could be used for export to Slovakia, Hungary, Slovenia and the Czech Republic.

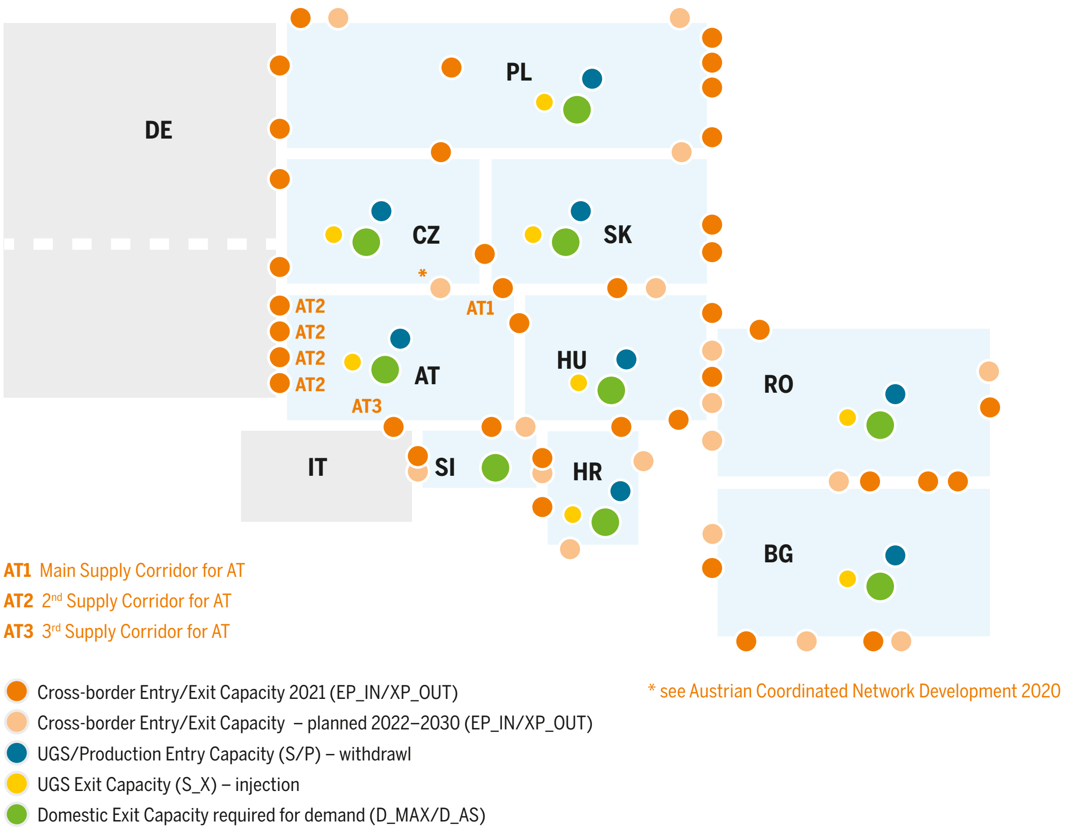


Figure 3.1: CEE Region N-1: Austria

3.2.2 BULGARIA (BG)

The following picture shows the main supply corridor for Bulgaria - IP Strandzha 2/Malkoclar at the border with Turkey (at the figure marked as BG 1). Other supply corridors are through Romania – IP Negru Voda 2,3/Kardam, IP Negru Voda 1 (at the figure marked as BG 2 and 3) and IP Ruse (BG)/Giurgiu (marked as BG5) through Greece IP Kulata/Sidirokastron (marked asBG4; this connection is bidirectional) and through Serbia IP Kireevo/Zaycar (marked as BG 6). The two new cross-border interconnections the Interconnection Greece-Bulgaria (IGB) and the Interconnection Bulgaria-Serbia (IBS) – are planned from 2022 and beyond.

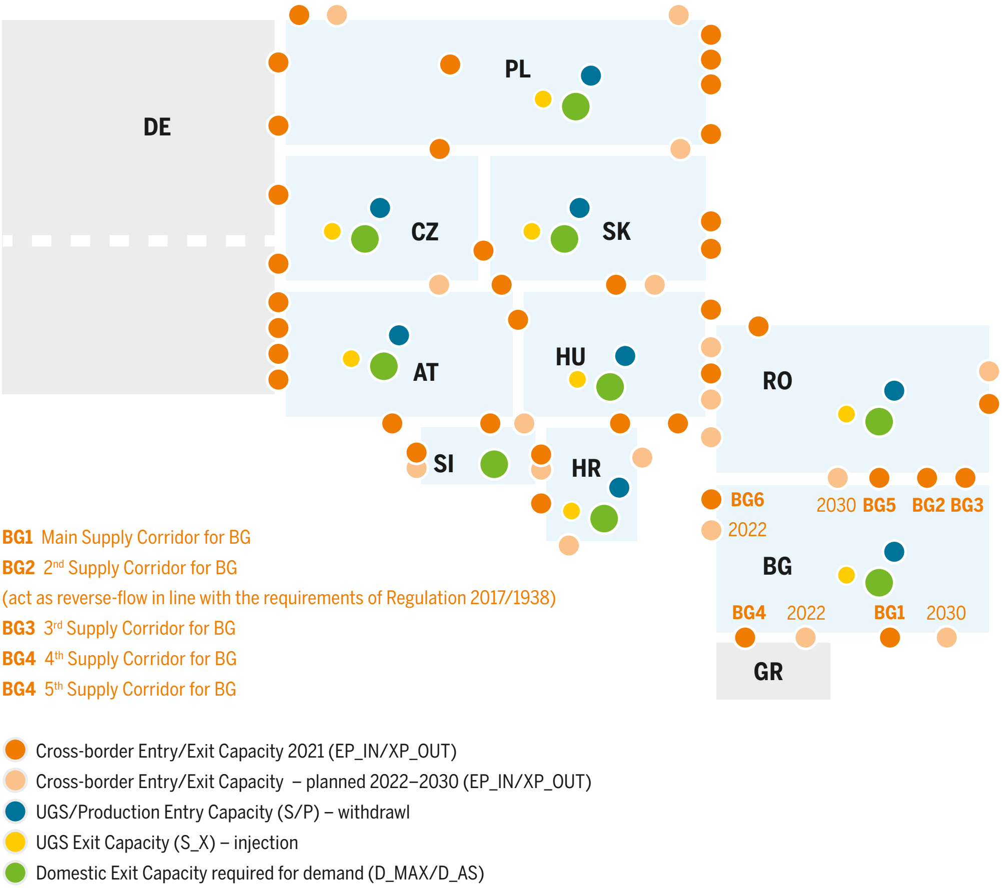


Figure 3.2: CEE Region N-1: Bulgaria

3.2.3 CROATIA (HR)

Croatia has three gas supply corridors. The main supply corridor is through Slovenia (at the figure marked HR1). The second one is through Hungary (marked HR2) and the third is the LNG terminal Krk (marked HR3). Supply corridors are for domestic demand at the moment. After the Ionian-Adriatic Pipeline (2025) is built, Croatia can then become a transit country.

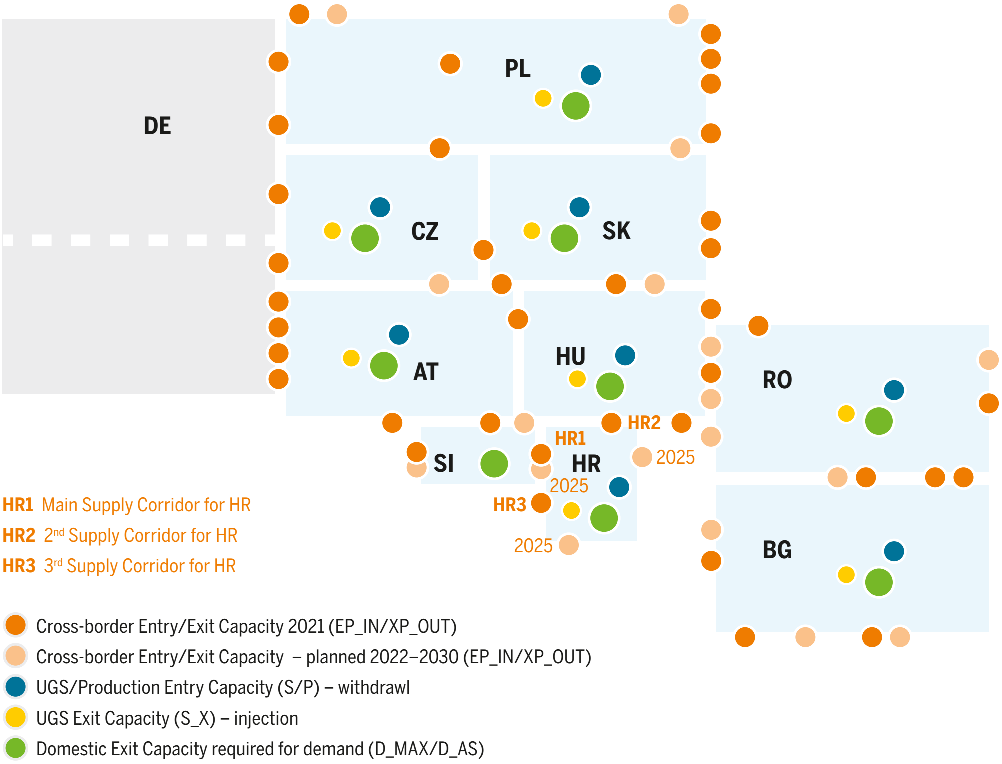


Figure 3.3: CEE Region N-1: Croatia

3.2.4 THE CZECH REPUBLIC (CZ)

Under ordinary conditions, the main supply corridor for the Czech Republic, which extension was completed in 2020 through completion of the Capacity4Gas project, is through Germany via the Nord Stream's pipelines, OPAL and EUGAL pipelines (at the figure it is marked as VIP CZ1; VIP Brandov), followed by the traditional supply route via Slovakia (marked CZ2; IP Lanžhot). Another gas supply corridor for the Czech Republic can be done through Germany from the NetConnect Germany ("NCG") market area (marked VIP CZ3; VIP Waidhaus). In case of a gas supply disruption through Ukraine, the remaining gas in the Czech Republic imported through VIPCZ1 and VIPCZ3 could be used for export to Slovakia, Poland, and Austria (via Slovakia). One new infrastructure project is currently planned between the Czech Republic and Austria. This project reacts on a non-binding capacity demand received in 2019 during the market demand assessment process for incremental capacity realized based on the Commission Regulation (EU) 2017/459.

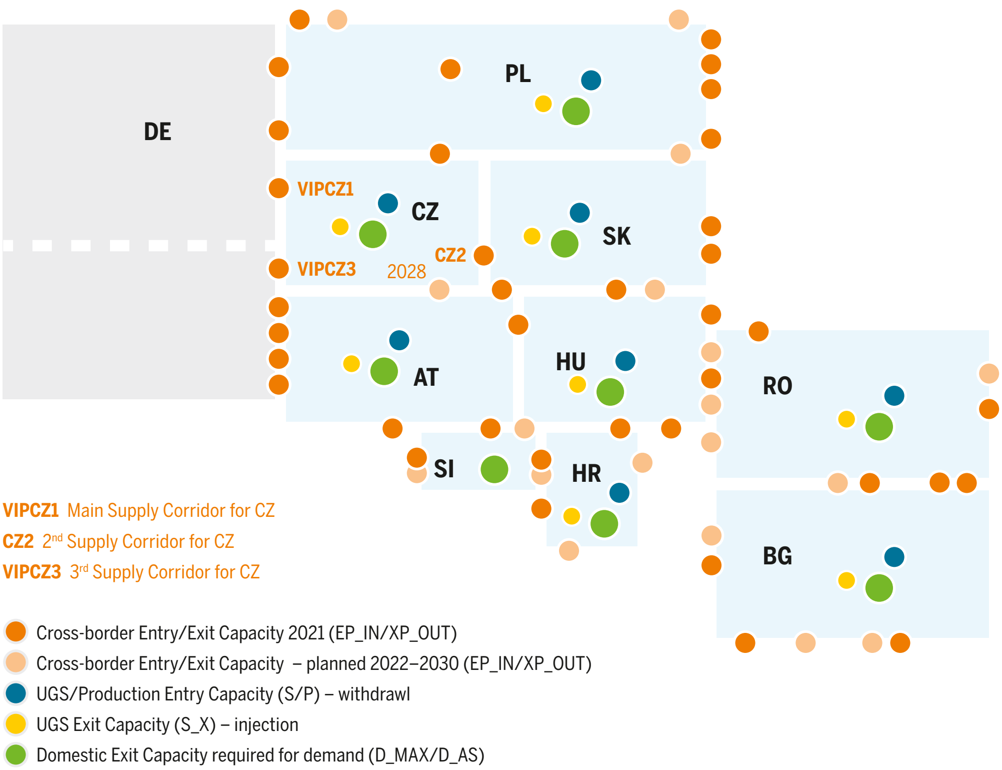


Figure 3.4: CEE Region N-1: Czech Republic

3.2.5 HUNGARY (HU)

The picture below illustrates the supply corridors for Hungary. The main supply corridor runs from Ukraine, which delivers most of the imported gas under normal conditions (at the figure marked as HU1). The second supply corridor through Austria (marked as HU2) and the third supply corridor through Slovakia (marked as HU3) are also of great importance. The other gas supply corridors for Hungary can possibly be made through Romania (marked as HU4) and Croatia (marked as HU5).

In case of a gas supply disruption on the Ukrainian/Hungarian interconnector, the main import supply corridors for Hungary from the north run through Austria (HU2) and Slovakia (HU3). The remaining capacity that could be used in case of supply disruption (from Ukraine) is the supply from Hungarian storage and domestic production points. During a Ukrainian disruption, Hungary would be the main gas supply direction for Romania and Serbia. Four new interconnectors and transit routes are under preparation. The planned commission between Slovenia and Hungary depends on market demand, the enhancement of transmission capacity of the Slovak-Hungarian interconnector (stage 1. permanent bidirectional capacity from 2019 and stage 2. enhancement capacity depends on market demand), and the planned capacity enhancement at the Hungarian/Romanian border depend on market demand. A new supply corridor HU6 will be commissioned in 2021 from direction Serbia to Hungary.

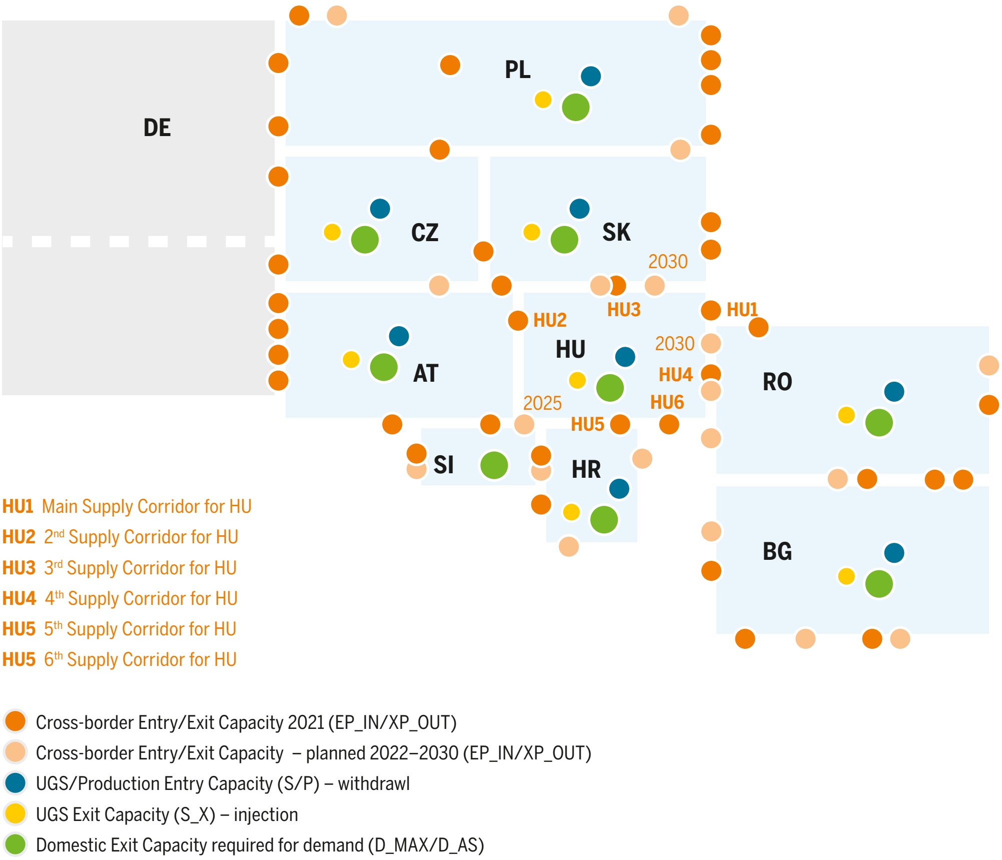


Figure 3.5: CEE Region N-1: Hungary

3.2.6 POLAND (PL)

The picture below illustrates the supply corridors for Poland. Under normal conditions, the main supply corridors run through the LNG terminal in Świnoujście (marked as PL1), Belarus (marked as PL2), and Ukraine (marked as PL3). Other gas supply corridors for Poland run through Germany (marked as PL4) and the Czech Republic (marked as PL5).

The commissioning of new interconnection projects with Slovakia and Lithuania are planned in 2022. A capacity extension of the LNG terminal at Świnoujście is planned for 2023, and a new supply corridor from Norway to Poland via Denmark is scheduled for 2022.

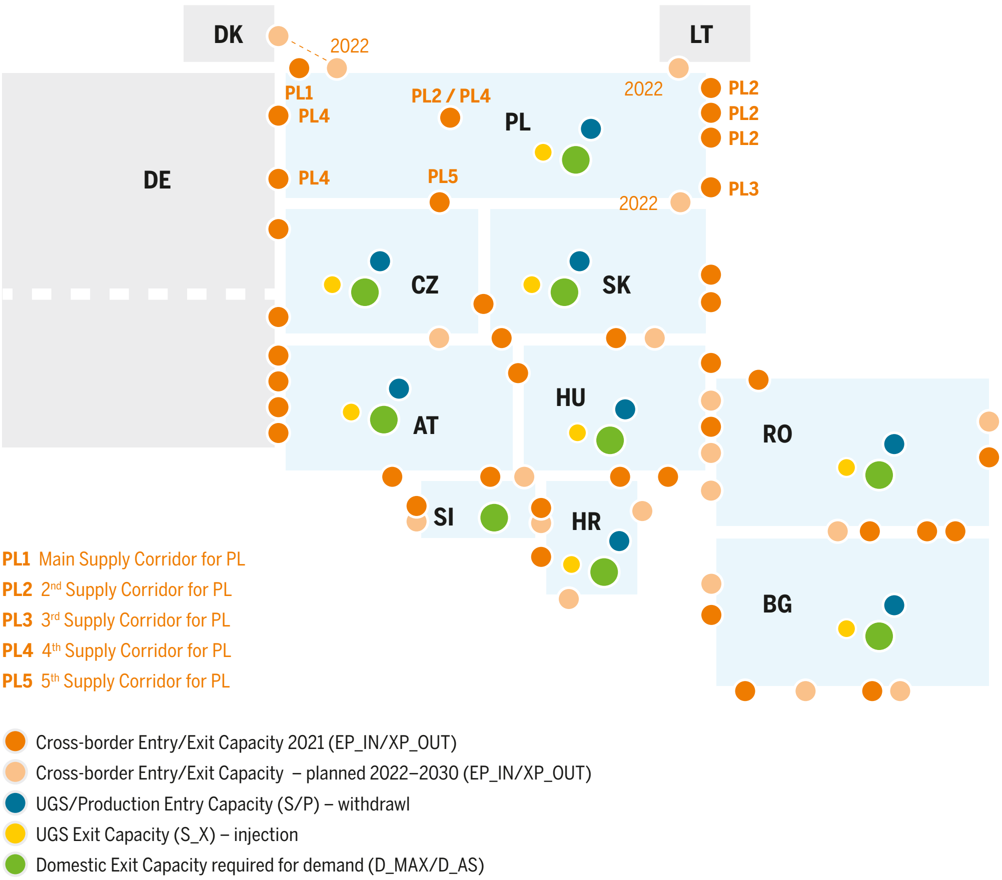


Figure 3.6: CEE Region N-1: Poland

3.2.7 ROMANIA (RO)

The following picture shows the main supply corridor for Romania, which under normal conditions and taking into account the size of the import capacity, runs through Ukraine (at the figure marked as RO1). In case of a total Ukrainian supply disruption, the other supply corridors for Romania run through Hungary (marked as RO2) and Bulgaria (marked as RO3). It is worth mentioning that, starting with 2021 gas import from the Russian Federation is achieved through Bulgaria, RO3 corridor, while the RO1 corridor is, for the moment, no longer used. Romania has a significant indigenous production of natural gas which can help to cover domestic consumption during a gas supply disruption through Ukraine. Three interconnections are planned.

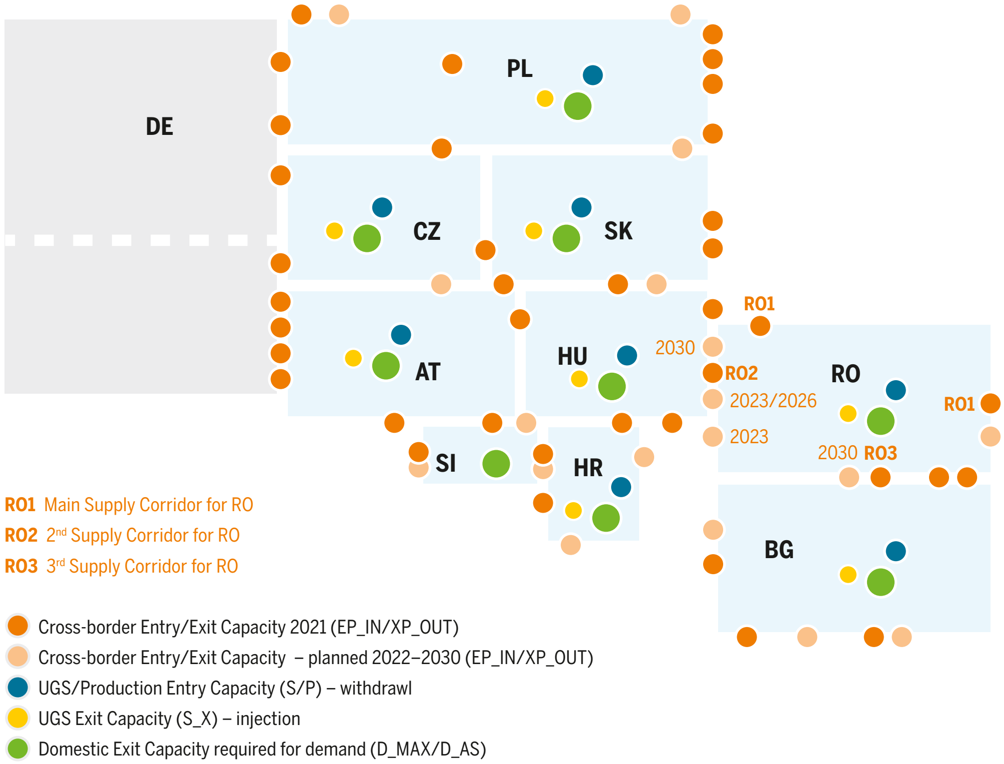


Figure 3.7: CEE Region N-1: Romania

3.2.8 SLOVAKIA (SK)

Taking into account the position of Slovakia on the gas route from Russia, it is obvious that the main supply corridor enters the country at the UA/SK border (at the figure marked as SK1). Other supply corridors, in case of a supply disruption through Ukraine, are through the Czech Republic (marked as SK2), Austria (marked as SK3), and Hungary (marked as SK4). In 2022 the commissioning of cross-border project with Poland is planned.

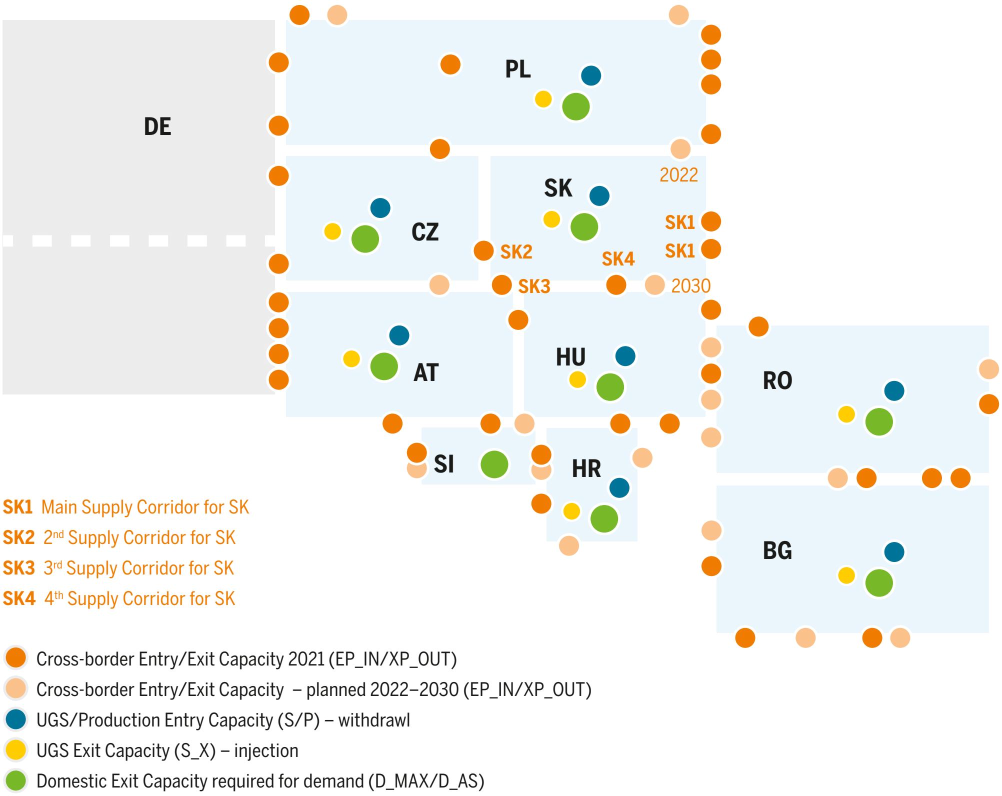


Figure 3.8: CEE Region N-1: Slovakia

3.2.9 SLOVENIA (SL)

The picture below shows the main supply corridor for Slovenia, which under normal conditions runs through Austria (at the figure marked as SI1). Other gas supply corridors, in case of a supply disruption through Ukraine, run through Italy (marked as SI2) and through Croatia (marked as SI3). The supply corridor through Croatia can possibly be upgraded from 2026 when incremental reverse flow capacity is planned to be built. The first interconnection between Slovenia and Hungary is planned for 2023. An interesting fact about Slovenia is that it has no indigenous production of natural gas or any underground storage in its territory.

Figure 3.9: CEE Region N-1: Slovenia

3.3 METHODOLOGY

3.3.1 CEE GRIP REGIONAL N-1 FORMULA

The CEE GRIP Regional N-1 analysis was prepared for the two independent scenarios of complete gas supply disruption through, respectively Ukraine and Belarus. Only nine out of the ten countries involved in the CEE GRIP are part of the analysed CEE region (AT, BG, HR, CZ, HU, PL, RO, SK, and SI). Germany is not part of the analysis, because not all TSOs from Germany are involved in the CEE GRIP. All entry points with neighbouring countries out of the analysed CEE region are taken into account, without any capacity reduction (with the exception of interconnection points with Ukraine and Belarus, respectively). On the other hand, exit points with neighbouring countries beyond the analysed CEE region are not taken into account. The supply corridors are defined by the route from the source to each country and flows to neighbouring countries are determined as the rest of the gas volume after the demand in the given country is covered. Another assumption for the analysis is that only one direction of gas flow through one interconnection point is possible. If two directions of gas flow through one interconnection point were possible, then one of the following rules was applied:

a) If there exists a country which does not meet the security of supply criterion according to REG 2017/1938 (i.e. the result of the N-1 formula shall be equal to or above 1), then the supply corridor which can help to meet the security of supply criterion was chosen.

b) The direction of gas flow which can increase the N-1 result of a neighbouring country with a smaller N-1 result than the export one, is chosen.

c) Where the direction of gas flow which should be used in the analysis was not clear, then the flow to a country which had the potential to export gas to countries outside the analysed CEE region is chosen.

The analysis has been prepared for three winter periods: 1.10.2021–31.3.2022, 1.10.2025–31.3.2026 and 1.10.2030–31.3.2031 and three summer periods: 1.4.–30.9.2021, 1.4.–30.9.2025 and 1.4.–30.9.2030. The N-1 formula used is presented below together with an explanation of all parameters. The analysis only takes into consideration the infrastructure capacities, as it assesses the infrastructure standards, not the supply standard. All planned infrastructure projects, and the rule of full season (winter October-March, summer April-September) in which the repercussion of the infrastructure project fully applies was considered in the analysis.

If not stated otherwise, all input data for the analysis are taken from the TYNDP 2020. Input data used for the analysis are part of the CEE GRIP Annex A – Capacities for Regional N-1 analysis.

3.3.1.1 Winter period

From each country, entry capacities at each interconnection point, as well as the withdrawal capacity of storage facilities, national production, domestic demand, and exit capacities to neighbouring countries are used for the calculation of regional N-1. After a matching/correction of entry and exit capacities of each interconnection point (lesser-of rule), the surplus gas is allocated to neighbouring countries to meet the domestic demand of countries which are “in need”. The N-1 value for winter is calculated for each country by setting the interconnection points of the main supply corridor to zero or to a minimum volume that an upstream country (next or nearer to Ukraine/Belarus transport to a relevant interconnection point) is able to export. If the investigated country has surplus gas after satisfying its demand for sharing, the gas is then allocated to downstream countries, where necessary. These values are used for the N-1 calculation as entries for a particular country. In case the N-1 value is equal to or above 1, this means that the respective country is able to cover its own demand in case of a gas supply disruption via Ukraine or Belarus. Under the assumption that underground storage facilities are filled up during the summer period (as the N-1 calculation assesses the infrastructure, not the supply standard), the maximum deliverability has been applied. The stock levels of underground storage facilities, as well as the duration of the disruption, have not been taken into consideration in the winter formula.

The N-1 Formula for the winter period is based on REG 2017/1938, when the technical capacity of the single largest gas infrastructure in the original formula is replaced by all interconnections with Ukraine (or Belarus respectively) in the modified formula for the CEE GRIP.

Winter N-1 Formula:

$$N-1_{WINTER} = \frac{\sum_i^n EP\_IN_m + P_m + S_m - UA/BY\_connections_m}{D\_MAX_m} \geq 1$$

EP_IN	All border entry points (transmission and LNG) capable of supplying gas to the calculated area (GWh/d)
P	National production, entry capacity (GWh/d)
S	Storage, entry capacity (withdrawal) (GWh/d)
D_MAX	Domestic winter peak demand (1 in 20) (GWh/d)

3.3.1.2 Summer period

In addition to the data for entry capacities used for the CEE GRIP Regional N-1 analysis during the winter period, the working gas volumes and maximum injection capacity to the underground storage facilities of each country are also used for the analysis during the summer period. The summer formula is set to determine how long a gas supply disruption through Ukraine and Belarus can last without endangering the ability to cover demand and/or to fill the storage facilities in the respective country. After a matching/correction of entry and exit capacities of each interconnection point (lesser-of rule), the surplus gas is allocated to neighbouring countries to meet their domestic demand. The N-1 value for the summer is calculated for each country by setting the interconnection points of the main supply corridor to zero or to the minimum volume that an upstream country (next or nearer to Ukraine/Belarus transport to a relevant interconnection point) is able to export. If the investigated country has surplus gas for sharing after satisfying its demand, the gas is then allocated to downstream countries, where necessary. These values are used for the N-1 calculation as entries for each particular country.

Summer N-1 Formula:

$$\sum XP\_OUT_{m,SUMMER} = \sum_i^n EP\_IN_m + P_m - D\_AS_m - UA/BY\_connections \geq 0$$

EP_IN	All border entry points (transmission and LNG) capable of supplying gas to the calculated area (GWh/d)
P	National production, entry capacity (GWh/d)
D_AS	Domestic average summer demand (1 in 20) (GWh/d)
XP_OUT	Remaining gas to fulfil demand in neighbouring countries and for injection into underground storage facilities in country concerned (GWh/d)

For calculation purposes, the time period for injection into underground storage facilities during the summer is considered to be 180 days in duration.


Picture courtesy of Ontras

3.4 DISRUPTION VIA UKRAINE

If planned infrastructure projects are implemented in time, then the Regional N-1 criterion for the winter of 2021/2022 will not be met for Poland due to increased daily maximum gas demand considering forecasts provided in the previous CEE GRIP edition (1,361 GWh/d in 2019) and the upward trend in the future (e.g. 1,529 GWh/d expected in 2021 and 1,662 GWh/d in 2026). In the analysed winter period 2025/2026 and 2030/2031, the countries from the CEE region have no trouble in covering their domestic demand in the event of a gas supply disruption through Ukraine. The results are presented in the following table.

Country	CEE GRIP Regional N-1 Winter		
	1.10.2021–31.3.2022	1.10.2025–31.3.2026	1.10.2030–31.3.2031
Austria	2.18	2.12	1.75
Bulgaria	3.36	3.23	2.87
Croatia	1.41	1.42	1.87
Czech Republic	2.56	2.19	2.46
Hungary	1.76	1.53	1.53
Poland	0.89	1.16	1.23
Romania	1.09	1.27	1.57
Slovakia	5.69	5.17	5.16
Slovenia	1.83	1.10	2.24

Table 3.1: Results of CEE GRIP Regional N-1 Winter in case of a disruption via Ukraine

Regarding the summer analysis, it came to the conclusion that all countries in the region are able to cover their demand and fill the storages in summer 2021, 2025 and 2030 for the upcoming winter seasons. In the 2021 summer period, a potential problem of injecting gas into underground storage facilities was detected in Hungary and Austria. In Hungary this potential problem would appears only if the gas supply disruption through Ukraine lasted longer than 66 days. A potential problem in Austria would raise in case the disruption lasts for more than 150 days. The commissioning of planned projects in subsequent years will respond to all identified problems during the summer periods.

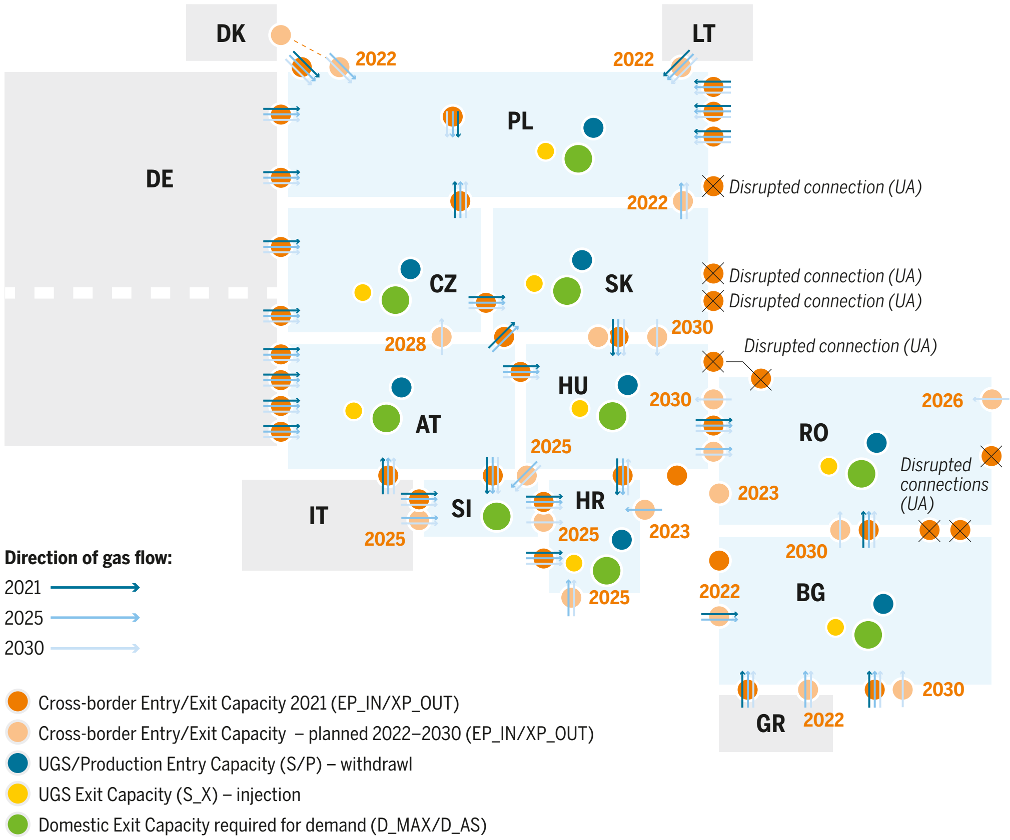


Figure 3.10: Direction of gas flow considered at each interconnection point under disruption via Ukraine

3.5 DISRUPTION VIA BELARUS

The CEE GRIP Regional N-1 analysis of a gas supply disruption through Belarus (including the interconnection points Wysokoje, Tietierówka, Kondratki and the Yamal-Europe Pipeline in the direction BY > PL) indicated that only Poland would be affected by this kind of gas supply disruption. The results of the analysis show that Poland does not meet the N-1 criterion during the winter period 2021/2022 due to expected increased of the Dmax. For the winter periods 2025/2026 and 2030/2031 Poland meets the N-1 criterion and that the results improve in the upcoming 10 years with the implementation of the new planned infrastructure projects.

Other countries in the CEE region would not be affected by a gas supply disruption via Belarus. Most of their gas transmission systems would operate in a business-as-usual regime, and their N-1 results would be above 1. This means that under normal circumstances all countries of the analysed CEE region (including Poland) would have sufficient capacity to satisfy both their domestic demand and transit needs to neighbouring countries over the reporting period.

The results for countries in the analysed CEE region which would be affected by a gas supply disruption via Belarus, are presented in table 3.2.

Country	CEE GRIP Regional N-1 Winter		
	1.10.2021–31.3.2022	1.10.2025–31.3.2026	1.10.2030–31.3.2031
Austria	No effect	No effect	No effect
Bulgaria	No effect	No effect	No effect
Croatia	No effect	No effect	No effect
Czech Republic	No effect	No effect	No effect
Hungary	No effect	No effect	No effect
Poland	0.82	1.14	1.23
Romania	No effect	No effect	No effect
Slovakia	No effect	No effect	No effect
Slovenia	No effect	No effect	No effect

Table3.2: Results of CEE GRIP Regional N-1 Winter in case of a disruption via Belarus

The analysis for the 2021, 2025 and 2030 summer periods did not identify any problem with covering the average summer domestic demand and to meet the injection requirements of underground storage facilities in the whole CEE region.

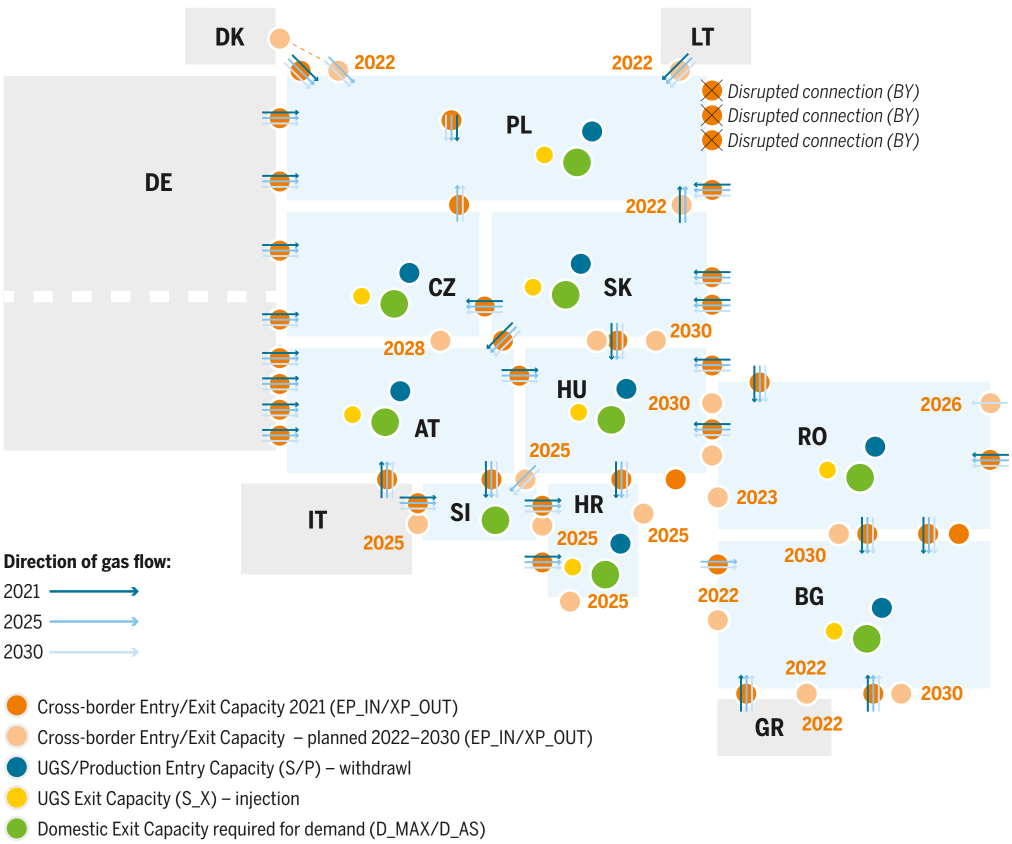


Figure 3.11: Direction of gas flow considered at interconnection points at Polish borders under a disruption via Belarus

4 DECARBONISATION IN THE CEE REGION

4.1 GENERAL NOTE

This chapter partially builds on the work done by the Gas Infrastructure Europe in 2020 and 2021 on the topic how gas infrastructure can contribute to meet EU's long-term decarbonisation objectives[2]. The report highlights and maps out the strengths and opportunities of the gas infrastructure in Central-Eastern and South-Eastern Europe, vis-à-vis the energy transition under the coal phase-out scenarios. The document analyses different decarbonisation pathways of participating countries – Austria, the Czech Republic, Germany, Greece, Hungary, Latvia, Poland, Romania, Slovakia and Slovenia. This chapter follows the structure of the GIE report and covers all countries of the CEE GRIP region: Austria, Bulgaria, Croatia, the Czech Republic, Germany, Hungary, Poland, Romania, Slovakia and Slovenia.

The second part of this chapter looks at the hydrogen strategies in the selected counties of the region where the strategy has been introduced or at least a draft in the public consultation phase exists.

The countries worked with the vision of the carbon neutrality by 2050 at the latest. Common features of the presented national hydrogen strategies could be highlighted as follows:

- Countries recognise that hydrogen will become key energy carrier in the decarbonisation process and decarbonised future.
- Country production of hydrogen will not be sufficient to cover expected demand, assumption of the significant hydrogen imports prevails.
- Acknowledgement of the key role of existing gas infrastructure in the hydrogen transmission, distribution and storage (repurposing/retrofitting).

4.2 CONTRIBUTION OF GASES IN CEE REGION TO THE DECARBONISATION OBJECTIVES

Efforts to achieve decarbonisation should fully respect the principle of technology neutrality and aim for minimising overall economic costs. It can be expected that use of natural gas will gradually decrease on a regional level over the coming decades, nevertheless considering the extensive use of coal in several countries in the CEE region, the environmental benefits of natural gas compared to solid fossil fuels must be highlighted. Natural gas produces approximately 40 % less CO_2 emissions than coal per energy output. Additionally, combustion of natural gas emits several times smaller volumes of nitrogen oxides, sulphur dioxide and particulate matter. Currently there is a limited number of other available solutions leading to such a decrease of GHG emissions that could be implemented as fast and that are cost-effective and technically available. Thus, natural gas through coal-to-gas switch can substantially contribute to decarbonisation of the energy sector in the short to midterm in the CEE countries with high share of solid fossil fuels in their energy mix.

At the same time, the gas sector can be gradually decarbonised. That would result in a lesser utilisation of natural gas and a higher utilisation of renewable and decarbonised gases such as hydrogen, biomethane and synthetic methane. The pace of decarbonisation of the gas sector varies among the states in the CEE region. However, there are already several ongoing projects and others are planned (see ETR projects in chapter 2). It is a fact that a development of hydrogen economy can be supported by the emergence of numerous national hydrogen strategies in the different countries (see chapter 4.3).

2 GIE paper Decarbonisation in Central-Eastern and South-Eastern Europe, April 2021

The gas sector in the CEE region has many strengths toward decarbonisation. However, there are also some challenges.

Strengths:

- Existing reliable and well-developed gas infrastructures.
- Well-founded experience in operating networks.
- In the mid-term, there will be more renewable energy sources (wind, solar) in the energy mix in the CEE region and the high flexibility of gas infrastructure will be necessary for an efficient deployment of those RES.
- Gases (natural gas, hydrogen, biomethane and synthetic methane) have a variety of applications, like the usage in district heating, power generation, transport, and in industrial appliances.

Challenges:

- Reliance on coal and lignite is still significant mainly in the electricity generation and in the heating sector.
- Smooth and fast switch from coal to gas and switch to renewable and low carbon gases, especially in power generation, heating sector and energy intensive industries will be crucial.
- Finding a balance between the decarbonisation path and its pace vs affordability (especially share of population at risk of energy poverty) and security of supply.
- High number of CEE cities are among the 100 most polluted cities in Europe according the 2019 report of IQAir.
- Significant source of the air pollution are low-stack emissions caused by burning coal and other solid fuels in single family buildings.
- Historical debt in buildings sector from energy efficiency point of view.
- Dependence on the natural gas imports mainly from Russian Federation.

Following pictures illustrate variety in the energy mix of the region in electricity and heat generation sectors. In the electricity generation sector (see Figure 4.1) Austria and Croatia generate more than 66 % of the electricity from RES. Poland, Bulgaria and the Czech Republic generate significant portion of the electricity from coal and lignite. In Slovakia and Hungary almost half of the electricity is generated by nuclear energy. Quite balanced energy mix is visible in Germany, Romania and Slovenia. Portion of the natural gas varies from 3.3 % up to 25 %. All data, if not stated otherwise, are from Eurostat.

In the heating sector (see Figure 4.2) natural gas has a strong position in all the CEE region countries except of Poland. In total coal and natural gas cover almost 80 % of heat generation in the CEE region. To replace 445 PJ, 39 % of heat generation from solid fossil fuels is a real challenge.

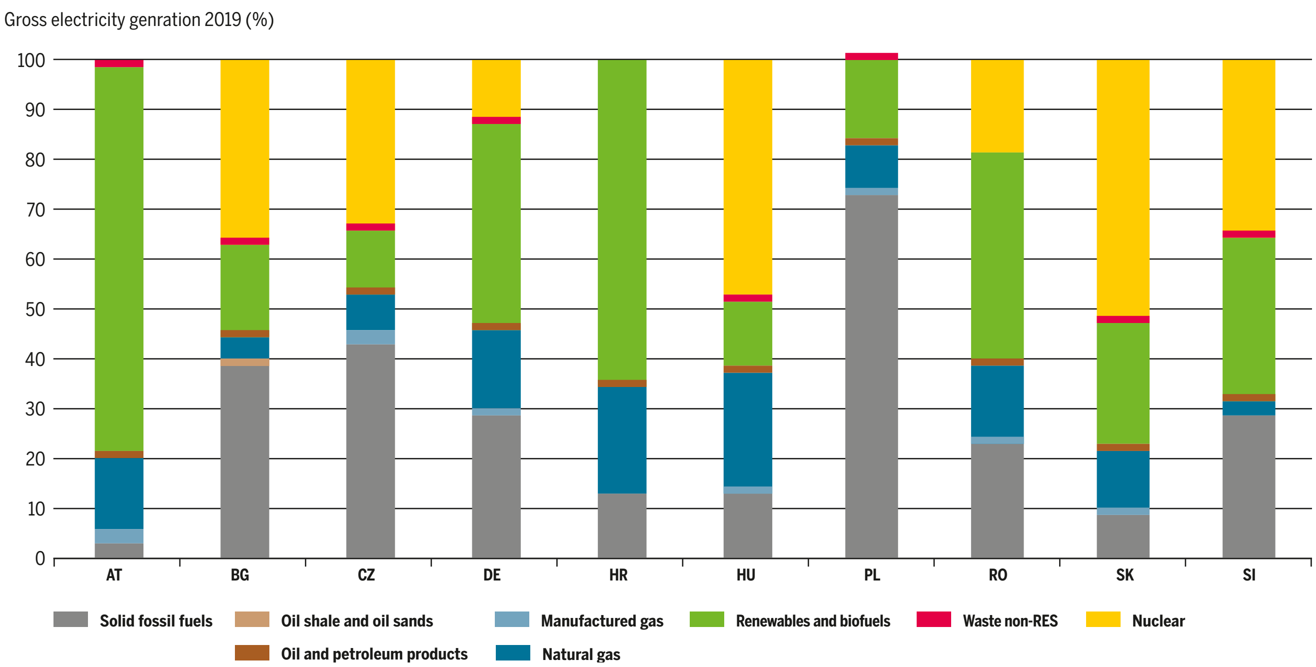


Figure 4.1: Gross electricity generation in the CEE region

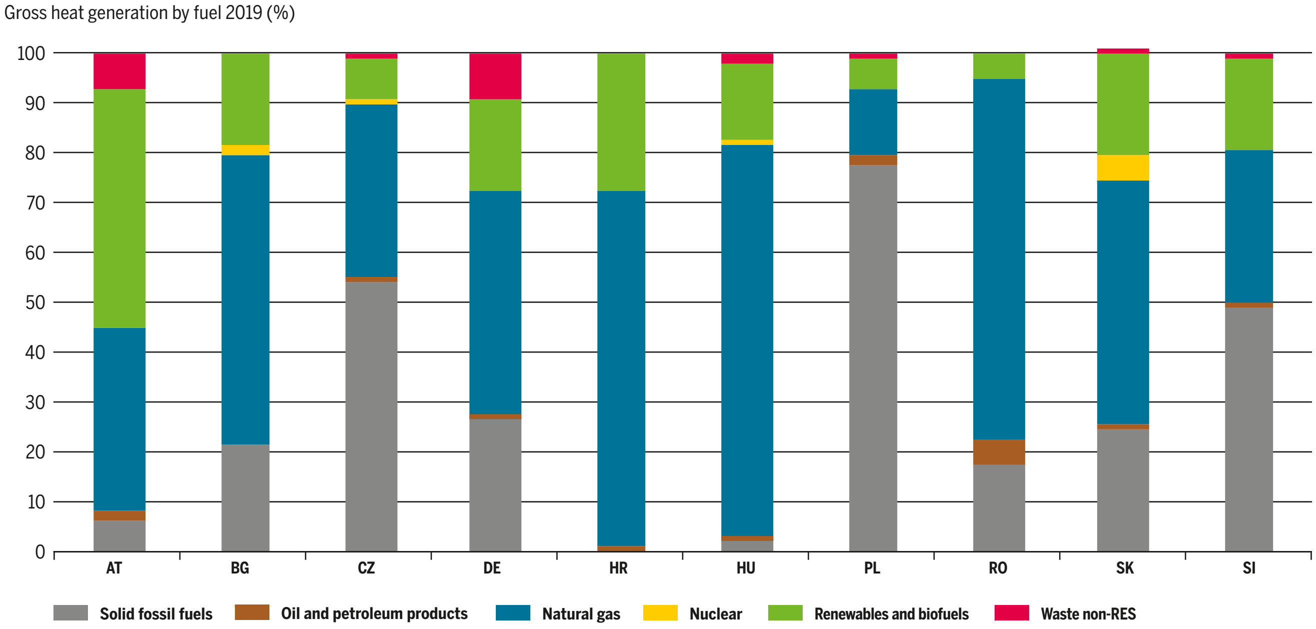


Figure 4.2: Gross heat generation in CEE region

4.2.1 AUSTRIA (AT)

Austria is the most advanced country in the CEE region in integration of the renewable sources into the energy system. Austria has introduced very ambitious plans for the decarbonisation of its economy, to reach 100 % of the electricity generation only by RES by 2030. Regarding gas Austria plans to move to renewable gases in the long-term perspective. Austria is important gas transit hub in Europe with higher volumes transported to Italy and Germany as consumed.

Natural gas represents as a source 15 % portion at the gross electricity production and 37 % at the heat generation. Austria disposes with significant underground storage capacity of 8.4 bcm of working volume.

According to the GIE report Austrian NECP foresees and increasing role for renewable gases and their contribution to energy storage and processing.

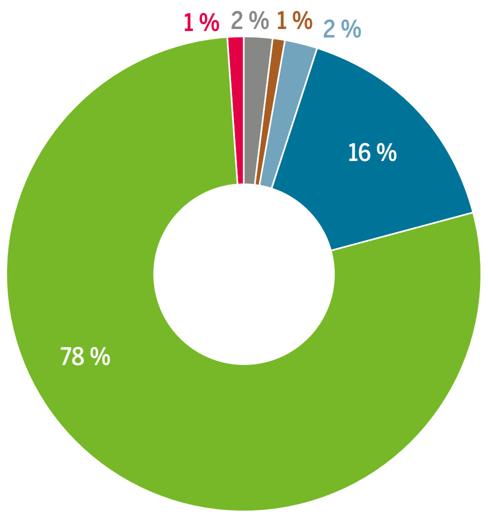


Figure 4.3: Gross electricity generation in Austria

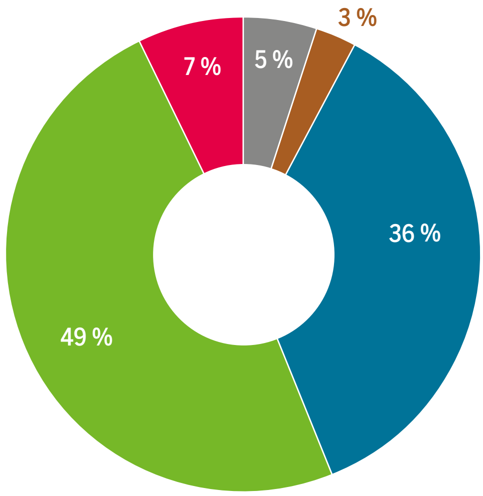


Figure 4.4: Gross heat generation in Austria

4.2.2 BULGARIA (BG)

In Bulgaria the main energy source in electricity generation is coal with 38 % share, while in heat generation the main energy source is natural gas with 62 % share followed by coal with 23 % share.

To meet EU's decarbonisation targets Bulgarian NECP envisages many measures aiming at reducing GHG emissions and increasing the share of energy from renewable sources in gross final energy consumption. The energy sector has the highest share in total GHG emissions. Coal-fired generation of electricity and heat contributes to over 90 % of the GHGs in the sector therefore the main potential for emission reduction is concentrated here. According to the NECP, the GHG emission levels in the energy sector will decrease by approximately 19 % until 2030 as compared to 2015.

Natural gas is considered a fuel that will ensure the transition to a low-carbon economy. Thus it is a priority for Bulgaria to diversify the sources and the routes for its natural gas supply.

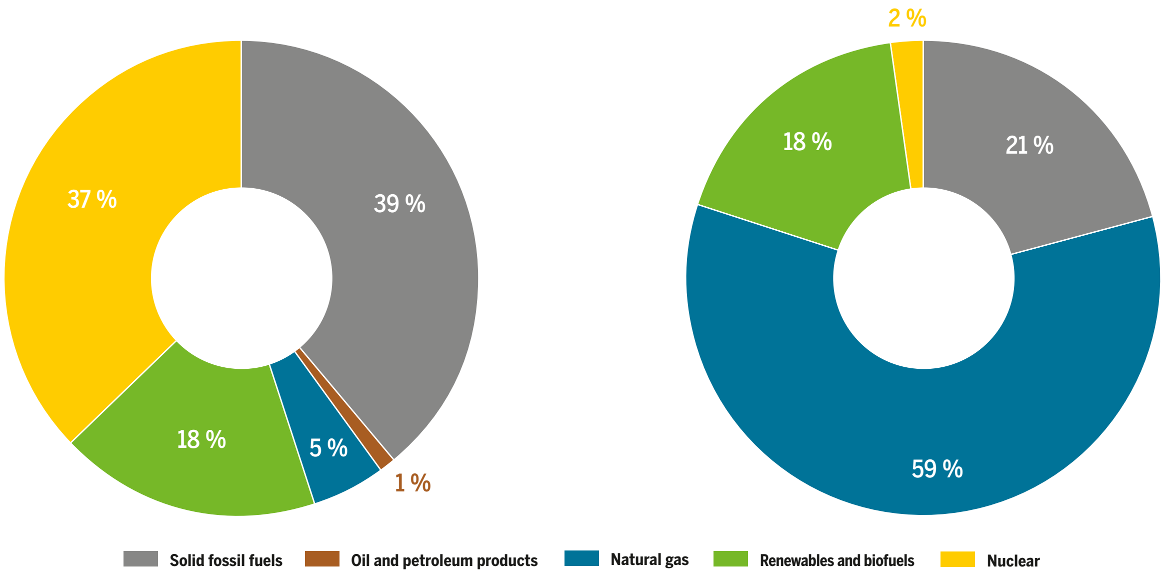


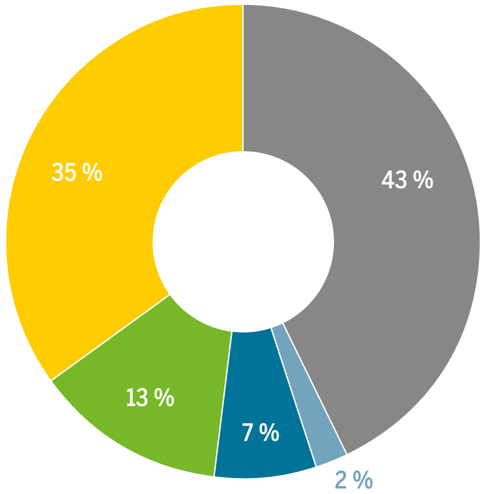
Figure 4.5: Gross electricity generation in Bulgaria

Figure 4.6: Gross heat generation in Bulgaria

4.2.3 CZECH REPUBLIC (CZ)

The Czech Republic is one of the transit countries for natural gas in the region. In some of the Czech regions there is an air pollution problem, and the quick switch from coal to gas in electricity and especially heat production is a mid-term a solution while also fast and cost-effectively contributing to decarbonisation. The NECP expects continual decrease of the coal share in the electricity generation until 2040 by more than 50 % compared to 2020 level. There is also ongoing national debate on the earlier coal phase-out (2038 or even 2033). The solid fossil fuels are to be substituted by natural gas (which is to be later decarbonised and/or to be substituted by renewables gases), nuclear energy and RES. According to the GIE report a coal to gas switch in central heating sector can bring down health risks caused by constantly exceeded pollution limits (especially by particulate matter, NOx and SOx). Central heating is by far the greatest source of particular matter pollution in the Czech Republic.

Regarding the green gases the NECP foresees increasing share of biomethane, with approx. 7 % share of the total gas consumption in 2030. The NECP does not provide detailed data on hydrogen production in the Czech Republic until 2030. However, based on the NECP the Czech Republic aims to support building of hydrogen production facilities and other facilities producing renewable and decarbonised gases such as biogas, biomethane, and synthetic gases.



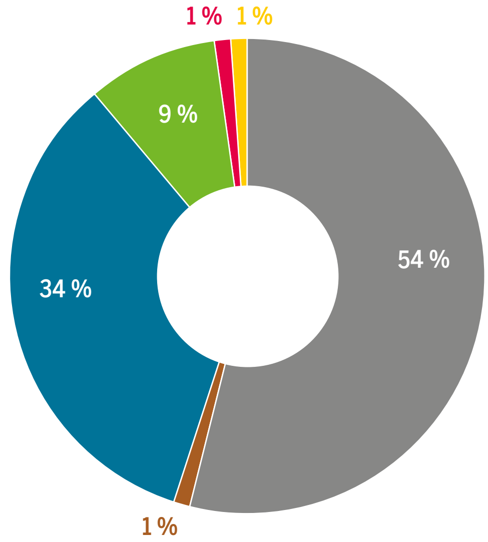


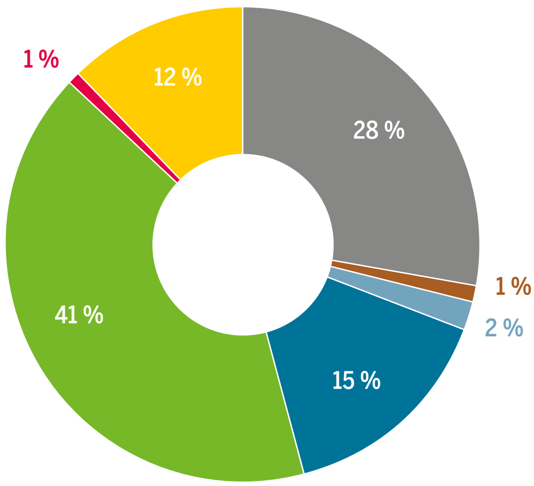
Figure 4.7: Gross electricity generation in the Czech Republic

Figure 4.8: Gross heat generation in the Czech Republic

4.2.4 GERMANY (DE)

Germany's electricity generation is mainly based on renewables (41 % incl. biofuels) and solid fossil fuels (28 %). The turning year was 2018 when the share of coal and renewable was almost equal. The heat generation sector shows a different picture. Here the main energy source is still natural gas (46 %) followed by fossil solid fuels (26 %).

Germany has ambitious plans in hydrogen production for upcoming decades. The Government foresees a hydrogen demand in 2030 of around 100 TWh and generation plants with capacity up to 5 GW to be built until 2030.



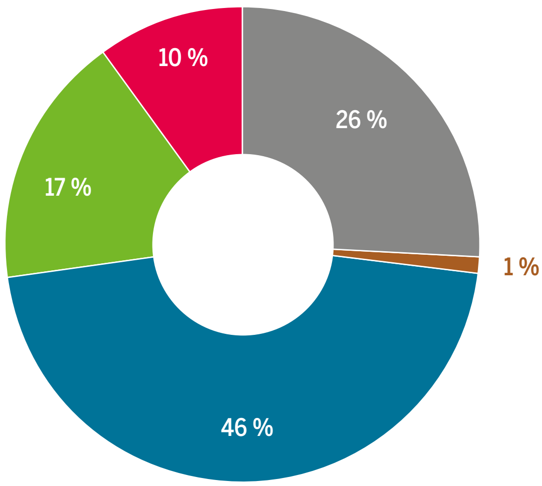
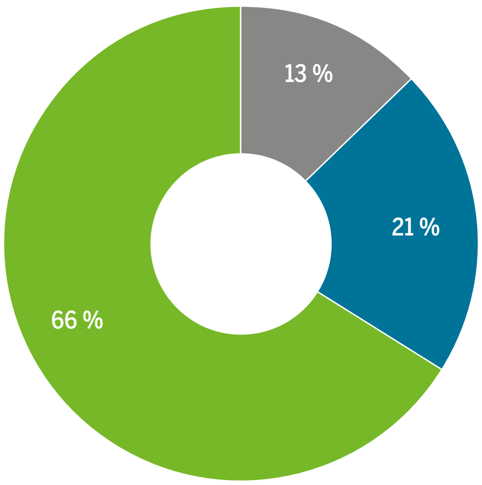


Figure 4.9: Gross electricity generation in Germany

Figure 4.10: Gross heat generation in Germany

4.2.5 CROATIA (HR)

Croatia is one of the greenest countries of the region in the electricity production with RES share of 66 %. In the heating sector the natural gas has similarly strong position. The key objectives outlined in the NECP are the reduction in greenhouse gas emissions for the Republic of Croatia for the year 2030, the share of RES in the gross final energy consumption and energy efficiency, expressed as consumption of primary energy and direct consumption of energy. The Republic of Croatia has set the following targets for reducing greenhouse gas emissions by 2030: in the ETS sector – at least 43 % compared to the 2005 level and for non-ETS sectors – at least 7 % compared to the 2005 level. Indicative targets for RES shares by 2030 are: in the gross direct consumption of energy 36.4 % share, in the gross direct consumption of electricity 63.8 %, in the gross direct consumption of energy for heating and cooling 36.6 % and in the direct consumption of energy in transport 13.2 %. Measures to reach NECP key objectives will not have significant impact on the natural gas consumption which is expected to stay at the consumption levels observed in 2019.



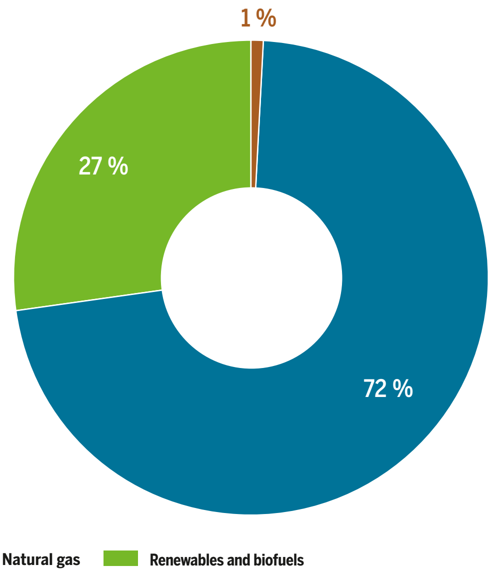
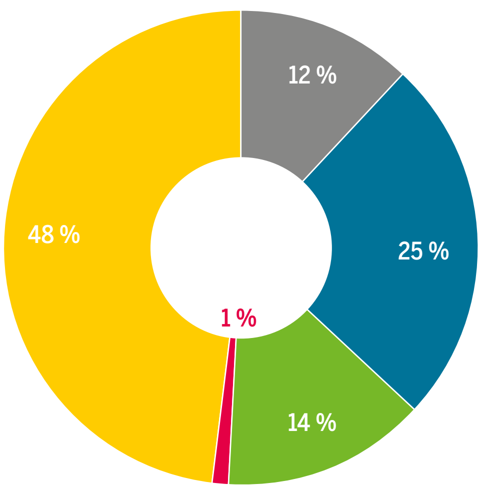


Figure 4.11: Gross electricity generation in Croatia

Figure 4.12: Gross heat generation in Croatia

4.2.6 HUNGARY (HU)

Nuclear power and natural gas are the most significant energy sources in Hungarian energy mix. The role of PV electricity is increasing fast. According to the NECP does not foresee significant role for renewable gases before 2040.



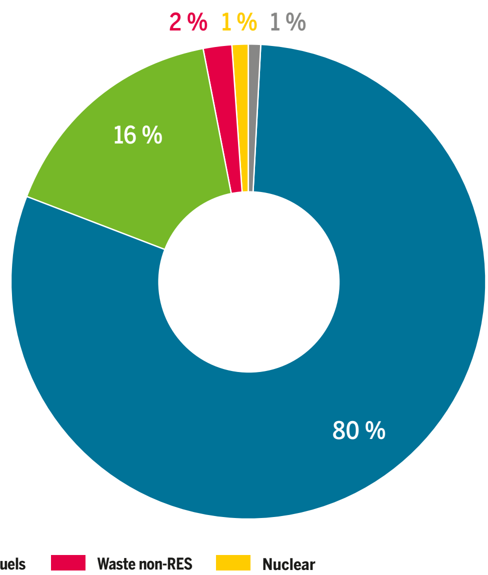


Figure 4.13: Gross electricity generation in Hungary

Figure 4.14: Gross heat generation in Hungary

4.2.7 POLAND (PL)

Poland is one of the biggest energy system in the CEE region, based on the coal and lignite. Due to this fact it is also one of the most air polluted country in the region. Poland is facing probably the biggest challenge in the region to decrease its portion of electricity and heat generated from solid fossil fuels. According to the national plans in 2040 this share shall decrease to 11–28 % in the electricity generation. NECP considers natural gas as a key fuel for the energy transition. It is expected to play a more prominent role in the future. Currently, natural gas is used mostly as feedstock in various industries, in households and other small & medium customers. in the years to come, the demand for natural gas will increase:

- in the heating & electricity generation sectors – new gas units will be put into commercial operations to meet increasing demand in respective sectors, replace ageing coal plants and thus contribute towards substantial emission reductions. New gas units will provide base-load supplies and back-up for variable renewables (solar PV, onshore and offshore wind);
- with enhancing the access to natural gas for domestic customers (i.e. gasification of the country);
- with a wider use of LNG and CNG as alternative fuels in sea and inland transport in Poland and the Baltic Sea region.

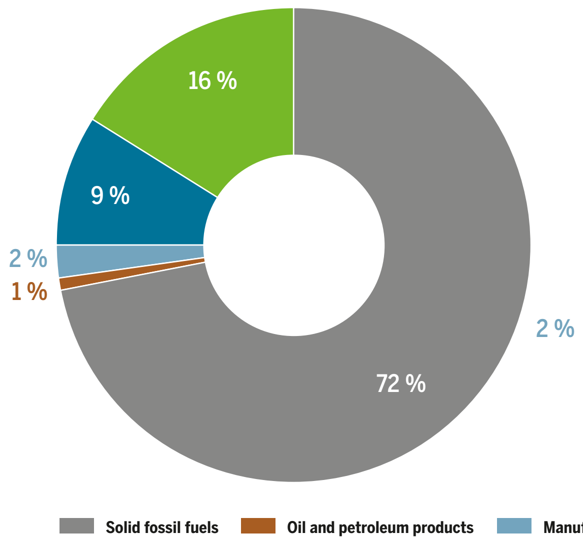


Figure 4.15: Gross electricity generation in Poland

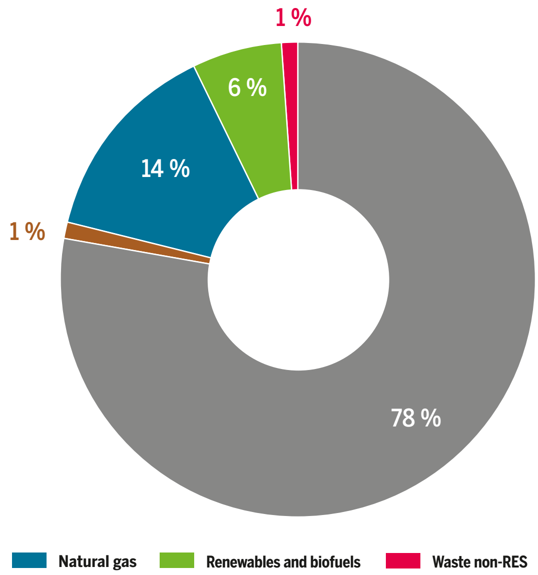


Figure 4.16: Gross heat generation in Poland

4.2.8 ROMANIA (RO)

Based on the outcomes of TYNDP modelling there are some gas infrastructure gaps indicated in Romania. In the sector of electricity generation Romania is among top countries with highest share of renewable energy. In the heat sector the major position of the natural gas still prevails. Based on the NECP Romania plans to keep natural gas in the centre of its energy system in the following years. Romania sees opportunities in hydrogen as a decarbonisation medium. The higher implementation of the RES depends on the expansion of the storage and technologies for injection of hydrogen in the form of synthesis gas from RES and the use of hydrogen in the industrial production.

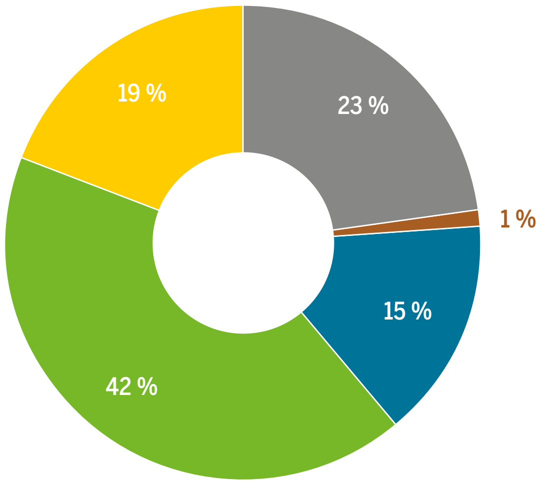


Figure 4.17: Gross electricity generation in Romania

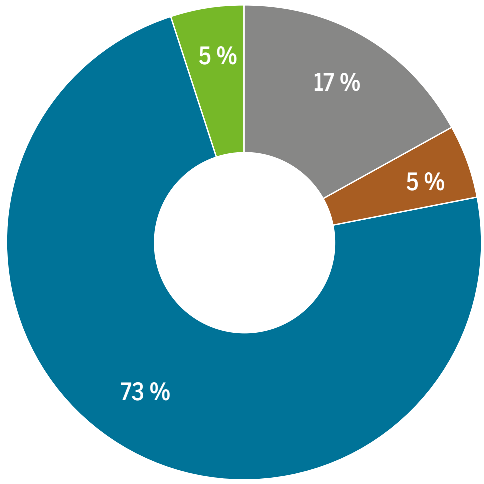


Figure 4.18: Gross heat generation in Romania

4.2.9 SLOVAKIA (SK)

Slovakia is important import corridor for Russian gas. In the electricity production the major energy source is nuclear. In the heat generation due to developed infrastructure in the district heating the natural gas plays important role with 47 % share. Slovakia has decided to stop the subsidy of the electricity generated from coal by 2023, the natural gas is one of the options on the table to replace the coal in the electricity generation mix. Massive use of the natural gas in the heating sector can be supported by implementation of new gasses and biomass production in the future.

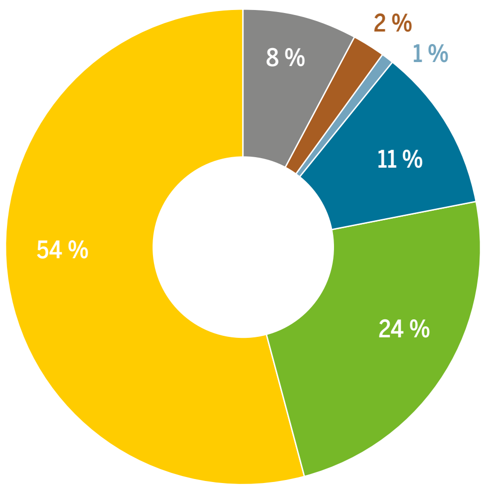


Figure 4.19: Gross electricity generation in Slovakia

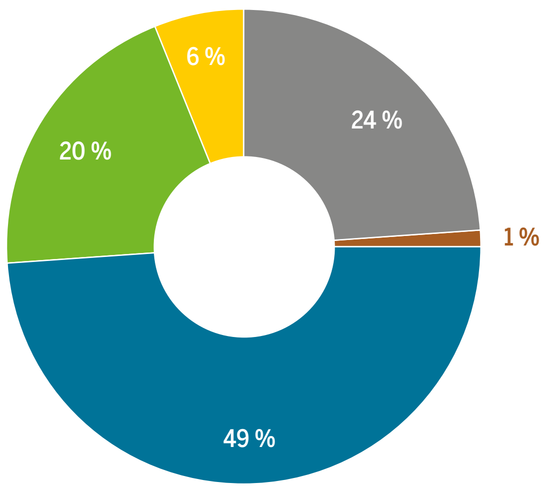


Figure 4.20: Gross heat generation in Slovakia

4.2.10 SLOVENIA (SI)

The NECP foresees at least 10 % of renewable gas by 2030 – hydrogen, biomethane, synthetic methane or biogas. Slovenia has three main energy sources in the electricity production mix – nuclear, renewable and biogas and solid fossil fuels. Solid fossil fuel is main energy source in the heat generation sector, followed by natural gas. In accordance with the decarbonisation projections, the share of renewable sources in the energy mix will increase.

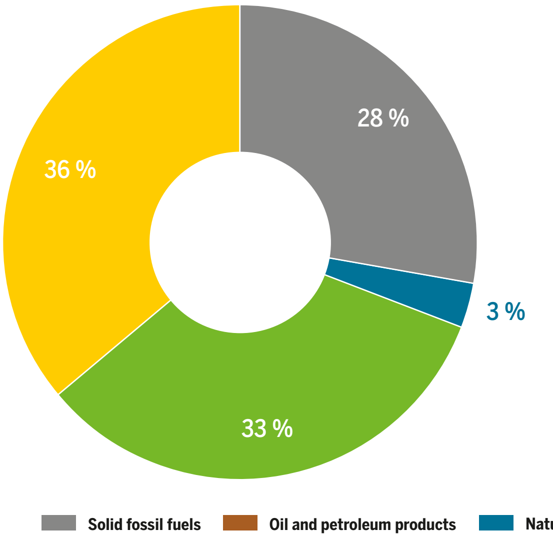


Figure 4.21: Gross electricity generation in Slovenia

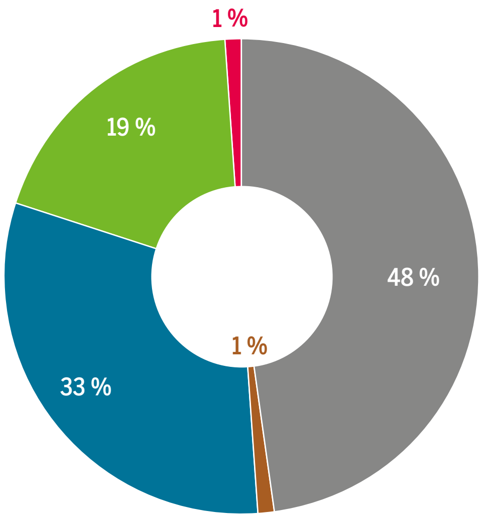


Figure 4.22: Gross heat generation in Slovenia

4.2.11 CONCLUSIONS

Based on the above mentioned the main conclusions of the GIE decarbonisation paper can be confirmed as follows:

1) In most cases, due to their transit character and historical circumstances, countries of the CEE region have natural gas in their energy mixes. For decades, in the vast majority of cases, it has been complementary to the fuel dominating in the national economy such as coal or nuclear energy.

2) Natural gas will be an intermediate fuel in the process of transition to the zero-carbon GHG emission economy, and at the same time, it can lead to both improved energy efficiency and lower energy efficiency costs compared to other conventional technologies.

3) The countries of the CEE region see the need to use new low-carbon gases, recognizing that their scale-up will vary depending on national conditions and the different starting points regarding each country's energy mix. Giving the important role that renewable and low-carbon gases will play as energy carriers in a more integrated energy system, new legislation and regulations should be introduced at the European level to create the right conditions for an EU-wide market to be developed.

4) The European Commission, through legislative proposals, should provide for solutions addressing the concerns and challenges raised in this report.

5) The development of hydrogen strategies and economies in the different member states as well as at EU-level underlines the necessity to invest into an EU-wide hydrogen infrastructure[3].

3 Decarbonisation in Central-Eastern and South-Eastern Europe: How gas infrastructure can contribute to meet EU´s long-term decarbonisation objectives, page 65

Picture courtesy of Gas Connect Austria

4.3 HYDROGEN STRATEGIES OF THE CEE COUNTRIES

4.3.1 AUSTRIA (AT)

State of play in Austria

According to the Austrian government programme 2020 – 2024 Austria should become hydrogen nation number one.[4] With this, it becomes clear that hydrogen is recognised as an energy carrier of the future. However, the national hydrogen strategy is still under development. Also on European level the framework for the hydrogen infrastructure and hydrogen market needs to be established. In 2021, the initiative to propose a revision of the existing EU gas rules to facilitate the market entry of renewables and low-carbon gases and remove any undue regulatory barriers has been initiated.

In summary, the regulatory and legal framework for the ramp-up of a hydrogen market is still in construction. In the meantime, Austria Transmission System Operators TAG and GCA have been active on drawing a vision, how the potential hydrogen infrastructure might develop in the next decades.

Vision

Renewable, decarbonised and low-carbon gases, especially hydrogen and biomethane, as well as sustainably generated electricity will be the backbone for achieving the European and national climate targets. As starting point, the focus is on the CO_2 reduction potential through substitution of existing fossil-based hydrogen applications, as well as future new hydrogen applications and process conversions up to space heating, combined with corresponding upscaling and adapted energy and feedstock management.

With the international and national transport of hydrogen via existing and future gas pipelines, a cost-efficient connection can be established between hydrogen production and hydrogen consumers. The transport of hydrogen via existing and future gas pipelines can be achieved by blending and deblending hydrogen into/from the existing gas network. An additional possibility how existing infrastructure could be used, is the repurposing of the existing infrastructure for dedicated pure hydrogen transportation.

Already today, the existing Austrian network has the potential to transport a content up to 4 % in the form of hydrogen blended with natural gas.

A vision for a dedicated hydrogen network is being developed in cooperation between the Austrian Transmission System Operator Gas Connect Austria GmbH, TAG GmbH in the frame of the European Hydrogen Backbone together with the other involved gas TSOs. The aim is to give a visionary representation of the future gas network, retrofitted or repurposed for transportation of CH_4, H_2 or a blend of both according to the capacity requirements which might change over time. It can be assumed that the retrofitting will cause only 10–20 % of the costs for the construction of new hydrogen pipelines[5].

4 Government programme of Austria 2020–2024, page 82

5 2021 European Hydrogen Backbone, Section 3. Cost of European Hydrogen Backbone

The vision of a transportation of hydrogen in blended or pure form in pipelines aims at creating an affordable pipeline infrastructure that is as cost-effective as possible and letting open the possibility to operate an existing methane infrastructure in parallel. For this purpose, the existing gas network is being examined for hydrogen compatibility with the help of comparative data and it is being determined which lines are basically suitable for transporting hydrogen. In a first extent, 2 categories were created.

a) Pipelines that are separated from the methane network and can be converted to hydrogen pipelines with relatively little effort. A parallel methane pipeline is still available. These lines are shown in Figure 4.23 in blue colour

b) Necessary gap closures for a newly installed hydrogen network. These lines are shown in Figure 4.23 in yellow colour.

Figure 4.23: Hydrogen compatibility of the AT existing gas network

The foreseen timing for implementation could start in 2030, when a first step towards a dedicated hydrogen network could be reached via blending and deblending into/from the existing infrastructure connecting Slovakia, Hungary, Slovenia, Italy and Germany.

By 2035, one of TAGs parallel pipelines could be repurposed to transit H_2 in both directions (from north to south and vice-versa). Furthermore, 3 interconnectors from Italy, Slovenia and Hungary could already emerge enabling H_2 transportation from North Africa and Ukraine to Slovenia, Hungary and Germany via Slovakia and Czech Republic.

By 2040, an additional interconnector to Germany could be added by entirely looping GCA's WAG pipeline offering an alternative transport route of Ukrainian H_2 to Germany (Slovakia to Germany). Upon completion, Austria's high-pressure grid would be ready to serve as a H_2 hub in the region. From then bidirectional H_2 transportation possibilities, at all interconnection points would be in place.

Although the timing is heavily dependent on both supply and demand of H_2 taking off and decreasing gas flows, the transported energy could provide security of supply when domestic production of hydrogen in North Europe is limited. In addition, GCA's network would also transport H_2 to Austrian (industrial) customers, such as one of Europe's largest steel plants in Linz, which is already running trials for hydrogen-based steelmaking and to a big refinery located near Vienna.

Already today about 10 % of the European methane storage volume is located in Austria. By converting part of the methane storage facilities into hydrogen storage facilities, a hydrogen trading center of European significance can be created in conjunction with a potent hydrogen pipeline infrastructure.

In a further step, the integration of the hydrogen between transmission and distribution levels will be deepened as well as and the further refining investigation of the material components. In any case, the aim is to integrate the Austrian hydrogen pipeline network into a future European network and to contribute to harmonized European trade.

Perspective

To turn the vision into reality a number of various conditions should be put in place, in particular:

- Transmission system operators should be allowed to own and operate H_2 network.
- Blending and deblending (the withdrawal of pure hydrogen from the natural gas-hydrogen blend) must be treated in a non-discriminatory manner, as they enable a progressive implementation of a long-range hydrogen transport at low cost in the medium and long term ("hydrogen backbone").
- A technology-neutral approach is required that allows every promising idea and every innovative project as well as all market participants to actively participate in the energy transition.

4.3.2 BULGARIA (BG)

The Integrated Energy and Climate Plan of the Republic of Bulgaria 2021–2030 (INECP) has been adopted in February 2020. The document sets out the main objectives and measures for the implementation of Bulgaria's national energy and climate policies and the principles and priorities for energy sector development.

The objectives set out in the INECP are as follows:

- promoting low-carbon economic development;
- developing a competitive and secure energy sector;
- reducing dependence on fuel and energy imports;
- ensuring that energy is available at affordable prices to all consumers.

The development of hydrogen technologies is among the goals of the Bulgarian government's policy in the area of research, innovation, and competitiveness. A pilot project for a hydrogen plant with a total installed capacity of 20 MW is planned to be developed. Based on project results an analysis of the further development of hydrogen power plants after 2030 will be conducted.

At this stage more than 10 Bulgarian organisations and companies are members of the European Clean Hydrogen Alliance.

In terms of hydrogen, the draft Bulgarian Recovery and Resilience Plan envisages:

- Adoption of a National Roadmap to improve the conditions for unleashing the potential of hydrogen technologies and mechanisms for production and supply of hydrogen;

- Designing, building, and commissioning of infrastructure in Maritsa East coal basin adequate for the transmission of hydrogen and low-carbon gaseous fuels;

- Scheme to support pilot projects for production of green hydrogen and biogas

As a first step, a report for evaluation of the potential for the development of hydrogen technologies will be prepared. The barriers to the development and implementation of these technologies will be identified and proposals for regulatory changes will be prepared to improve the conditions for unleashing the potential for development of hydrogen technologies and the mechanisms for production and supply of hydrogen.

The draft Recovery and Resilience Plan envisages construction of about 125 km gas transmission infrastructure in the Maritsa East coal basin, suitable for transport of hydrogen and low-carbon gaseous fuels. The new infrastructure is planned to be part of Bulgartransgaz EAD network. It will be accessible to all consumers, including coal-fired power plants.

The main purpose of the scheme to support pilot projects for production of green hydrogen and biogas is to provide support for designing pilot projects enabling the introduction of green hydrogen and biogas with application in industrial productions, as well as to be used in the future in transport and for electricity and thermal energy production. The specific objectives of the scheme are:

- Establishing strategic frameworks to identify potential opportunities and challenges through consultation with stakeholders;

- Development of pilot projects allowing the introduction of green hydrogen and biogas in industrial processes, with a view to their future use in transport and for the production of electricity and heat;

- Create a knowledge cluster and solutions for the production of renewable gases, their application for sector integration, in order to stimulate innovation through promotion, exchange of knowledge and experience, knowledge transfer, building a platform with a database of knowledge and innovation, dissemination of information and cooperation between enterprises.

As part of the Plan, 55 MW electrolyser projects that will produce 7,800 tonnes per year of green hydrogen are envisaged.

The draft Recovery and Resilience Plan envisages also a project for the construction of high efficient combined cycle gas plant which will replace at least 1.0 GW coal based capacity in TPP Maritsa East 2. The project promotes the energy transition process. As a next step, by the end of December 2029, the installed 1.0 GW coal based capacity will be transferred to a hydrogen power plant.

Another initiative in which Bulgaria intends to participate is National research programs of the Ministry of Education and Science – Low-carbon economy for transport and life (EPLUS) and Environmental protection and lowering the risk of adverse events and natural disasters, aiming to generate know-how with a focus on the storage and conversion of renewable energy, hydrogen-based technologies and eco-mobility, conducting fundamental and applied research. The programs will be implemented over 3 to 5 years.

4.3.3 CZECH REPUBLIC (CZ)

The principles of the Czech Hydrogen Strategy

The Czech government has approved the Hydrogen Strategy of the Czech Republic (hereinafter the H_2 Strategy) on 26 July 2021. It follows the European Hydrogen Strategy and is being created in the context of the EU's target to achieve climate neutrality; therefore, the H_2 Strategy has **two strategic targets**:

A. Reduction of greenhouse gases emissions.

B. Support of economic growth.

For these two strategic targets to be achieved, the H_2 Strategy has **four specific targets**:

1. Volume of low-carbon hydrogen production.
2. Volume of low-carbon hydrogen consumption.
3. Readiness of infrastructure to transport and store hydrogen.
4. R&D, innovation, and technology production.

The H_2 strategy is then based on four pillars – production, utilisation, transport and storage, and technologies. These pillars match the four specific targets and are interconnected. In the first phases of H_2 economy development in the Czech Republic the H_2 strategy focuses on ensuring a balance between production and utilisation of H_2. The focus is not only on renewable H_2 but also on low-carbon H_2 produced from natural gas with CCS/U, by pyrolysis of waste, or by using power and heat from nuclear power plants.

The H_2 Strategy divides the H_2 deployment into three periods:

1) 2021–2025: Use of H_2 is mainly expected in the mobility sector and development of H_2 clusters will prevail, i.e., production is being built near consumption sites. Large production capacities are being built for future development of H_2 economy. No pipelines for pure H_2 will probably be used during this period so H_2 will be transported in liquid or pressurized form. Some initial injection (pilot projects) of H_2 into gas grids may occur.

2) 2026–2030: Use of H_2 in industry to be verified in this period (pilot projects with support). Planning of building new H_2 pipelines and mainly repurposing of existing pipelines will start. Injection of H_2 into gas grid will take place to decrease emission intensity of households and industry. Serial production of H_2 vehicles will take place.

3) 2031–2050: H_2 mobility sector should not need support scheme anymore and function independently. Building as well as repurposing of pipelines will start. Gradual shift from fossil fuels to H_2 in segments of industry is forecasted (commercial operation without support) but will be conditioned by existence of H_2 pipeline infrastructure mainly to transport cheap imported H_2. Some households and building might switch to H_2.

Transmission in the Hydrogen Strategy of the Czech Republic

The Czech Republic has well-interconnected and reliable gas infrastructure system which has historic experience with H_2 from transportation of town gas containing about 50–60 % of H_2. Based on existing studies and research, the current gas system is technically ready to transport, distribute and store 2 % H_2 in blend with natural gas. The limitations of H_2 transport in gas network are primarily because of final consumers and various appliances. With some technical adjustments it will be possible to increase share of H_2 (i.e., retrofitting) while transmission of hydrogen blends is the simplest and cheapest solution to kick start the development of hydrogen economy. However, later it will be probably the most cost-effective to transport pure hydrogen. This will require bigger technical modifications for the existing gas infrastructure to be able to transport pure H_2 (i.e., repurposing). Both retrofitting and repurposing present more cost-effective way than building new H_2 infrastructure.

Transportation via pipelines was found as the most effective mode in large volumes and for longer distances, i.e., in later phases of H_2 deployment in the Czech Republic where there will not be only H_2 clusters. The H_2 strategy emphasises the fact that infrastructure development planning and potential retrofitting/repurposing is a long process and must be done in advance so that the infrastructure is ready in time. If the infrastructure would not be ready in time, the development of H_2 economy in the Czech Republic would be extremely difficult as production and consumption sites must be interconnected.

The H_2 strategy expects that the Czech Republic will import H_2 from countries that have more suitable conditions for production of renewable H_2 due to bigger potential for solar and wind power plants deployment. The infrastructure will have to be ready for the H_2 import. Moreover, the Czech Republic can be an important player in transporting H_2 from south to north and from east to west and keeping its status as a transit country. Thus, the Czech Republic must be connected to neighbouring countries and to trans-European hydrogen system. The first plans to create the trans-European hydrogen system are described in the European Hydrogen Backbone project which NET4GAS, s.r.o. (the Czech TSO) is a part of. This project expects that the trans-European H_2 system will be from three quarters based on the existing gas infrastructure and the remaining part will be necessary to build.

4.3.4 GERMANY (DE)

The National Hydrogen Strategy (NHS) of Germany was published in June 2020 by the Ministry of Economics and Energy. The NHS is aiming for the creation of a pathway towards a hydrogen market within the current decade from 2020 to 2030 and beyond. This is happening primarily in order to achieve the European 2030 climate targets but also as a response to the general European principles of carbon-neutrality by 2050.

The NHS lines out potentials in energy provision, within industry and mobility as well as within the district heating market in the long term. Furthermore, hydrogen has the potential to store renewably produced electric energy. To provide an efficient and sustainable development of the market, as well as fair conditions in the fields of distribution and supply, a governance system is established. It is going to contain a committee of state secretaries that will govern the NHS, as well as monitor and establish measures to ensure continuous progress. To support and advise the committee, 26 experts from industry, science and society will form a board.

The path of the NHS is divided into two phases. The first phase approaches the upscaling of the national hydrogen market from 2020 to 2023, using investment strategies and scientific innovation. The second phase describes the integration of the national market within the EU market as well as within international markets from 2023 to 2030. This idea is embedded in the idea of sustainable development and the support of countries with high potential and low economic power. Therefore, the economic strength of Germany will not be the production of hydrogen but the exportation of highly developed technological devices necessary for energy transition.

The current yearly national demand of hydrogen is 55 TWh, whereby only 7 % are produced via electrolysis. By 2030, a demand from 90 TWh to 110 TWh is projected. This surplus is estimated mainly within the sectors of chemical industry, steel industry and transportation. To provide the requested amount of hydrogen, electrolyser networks will be scaled up and improved towards energy efficiency. The green hydrogen that will be produced, will not be sufficient for the projected market. Therefore, green hydrogen will be imported, as well as blue and turquoise hydrogen.

To enable a long-term market for hydrogen, the supply will be supported through state aid and legal frameworks. To generate green hydrogen, offshore energy plants for renewable electricity will offer a large opportunity for Germany's coastal area. Via electrolysis green hydrogen will be produced, which is to be transformed into other energy carriers that are summarized in the term Power-to-X (PtX). These products need to be transported across Europe and stored in multiple places to ensure a permanent supply of renewable energy carriers.

The NHS describes the existing national pipeline infrastructure as a future hydrogen and PtX product network. Therefore, the existing pipelines must be adjusted to the new technical requirements. Also new, additional pipelines must be built in order to enable the process of transformation of the energy system. Pipeline networks are playing a key role in sector coupling and ensuring energy security in the future years and in the phase of transition. In order to support this process, the NHS is describing the development of a new regulatory framework especially established for a future hydrogen market. Furthermore, labelling and standardization systems will be implemented to guarantee the sustainability and quality of the products.

Regarding the European market, Germany will become a player in international transition of hydrogen, therefore, international pipeline systems will play a major role as well. To give incentives towards transition, state aid programs will be conducted. The minimum sum of the subsidies to be expected within the next years (2020–2030) lays around 12.5 billion EUR.

4.3.5 HUNGARY (HU)

In May 2021 the Hungarian Government accepted Hungary's National Hydrogen Strategy (NHS).

The main goal is the establishment of a hydrogen economy in Hungary, therefore contributing to the achievement of decarbonisation goals and providing an opportunity for Hungary to become an active participant of the European hydrogen sector.

VISION OF THE HYDROGEN STRATEGY			
We are developing potent competencies with regard to the key elements of the hydrogen value chain, which, supplemented through targeted RDI and economic development activities, will serve to promote the shift towards a carbon-free society and to maintain the competitiveness of the Hungarian economy.			
PRIORITY OBJECTIVES - 2030			
Production of large volumes low-carbon and decentralized carbon-free hydrogen Establishing the conditions necessary to produce low-carbon and carbon-free hydrogen that is in compliance with user requirements and is competitively priced. • **20 thousand tons / year low-carbon hydrogen** **+** • **16 thousand tons / year "green"* and other carbon-free hydrogen** • **240 MW electrolyser capacity****	**Decarbonisation of industrial consumption, partly with hydrogen** At first, predominantly low-carbon hydrogen will be used to make the industrial processes and product use "more green", with a shift to carbon-free hydrogen usage on the longer term. • **20 thousand tons / year low-carbon hydrogen** **+** • **4 thousand tons / year "green"* and other carbon-free hydrogen** • **avoiding the emission of 95 thousand tons of CO_2**	**Green transport** Accelerating the transition to clean modes of transportation by a gradual transition from gas oil usage to clean alternatives. Within this framework, on the 2030 timeline, hydrogen may become a realistic alternative primarily in heavy-duty vehicle traffic. • **10 thousand tons / year "green"* and other carbon-free hydrogen** • **20 hydrogen refuelling stations / 40 refuelling points** • **4.8 thousand HFC vehicle** • **avoiding the emission of 130 thousand tons of CO_2**	**Electricity and (natural) gas support infrastructure** Building sector integration ability - primarily seasonal energy storage ability - by utilising intersectoral synergy, establishing infrastructure that will enable the transition to carbon neutrality, and reconstructing existing infrastructure. • **60 MW average cut-off capacity** • **min. 2% per year volume blending ratio in the natural gas system (where appropriate)**
SUPPORT OBJECTIVES			
Taking advantage of industrial and economic development opportunities Enhancing the activities at the intersection of industrial trends and Hungary's domestic strengths in order to promote competitiveness and stimulate domestic penetration.	**Horizontal conditionality: establishing a stimulating operational environment** • Establishment of comprehensive regulatory and operational frameworks, • promoting partnership and international cooperation.	**RDI and education to promote the success of hydrogen during the transition** • It is essential for the implementation of strategic objectives to establish a system of scientific, technological and horizontal competencies that can serve as a foundation for the domestic use and development of new technologies and for demonstrating the legitimacy of such technologies on the domestic market.	

Hungary plans to establish two new hydrogen valleys by 2030.

The hydrogen production goal of the Strategy is establishing the conditions necessary to produce low-carbon and carbon-free hydrogen that is in compliance with user requirements and is competitively priced by promoting the implementation of centralised and low-carbon production methods able to satisfy large volumes of local, industrial demand, and decentralised carbon-free production methods able to satisfy minor demand.

Industrial decarbonisation

At first, the reduction of the carbon footprint of industrial processes and product use is to be achieved through the usage of low-carbon hydrogen, with a shift to carbon-free hydrogen usage on the longer term.

Green transportation

The general goal of the Strategy as regards transportation is speeding up the transition to clean methods of traffic partly by way of hydrogen usage, which can be implemented parallel to the gradual reduction of gas oil use with a focus on heavy-duty vehicle traffic. A priority sub-target is the reduction of the carbon footprint of truck traffic through the use of hydrogen, the expansion of hydrogen mobility to bus traffic and waste collection, and, at the same time, the construction of a hydrogen refuelling infrastructure based on an island, as well as a corridor logic.

Electricity and natural gas support infrastructure

Hungary's goal is building sector integration ability – primarily seasonal energy storage ability – by utilising intersectoral synergy, establishing infrastructure that will enable the transition to carbon neutrality, and reconstructing existing infrastructure

Implementation of the Strategy

To implement the Strategy as soon as possible, there are six comprehensive, so-called prioritised projects, which, till 2030, are complemented by professional measures scheduled along 3 timelines. Prioritised projects, which are meant to implement the primary goals of the Strategy and which should be launched as soon as possible, are as follows (with the estimated subsidy requirements in parentheses):

1) Green Truck Programme for making freight traffic greener (HUF 35–40 bn)

2) Green Bus Programme Plus for making public services, concerning transportation at the local level, greener (HUF 10–20 bn)

3) Establishment of hydrogen valleys in Hungary to promote the establishment of interconnected networks of the hydrogen value chain within the given geographical regions (HUF 10–15 bn)

4) Hydrogen Highway Project for creating a foundation for carbon-free hydrogen production, transportation and energy storage (HUF 20–30 bn)

5) Blue Hydrogen Project for reducing the carbon footprint of industrial hydrogen usage (HUF 20 bn)

6) Research, development and innovation in service of the establishment of a hydrogen economy (HUF 10 bn)

2021-2023 ESTABLISHMENT OF FRAMEWORKS	2024-2025 FIRST RESULTS	2026-2030 RISE
The development of the implementation framework of the Strategy and the operational plans of the hydrogen economy, the establishment of the conditions necessary for producing low-carbon hydrogen, the launch of electrolysis-based hydrogen production and prioritised comprehensive projects, and the preparation of associated test projects will be in focus during this stage. In addition to all this, the installation of hydrogen refuelling points, the development of an educational-training background, and the establishment of international cooperative partnerships will also begin. Since hydrogen demand will be satisfied at first near or at the site of production, the need for transportation infrastructure will be limited to a minimum.	Developments concerning all pillars of the Strategy will be launched, with particular attention being paid to the building of domestic manufacturing and service background capacities. The reduction of the carbon footprint of existing hydrogen production and usage will gain momentum in the refinery sector, in the petrochemical industry and in ammonia production. Hydrogen production through electrolysis will expand, and hydrogen-based mobility will be introduced to heavy-duty vehicle traffic. The infrastructural requirements associated with hydrogen transportation will remain limited, as, in the beginning, demand will be satisfied near or at the place of production. However, in certain domains, the small scale blending of hydrogen and natural gas may alreahy occur in certain sectors. Additionally, the drawing up of the concept of regional connection to the European Hydrogen Backbone and the expansion of the hydrogen refuelling infrastructure network will continue.	As the previously initiated developments become productive, the partial decarbonisation of existing industrial hydrogen usage will be realised, industrial production processes will be made more green, and the transition to clean methods of transportation will become more accelerate. The basis for the countrywide network of hydrogen refuelling stations will be established, and the natural gas transportation, storage and distribution network and the user systems will be prepared for the uptake of larger rates of clean hydrogen will begin. The first hydrogen valleys will also serve as proof of the successful implementation of the Strategy. By the end of the period, our hydrogen economy will be integrated into the European hydrogen economy. As regards costs, low-carbon and carbon-free hydrogen is becoming increasingly competitive against "grey" hydrogen. Expanding hydrogen uses to cover additional domains (steel production, cement industry) will require additional intervention.

Between 2030 and 2040, with the advancement of technology, we can expect further increase in the use of hydrogen. In the period after 2040, the use of hydrogen technology may further expand in the natural gas network and the cooling-heating sector.

FGSZ's envisage in short and midterm:

- In the first five years, the blended H_2+Natural gas (NG) will appear and will increase in volume gradually.
- New H_2 or H_2+natural gas entry points on TSO system will appear.
- The gas quality measurement system shall be upgraded for blended gas. The gas quality management system shall be established for blended gas.
- TSO intends repurposing NG pipelines to H_2+naturall gas pipeline or pure H_2 pipeline according to the demand. And looking for the possibilities to join to the European Hydrogen Backbone system, which will gradually be growing.
- TSO is studying the possibilities changing some current gas turbine driven compressor unit to electric driven compressor unit.

Between 2030 and 2040

- Monitoring new production technologies, expanding international collaborations in order to employ market-ready solutions domestically as soon as possible.
- Supporting carbon dioxide capture and utilisation solutions in the petrochemical and chemical industry.
- Facilitating conditions for raw material usage necessary to meet the industrial heat demand (e.g. cement manufacturing).
- Expanding usage in the steel and the cement industries.
- Expanding the use of fuel cell buses in interurban public transportation.
- Promoting hydrogen propulsion technologies in railroad transportation (utilisation), where the implementation is economically feasible.[5]
- Promoting, on a larger scale, the use of hydrogen propulsion technologies in water transportation to reduce the environmental impact on our bodies of water.[6]

After 2040

- Preparing the gas distribution network and user systems for the uptake and utilisation of clean hydrogen.
- Examining the possible uses of carbon-free hydrogen in the satisfaction of cooling/heating demand and promoting the potential introduction of such technologies.

4.3.6 POLAND (PL)

An action plan for the development of a hydrogen market in Poland is currently set out in a draft "Polish Hydrogen Strategy until 2030 with a perspective until 2040" that was released by the Ministry of Climate and Environment. The draft strategy defines objectives and activities for the ramp-up of national competencies and technologies with the objective of building a low-carbon hydrogen economy. These objectives refer to three areas, which can benefit from the development of hydrogen technologies – energy, transport and industry, as well as to its production, distribution and the necessary regulatory and funding changes.

Modern hydrogen technologies, due to their features and interlinkages with a number of industries, are considered in the strategy as the key factor in maintaining the competitiveness of the Polish economy. The current situation on the energy market offers an opportunity for hydrogen to play a significant role in creating a low-carbon economy. Importantly, the business and technological environment is conducive to the development of production, distribution and use of hydrogen both in the energy sector, industry and in transport. In the near future, it will be possible to commercialize other technologies, such as the use of hydrogen in the production of synthetic fuels, in power-to-gas, power-to-liquid and power-to-ammonia installations.

The strategy puts an emphasis on the development of strong domestic competences in the production of key components in the value chain of modern hydrogen technologies. For this purpose, it is necessary to develop electrolysed and fuel cell installations, transportation networks, hydrogen storage facilities and refueling infrastructure. Through appropriate support for research and development, Poland has a chance to use the scientific potential and expert experience in the field of hydrogen technologies, relying on its innovative technologies.

The draft strategy identifies **6 objectives** which need to be achieved:

Objective 1 – Implementation of hydrogen technologies in the energy sector – activities aimed at the development and utilisation of low-emission hydrogen technologies in the energy sector to reduce the emissions and diversify the energy generation structure, to limit the use of fossil fuels and reduce the state's dependence on fuel imports.

Specific objectives:

- commissioning of P2G 1 MW installations based on Polish technologies (support for stabilising the operation of distribution networks),
- co-combustion of hydrogen in gas turbines (depending on technical possibilities) and conversion of existing installations;
- support for research and development in the creation of co- and poly-generation systems in order to create demonstration installations and then commissioning of medium-sized installations,
- use of hydrogen and hydrogen derivatives to store energy.

Objective 2 – Use of hydrogen as an alternative fuel in transport, especially in urban transport (buses), road transport (heavy and long-distance transport), rail transport (locomotives and traction vehicles equipped with fuel cells and batteries) and sea transport, and in the long term also in aviation.

Specific objectives:

- creation of conditions enabling the admission to operation of 100–250 hydrogen-powered buses manufactured in Poland in 2025 and the commencement of operation of 800–1000 hydrogen buses in 2030,
- development of a core network by building 32 hydrogen refuelling stations by 2025, further expansion of refuelling stations in the subsequent years,
- construction of the first hydrogen trains/locomotives that will replace their diesel counterparts on routes difficult to electrify,
- production of synthetic fuels by the reaction of hydrogen with CO, CO_2, N_2.

Objective 3 – Support for the decarbonisation of industry and consequently the contribution towards the reduction of greenhouse gas emissions of the whole economy, especially in hard-to-abate sectors (e.g. heavy industry).

Specific objectives:

- support for activities aimed at obtaining and applying low-emission hydrogen for petrochemical, chemical and fertilizer production processes,
- implementation of pilot projects in hard-to-abate sectors (in particular in steel, refining and chemical),
- introduction of a carbon contract for difference as an instrument to support the transformation of industry,
- financial and organizational support for feasibility studies of industrial hydrogen valleys, the creation of at least 5 hydrogen valleys with a significant element of hydrogen transmission infrastructure.

Objective 4 – production of low- and zero-emission hydrogen in new installations by 2030.

Specific objectives:

- by 2025 commissioning of an installation for the production of hydrogen from low-emission sources, e.g. in the process of electrolysis, from biomethane, waste gases, from natural gas using CCS/CCU, by pyrolysis and other alternative hydrogen production technologies,
- launching the production of synthetic gases in the hydrogen methanation process,
- use of the installed capacity in RES for the production of hydrogen and synthetic fuels based on the electrolysis process (installed capacity of electrolysers to reach 2 GW in 2030),

Objective 5 – efficient and safe distribution of hydrogen from the production sites to the end users and its safe storage, the development of an analysis of the most optimal form of energy transmission for the ramp-up of the hydrogen economy and then taking appropriate implementation measures.

Specific objectives:

- gradual development of hydrogen transmission and distribution networks (for hydrogen blends and pure hydrogen),
- R&D activities in the accommodation of large-scale salt caverns for hydrogen storage,
- injection of SNG produced in P2G systems to gas grids,
- road, rail and intermodal hydrogen transport.

Objective 6 – building a stable regulatory environment to remove barriers to the development of the hydrogen market and to encourage a gradual increase in the use of renewable energy for the purpose of electrolysis. The most important activities in this area include the creation of a regulatory framework for the functioning of hydrogen as an alternative fuel in transport, creating a legal basis for the functioning of the hydrogen market and, in the longer term, the development of a legislative hydrogen package (regulations specifying the details of the market functioning, implementing EU law in this area and setting out incentives for low-emission hydrogen).

The final version of Poland hydrogen strategy is expected in the second half of 2021. In parallel, representatives of industry, academia and public administration joined forces to draft and publish a sector deal on hydrogen with the aim of defining a list of long-term activities for the development of the hydrogen industry, to be undertaken by public and private entities. The sector deal on hydrogen was signed in mid-October 2021.

4.3.7 SLOVAKIA (SK)

In the spring 2021 the Slovak Ministry of Economy presented the consultation draft of the document "National Hydrogen Strategy "Ready for the Future" (hereinafter as "NHS" or "National Hydrogen Strategy") to the wide public. The NHS was approved by the Slovak Government in June 2021.

Key points of the document:

- Strategy confirms the 2050 carbon neutrality commitment of the Slovak Republic
- Declared aim to be hydrogen independent
- Existing gas infrastructure will play a key role in the transformation to a carbon neutral economy of the Slovak Republic

The National Hydrogen Strategy defines the strategic role of the state in the use of hydrogen technologies in the Slovak Republic in the context of current developments in the European Union countries. .

Steps, presented in the document towards hydrogen implementation into the Slovak economy, shall contribute to increase of the competitiveness of the Slovak economy and at the same time significantly contribute to the carbon neutrality in accordance with the Paris Climate Agreement, to which the Slovak Republic has signed up. The NHS defines the conditions for the implementation of hydrogen technologies in accordance with the long-term strategic development plan of the Slovak Republic until 2030, resp. 2050.

In order to create a platform for professional dialogue in terms of hydrogen utilisation, the Ministry of Economy of the Slovak Republic organised a conference „Hydrogen Future of Slovakia" on 16 July 2020. Representatives of industry, science, research, academia and social sector positively evaluated the creation of a platform within which strategic intentions and opportunities were formulated.

Slovakia thus immediately followed up on the adoption of the Hydrogen Strategy for a Climate Neutral Europe, which was adopted by the European Commission (EC) in July 2020.

To achieve the ultimate goal of decarbonisation, the Slovak Republic expects to use hydrogen as an energy carrier in its industry sectors and in public life, wherever the direct use of electricity is not possible or is cost-inefficient.

The goal of the Slovak Republic is to create favourable conditions for hydrogen production so that the Slovak economy could rely on its own production as much as possible in the future.

The hydrogen utilisation is preferably expected in following sectors:

- **Chemical and petrochemical industry**: The chemical industry with a current consumption of more than 200,000 t/year is the largest producer and consumer of grey hydrogen and thus it is a sector with a great potential for hydrogen consumption in the future.
- **Steel industry and metallurgical processes**: In the Slovak Republic, hydrogen is used as an inert gas in protective atmospheres in heat treatment of steel products or in direct reduction of iron ore as a substitute for blast furnace technologies, which are characterised by high emission values.
- **Gas sector**: The development of markets for the use of hydrogen in the Slovak Republic requires the creation of innovative logistics solutions for its transmission, distribution and storage. The existing capacity of the natural gas transmission and distribution network will be used. For the storage of hydrogen, the possibilities of its storage in the current underground storage facilities will be used.

In the future, solutions will be sought for the technological repurposing/retrofitting of the Slovak natural gas transmission network for the transport of hydrogen, its expansion and connection to gas networks within the European area.

The Slovak Government will also focus on the possibilities of the natural gas transmission network to be used for the transport of hydrogen, unless its capacity is fully used for the transport of natural gas. At the same time, solutions will be sought for the technological adjustment of the gas distribution network to the possibilities of national hydrogen distribution, depending on the development of the hydrogen market.

Hydrogen in the gaseous state can be blended into the natural gas distribution network, which is well developed in the Slovak Republic. It will be possible to use it for the transport and distribution of hydrogen after technical modifications, which will be preceded by a detailed expert analysis of the technical condition of gas networks (eg pipelines, pressure relief devices, fittings, flow measurement, etc.) with additions to safety features and components required for hydrogen if required. The use of hydrogen and various forms of gaseous mixtures containing hydrogen will play an important role in the decarbonisation of heat management. The determination of the maximum safe level of hydrogen blending will be preceded by a detailed research and testing of the impact of hydrogen on the materials and components of the gas equipment used. The necessary technical modifications of the gas network will be identified and implemented. An important element of research and development will be the identification of suitable technologies and procedures for mixing and, conversely, the subsequent separation of hydrogen from a mixture with natural gas.

Heat management - Quantification of the effective rate of replacement of natural gas with hydrogen for heat management will require further analyses focusing on the ability of the electricity system to cover the induced additional electricity and gas network consumption and to store the required volumes of hydrogen for the long term period.

Transport - A network of filling stations will be built in the Slovak Republic for the use of hydrogen in transport, especially in a heavy one. The criterion will be the concentration of traffic in the region and the expected hydrogen consumption. Hydrogen decarbonisation reduces some of the negative effects of mobility on the environment. At the same time, it offers extensive space for the transformation of the production of vehicles, as one of the main parts of the Slovak industry.

A special group of hydrogen production consists of plants using the principles of high-temperature pyrolysis and gasification, in which non-recyclable waste of various kinds is treated. Hydrogen-rich synthesis and pyrolysis gas with CO_2 processing (CCU) is a source of blue hydrogen. This gas is also used as a fuel for other energy and petrochemical applications. An important role is played by the technology of pyrolysis of natural gas, in which, in addition to hydrogen, solid carbon is also produced.

Based on the existing use of hydrogen, it can be assumed that in the Slovak Republic by 2030, 200 kt of hydrogen will be consumed annually. Intensive use of hydrogen assumes an increase in its total consumption from 400 to 600 kt by 2050, out of which up to 90 % from low-carbon sources. Due to the capacity limits of sources and the electricity system, the implementation of the most ambitious scenario of hydrogen production will require the involvement of all available technologies of hydrogen production, its transport, distribution and storage.

Increasing the prices of emission allowances and reducing the costs of hydrogen production might in the future lead to a partial replacement of natural gas consumption for hydrogen in the heating and cooling segment. The priority interest will be to strive for the greatest possible coverage of domestic hydrogen consumption in industry.

Through the hydrogen strategy, the Slovak Government will create a coherent framework for the use of hydrogen throughout its chain. It will cover the production of hydrogen, its transport, distribution and storage, as well as the use and manufacture of products, technologies and components for the hydrogen economy, including all necessary safety features and components.

The Government of the Slovak Republic declares to participate in:

- introduction of measures for the use of low-carbon hydrogen and its compounds in transport,
- implementation of policies for the use of low-carbon hydrogen technologies in relevant areas of the national economy,
- developing a common standard for low CO_2 emissions within the low carbon hydrogen supply chain,
- introduction of general terminology and criteria for quality certification of processes based on the use of low-carbon hydrogen throughout the life cycle from production, transport, distribution to use.
- introduction of legislative and regulatory measures and safety regulations to support the readiness of the gas infrastructure for the transmission, distribution and storage of hydrogen;
- support for research, development and innovation of hydrogen technologies

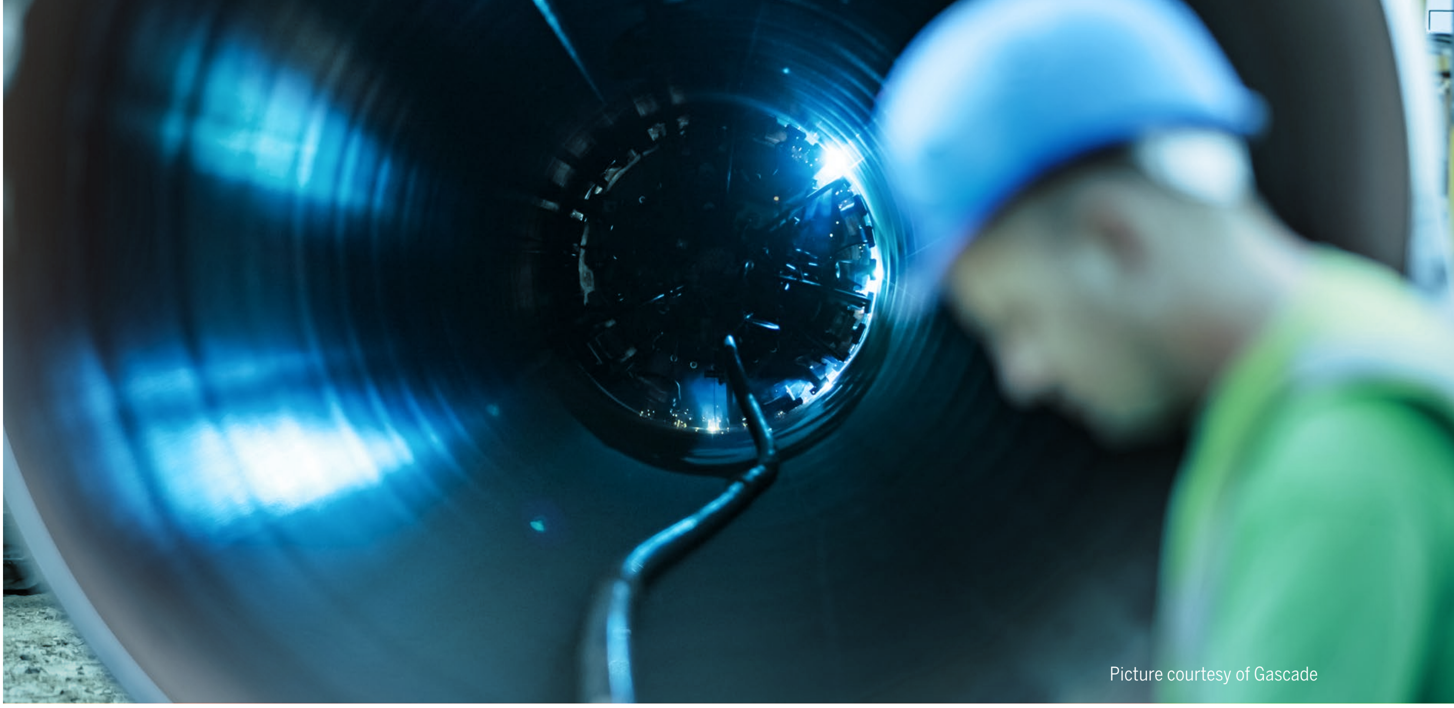
In order to ensure a sufficient amount of hydrogen produced in the territory of the Slovak Republic, or for its purchase from countries in which it will be possible to produce it at lower costs, as well as for its extensive use, the Government of the Slovak Republic must take the following measures:

- develop policies to stimulate demand in the hydrogen end-use sectors, which will be linked to decarbonisation targets,

- implement support measures that will facilitate the emergence of innovative products, technologies and industrial solutions for the production of hydrogen and its processing in the processes of the Slovak industry and energy,
- participate in the development of a common standard for low CO_2 emissions during the production of hydrogen, as well as within its implementation chain and its anchoring in the relevant legal standards.
- introduce general terminology and criteria for hydrogen certification,
- to ensure the participation of the Slovak Republic in the creation of a pilot program to support the production of low-carbon and recycled steel and basic chemicals,
- take into account hydrogen production scenarios in terms of the impact on electricity consumption and the development of energy infrastructure in national strategic documents and government policies
- create conditions for the issuance of guarantees of origin for hydrogen produced from RES in the form of self-consumption as part of the adjustment of the legal framework for the promotion of renewable energy sources and analyse the possibilities for extending the issuance of guarantees of origin to hydrogen produced in other ways,
- Assess and propose support measures to stimulate the readiness of gas infrastructure for hydrogen transmission, distribution and storage.

In addition to financial support, the Government of the Slovak Republic will focus on other types of support for the development of hydrogen technologies. According to the International Energy Agency, national governments can help develop this area by applying the following policies:

- generating long-term signals that boost investor confidence,
- stimulating commercial demand for hydrogen,
- introducing measures to reduce the risks arising from the introduction of new technology throughout the hydrogen supply chain,
- supporting research, development and knowledge sharing in the field of hydrogen technology applications,
- harmonizing standards and removing legislative barriers to the implementation of hydrogen-based solutions,
- removing barriers and taking measures to reduce the price of self-produced electricity,
- effective use of regulatory tools.



Picture courtesy of Gascade

5 CONCLUSIONS

This is already the fifth edition of the Gas Regional Investment Plan for Central and Eastern Europe (CEE GRIP). It provides a specific regional view emphasising the regional gas infrastructure outlook, specific assessments, and the basis for the identification of potential future gas infrastructure needs in the CEE region. The EU-wide TYNDP 2020 and the current CEE GRIP are strongly linked due to their use of the same harmonised data set. Therefore, the analysis performed in this report can complement the findings in the TYNDP 2020.

Generally, the CEE region is mostly characterised by its high dependence on Russian gas, its vulnerability to Ukrainian or partially Belarusian gas transit disruptions. The CEE GRIP Regional N-1 analysis is based on the security of supply analysis according to the REG 2017/1938 but modified for regional purposes. The calculation assumes the disruption of gas supplies via Ukraine and Belarus both in the summer and winter periods. An interruption of the gas route through Ukraine would be expected to have a potentially impact on Poland during the winter period 2021/2022. However, if planned infrastructure projects are implemented in subsequent years, it will have a positive effect on the N-1 value. Due to geographical reasons, a disruption of gas supplies via Belarus only affects Poland, but the assessment indicates a decreasing dependency over the entire time span for both winter and summer periods.

Regarding the summer period, the analysis resulted in the identification of a potential problem in Hungary and Austria for a gas supply disruption via Ukraine in summer 2021, as a deficit of gas causes the inability to fully fill the underground storage facilities in respective countries. This could be a case, if a gas supply disruption via Ukraine lasted more than 66 (Hungary) or 150 days (Austria). All these identified problems are fully resolved by the commissioning of the planned projects in the following years. The other countries in the CEE region are able to cover their gas demands and to meet the injection requirements of underground storage facilities while facing Ukrainian or Belarusian gas supply route disruptions.

As a special part of this report, a whole chapter focuses on contribution of gases to the decarbonisation targets in the CEE region and offers a first mapping of the hydrogen/new gases strategies being prepared in participating countries. Based on the presented case studies, the natural gas will increase its role in the energy mix of respective countries in the upcoming decade. It will contribute to handle the material issue in the region – improving air pollution having negative impact on citizens' quality of life by replacing more polluting energy sources (coal, lignite, waste) by affordable cleaner energy sources. In the region there are number of projects in various project development stages to contribute to decarbonisation efforts. Some countries of the region already adopted their hydrogen long-term strategies, some countries are on the way of its adoption – key message of the documents/drafts is that existing gas infrastructure will be key in the successful transformation to decarbonised economies.

The CEE GRIP TSOs hope that you have found this report useful and informative and would like to warmly encourage all interested stakeholders to provide any feedback.

ABBREVIATIONS

CEE GRIP	Gas Regional Investment Plan for Central and Eastern Europe
CEE region	Central and Eastern Europe region
ENTSOG	European Network of Transmission System Operators for Gas
ETR projects	Energy transition related projects
EU	European Union
FID	Final Investment Decision
GHG	Greenhouse Gas
GWh/d	Gigawatt hour per day
LNG	Liquefied Natural Gas
LSO	LNG System Operator
Non-FID	Without Final Investment Decision
NP	National Production
PCI	Projects of Common Interest
REG 347/2013	Regulation (EU) No 347/2013 of the European Parliament and of the Council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009
REG 715/2009	Regulation (EC) No 715/2009 of 13 July 2009 on conditions for access to the natural gas transmission networks and repealing Regulation (EC) No 1775/2005
REG 2017/1938	Regulation (EU) No 2017/1938 of the European Parliament and of the Council of 25 October 2017 concerning measures to safeguard security of gas supply and repealing Regulation 994/2010
SoS	Security of Supply
TEN-T	Trans-European-Network for Transport
TSO	Transmission System Operator
TYNDP	EU-wide Ten-Year Network Development Plan
UGS	Underground Gas Storage

COUNRY CODES (ISO)

Austria	AT
Belarus	BY
Bulgaria	BG
Croatia	HR
Czech Republic	CZ
Germany	DE
Denmark	DK
Greece	GR
Hungary	HU
Italy	IT
Lithuania	LT
Poland	PL
Romania	RO
Russia	RU
Slovakia	SK
Slovenia	SI
Ukraine	UA

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