european network
of transmission system operators
for gas

GAS REGIONAL INVESTMENT PLAN CENTRAL-EASTERN EUROPE

2019

MAIN REPORT

CENTRAL-EASTERN EUROPE

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FOREWORD

Dear reader,

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

The current edition of the CEE GRIP builds on the previous editions of the CEE GRIPs and also on the ENTSOG TYNDP 2018 providing an outlook about infrastructure projects in the region that are either planned or under the construction

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

Special emphasis of the document is put on the role of the natural gas in the CEE region. This topic is important especially in time when a European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy is getting under its way. We do think that the natural gas in the countries of the CEE region will still play the important role in the upcoming decades in order to support the energy transition and to balance the implications of social acceptability of the necessary changes (e.g. energy poverty).

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 parties 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 fourth 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 2018 (TYNDP 2018). A harmonised data set is used for developing both reports in parallel. The CEE GRIP supports and complements the TYNDP 2018[1]. The GRIP of the CEE region is presented based on analyses in light of the possible evolution of gas infrastructure with a focus on specific regional matters of supply, demand, and infrastructure capacity.

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 four main sections, depending on the subject of analysis:

INFRASTRUCTURE PROJECTS IN THE CEE REGION

- In total, there are 90 gas infrastructure projects planned for implementation in the CEE region in the upcoming decade – 18 projects have already reached a final investment decision (FID) and 72 projects are at an earlier stage of development (non-FID).
- There are 9 projects that have been commissioned in the CEE countries since the release of the CEE GRIP 2017. These projects contributed to the improved diversification of gas supply sources and infrastructure integration.
- Majority of the projects are transmission pipelines projects – 80, others are 5 LNG projects and 5 UGS projects.

ASSESSMENT – INFRASTRUCTURE RESILIENCE IN THE CEE REGION

- Two additional stress scenarios were analysed and presented in the report beyond the TYNDP 2018 scope. These stress scenarios are (i) a simultaneous disruption of the gas supply routes via Ukraine and Belarus and (ii) a disruption of the whole Russian gas supply source.
- The simultaneous disruption of gas routes via Belarus and Ukraine shows a supply disruption in the countries Romania, Croatia and Bulgaria. Some countries will be affected under certain demand scenario – Hungary and Poland. Gas supplies to Germany, the Czech Republic, Austria, Slovakia, and Slovenia would almost not be affected, as deliveries to these countries would be redirected via Nord Stream pipeline.
- The disruption case of the whole Russian gas source is the most extreme possible for the region and shows the countries concerned to be highly dependent on Russian gas supplies. However, with the implementation of planned infrastructure projects (which improve the security of supply and the diversification of gas sources and routes) this dependency is mitigated, as these projects will foster the diversification of gas supply sources and improve infrastructure integration between the CEE countries.

1 https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2018

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 CEE GRIP purposes.
- In the winter period 2020/2021 under the Ukrainian gas route disruption case, Bulgaria, Romania and Poland do not meet the basic N-1 criterion (the result has to be equal to or greater than one) for various reasons. Except for infrastructure gaps, in the case of Poland, it is due to increased daily maximum demand by almost 1/3 between years 2017 and 2020. 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, Austria and Romania during the Ukraine disruption scenario in summer 2020, such a disruption could cause a lack of filling the underground storage facilities, in case the disruption lasts longer than 66 days (Hungary), 125 days (Austria), or 155 days (Romania).
  - Some potential problems were also identified in Poland in summer 2020, if the disruption via Belarus would last for more than 116 days.
  - All these identified problems would be fully solved by the commissioning of the planned projects in the following years.

ROLE OF NATURAL GAS IN THE CEE REGION IN THE LONG-TERM PERSPECTIVE

- A gradual transformation of the energy markets in the CEE region is ongoing since 1990. With a partial switch from a high to low and zero-emission sources of energy and the application of energy efficiency measures greenhouse gas emissions have been reduced considerably. Despite these developments carbon intensive fuels still play a major role in the energy markets.
- Natural gas in the countries of the CEE region will play important role in the upcoming decade to support the energy transition and to balance the implications of social acceptability of the necessary changes (e. g. energy poverty).
- Switch to natural gas from carbon-intensive and polluting energy sources will help to reduce emission in a considerable manner and to improve the air quality in the CEE region as a whole.
- There are various projects of greening the gas system in early development phases; mainly in area of energy storage, P2G, testing of hydrogen-natural gas mixtures on gas transmission system elements. These technologies are not mature enough yet to be deployed on a large scale and on a commercial basis. The legislative and regulatory framework needs to be adapted to recognize the existence of these technologies in energy markets and to incentivize their development.

1 INTRODUCTION

The Gas Regional Investment Plans (GRIPs) are being prepared 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 fourth 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 Ten-Year Network Development Plan 2018[2] (TYNDP 2018) 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 2018. This ensures consistency between these two reports. Due to the fact that the CEE GRIP is published after the TYNDP 2018, the contributing transmission system operators (TSOs) in 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 2018 were used in this report, they are clearly explained in the text of specific chapters and annexes. The difference between the TYNDP 2018 and the CEE GRIP is also analysed in the time period. While the TYNDP 2018 looks 20 years ahead due to REG 347/2013 and the ENTSOG Methodology for Cost-Benefit Analysis of Gas Infrastructure Projects currently in force[3], the CEE GRIP focuses on a 10-year timeline to provide more precise information about the near future.

Beyond the TYNDP 2018, 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
- Specific simulations of network modelling to assess market integration and SoS
- The development of a regional approach to SoS demand and supply scenarios
- CEE GRIP Regional N-1 analysis up to a 10-year time frame

On top of that, the present edition of the CEE GRIP takes a closer look at the role played by natural gas in Central-Eastern Europe to build low-emission economies and meet the climate and energy objectives of the European Union in the long-term perspective.

The general methodological approach used in the CEE GRIP is based on the one used in the TYNDP 2018. For analyses and results carried out beyond the focus of the TYNDP 2018, 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. Throughout this 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.

2 https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2018

3 https://www.entsog.eu/methodologies-and-modelling#2nd-cba-methodology

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.

INVOLVED TSOs		
Country:	**TSO:**	
Austria	GAS CONNECT AUSTRIA GmbH	
	Trans Austria Gasleitung GmbH	
Bulgaria	Bulgartransgaz EAD	
Croatia	Plinacro d.o.o.	
Czech Republic	NET4GAS, s.r.o.	
Germany	Fluxys TENP GmbH	
	GASCADE Gastransport GmbH	
	Gasunie Deutschland Transport Services GmbH	
	GRTgaz Deutschland GmbH	
	ONTRAS Gastransport GmbH	
	Open Grid Europe GmbH	
	terranets bw GmbH	
Hungary	FGSZ Ltd.	
Poland	Gas Transmission Operator GAZ-SYSTEM S.A.	
Romania	Transgaz S.A.	
Slovakia	eustream, a.s.	
Slovenia	PLINOVODI d.o.o.	

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 aknowledged by the 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, Gasunie Deutschland Transport Services GmbH, GRTgaz Deutschland GmbH, ONTRAS Gastransport GmbH, Open Grid Europe GmbH, terranets bw 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

This chapter focuses on the infrastructure level. It provides a short summary of projects that have been commissioned since the publication of the last edition of the CEE GRIP. As was the case in the previous editions, it also gives an overview of gas projects planned for implementation in the upcoming decade.

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 2018. 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 Central-Eastern Europe (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.

The path towards a well-functioning and competitive gas market in Central-Eastern Europe is not yet complete however. 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. This case shows that the activity linked to the need for new infrastructure developments to foster diversification of gas supply sources and to further improve market integration remains highly dynamic and remains part of the core business of the CEE TSOs. Such actions are expected to contribute towards the enhancement of a regional gas market in the CEE region with a high level of security, competition and liquidity.

Table 2.1 summarises investment projects that were included in the CEE GRIP 2017 and have been commissioned since the release of the last CEE GRIP report in May 2017.

Promoter	Name	Code
Bulgartransgaz EAD	A project for the construction of a gas pipeline BG-RO	TRA-N-379
Fluxys TENP GmbH	Revers flow TENP Germany	TRA-F-208
GRTgaz Deutschland GmbH	CS Rothenstadt	TRA-F-337
	West to East operation of the IP Waidhaus	TRA-F-753
Open Grid Europe GmbH	Pipeline project "Schwandorf-Finsing"	TRA-F-343
	Compressor station "Herbstein"	TRA-F-344
	Compressor station "Werne"	TRA-F-345
Plinacro Ltd	LNG evacuation pipeline Omišalj – Zlobin (Croatia)	TRA-N-90
SNTGN Transgaz SA	NTS developments in North-East Romania	TRA-N-357

Table 2.1: Investment projects commissioned after the publication of the CEE GRIP 2017

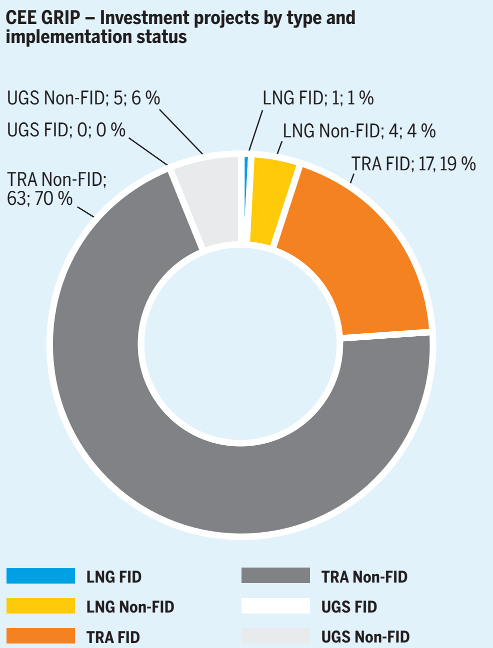


Figure 2.1: Investment projects included in the CEE GRIP by type and implementation status

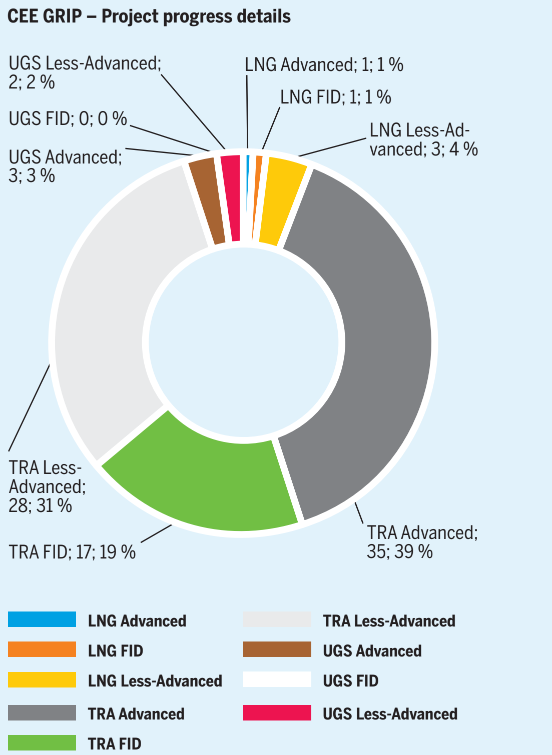


Figure 2.2: CEE GRIP – Project progress details

TSOs and other project promoters submitted a total of 90 investment projects within the geographical coverage area of the CEE GRIP in the TYNDP 2018. Compared to the previous edition the number of projects decreased by 21. The CEE GRIP projects are planned to be commissioned in the upcoming decade.

Figure 2.3 displays more detailed split of the non-FID projects by their maturity status as defined by TYNDP 2018 – advanced and less-advanced projects.

Note: For Germany are counted only the projects promoted by the CEE GRIP participating TSOs.

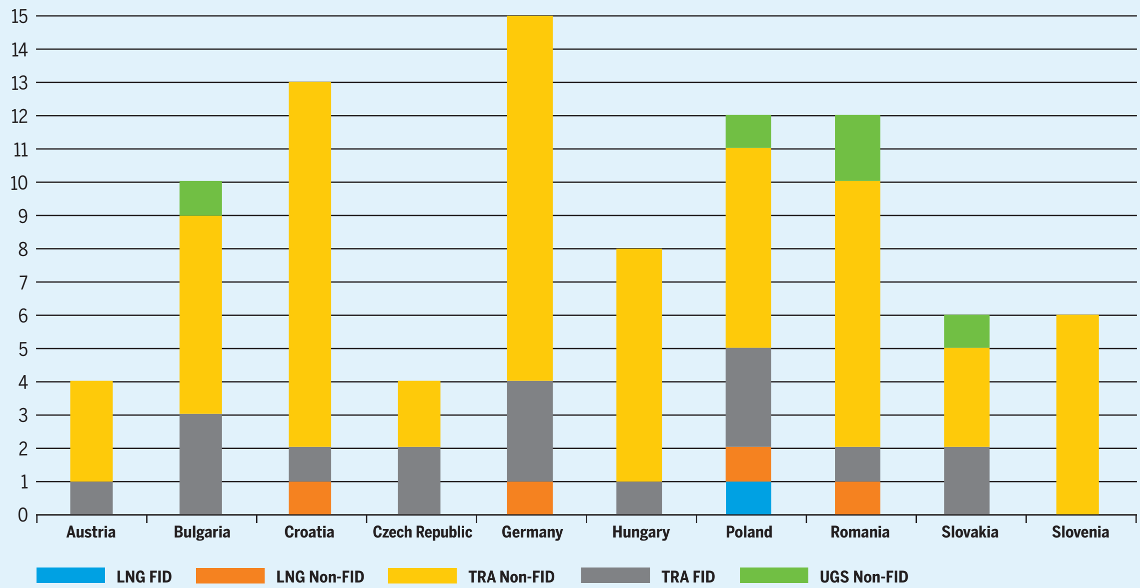


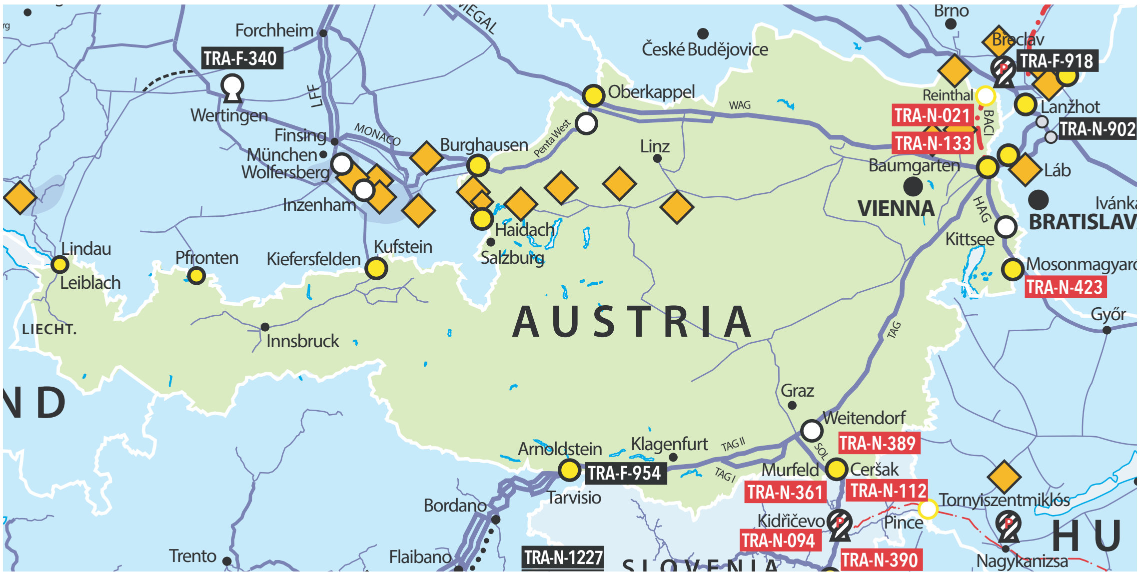
Figure 2.3: Investment projects included in the CEE GRIP by type and implementation status by country

The following tables present the main information on the projects within the geographical coverage area of the CEE GRIP. The current edition of the Gas Regional Investment Plans shall be based on the data used in the TYNDP 2018. For the sake of clarity, the presented updates as of 30 May 2019 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 2018 Annex A.

AUSTRIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP



TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commissioning year *	PCI (3rd list)
TRA-N-954	TAG Reverse Flow	Trans Austria Gasleitung GmbH	2019	2020	No
TRA-N-361	GCA 2015/08: Entry/Exit Murfeld	GAS CONNECT AUSTRIA GmbH	2022	2024	Yes
TRA-N-021	Bidirectional Austrian-Czech Interconnector (BACI) **	GAS CONNECT AUSTRIA GmbH	2021	2024	Yes
TRA-N-423	GCA Mosonmagyaróvár	GAS CONNECT AUSTRIA GmbH	2022	2024	Yes

Notes: *Update of expected commissioning year reflects a situation as of 30 May 2019.
**Implementation of the PCI project BACI will depend on the outcome of the pilot project 'Trading Regional Upgrade'.

Table 2.2: List of projects in Austria

BULGARIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP.

TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commission-ing year *	PCI (3rd list)
TRA-F-137	Interconnection Bulgaria- Serbia	Ministry of Energy	2022		Yes
TRA-F-378	Interconnector Greece-Bulgaria (IGB Project)	ICGB a.d.	2025		Yes
TRA-N-140	Interconnection Turkey-Bulgaria	Bulgartransgaz EAD	2022		No
TRA-N-298	Rehabilitation, Modernization and Expansion of the NTS	Bulgartransgaz EAD	2024		Yes
TRA-N-654	Eastring – Bulgaria	Bulgartransgaz EAD	2028		Yes
UGS-N-138	UGS Chiren Expansion	Bulgartransgaz EAD	2024		Yes
TRA-N-592	Looping CS Valchi Dol – Line valve Novi Iskar	Bulgartransgaz EAD	2022		Yes
TRA-N-593	Varna-Oryahovo gas pipeline	Bulgartransgaz EAD	2022		Yes
TRA-N-594	Construction of a Looping CS Provadia – Rupcha village	Bulgartransgaz EAD	2022		Yes
TRA-N-1197	Expansion of the gas infrastructure between BG-TR and BG-RS borders	Bulgartransgaz EAD	2022		No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.3: List of projects in Bulgaria

CROATIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018.

TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commission-ing year *	PCI (3rd 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		Yes
TRA-N-90	LNG evacuation pipeline Omišalj – Zlobin (Croatia)	Plinacro Ltd	2019		No
TRA-N-86	Interconnection Croatia/Slovenia (Lučko – Zabok – Rogatec)	Plinacro Ltd	2021		Yes
TRA-N-66	Interconnection Croatia –Bosnia and Herzegovina (Slobodnica- Bosanski Brod)	Plinacro Ltd	2020		No
TRA-N-75	LNG evacuation pipeline Zlobin-Bosiljevo-Sisak-Kozarac	Plinacro Ltd	2020		Yes
TRA-N-1057	Compressor stations 2 and 3 at the Croatian gas transmission system	Plinacro Ltd	2022		Yes
TRA-N-302	Interconnection Croatia-Bosnia and Herzegovina (South)	Plinacro Ltd	2021		No
TRA-N-68	Ionian Adriatic Pipeline	Plinacro Ltd	2023		No
TRA-N-70	Interconnection Croatia/Serbia (Slobdnica-Sotin-Bačko Novo Selo)	Plinacro Ltd	2023		No
TRA-N-1058	LNG Evacuation Pipeline Kozarac-Slobodnica	Plinacro Ltd	2023		Yes
TRA-N-303	Interconnection Croatia-Bosnia and Herzegovina (west)	Plinacro Ltd	2027		No
TRA-N-336	Interconnection Croatia/Slovenia (Umag-Koper)	Plinacro Ltd	2027		No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019..

Table 2.4: List of projects in Croatia

THE CZECH REPUBLIC

Map of projects in the specified country based on the ENTSOG TYNDP 2018.

TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commissioning year *	PCI (3rd list)
TRA-N-136	Czech-Polish Gas Interconnector (CPI)	NET4GAS, s.r.o.	2022	2023	Yes
TRA-F-752	Capacity4Gas (C4G) – DE/CZ	NET4GAS, s.r.o.	Phase 1: 2019 Phase 2: 2021		Yes
TRA-F-918	Capacity4Gas (C4G) – CZ/SK	NET4GAS, s.r.o.	2020		No
TRA-N-133	Bidirectional Austrian Czech Interconnection (BACI)	NET4GAS, s.r.o.	2021	2024[a)]	Yes[b)]

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.
a) The expected commissioning year of the BACI project was postponed due to testing of the pilot project "Trading Regional Upgrade" (TRU).
b) The PCI status of the project was granted with the following addition: Implementation of BACI as a PCI will depend on the outcome of the pilot project 'Trading Regional Upgrade'.

Table 2.5: List of projects in the Czech Republic

GERMANY

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP.

TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commission-ing year *	PCI (3rd list)
TRA-N-814	Upgrade for IP Deutschneudorf et al. for More Capacity	ONTRAS Gastransport GmbH	2019		No
TRA-F-241	MONACO section phase I (Burghausen-Finsing)	bayernets GmbH	2018		No
TRA-F-291	NOWAL – Nord West Anbindungs-leitung	GASCADE Gastransport GmbH	2020		No
TRA-F-208	Reverse Flow TENP Germany	Fluxys TENP GmbH, Open Grid Europe GmbH	2018	2020	No
TRA-F-1271	Compressor Station Krummhoern	Open Grid Europe GmbH	2022		No
TRA-F-937	Nord Stream 2	Nord Stream 2 AG	2019		No
TRA-N-340	CS Wertingen	bayernets GmbH, Open Grid Europe GmbH	2019		No
TRA-N-763	EUGAL – Europäische Gasanbin-dungsleitung (European Gaslink)	GASCADE GmbH / Fluxys Deutschland GmbH / GUD GmbH&Co.KG / ONTRAS GmbH	2020		No
TRA-N-949	Oude(NL)-Bunde(DE) GTG H-Gas	Gastransport Nord GmbH	2027		No
TRA-N-951	Embedding CS Folmhusen in H-Gas	Gasunie Deutschland Transport Services GmbH	2020		No
TRA-N-808	Transport of gas volumes to the Netherlands	Gasunie Deutschland Transport Services GmbH	2025		No
TRA-F-329	ZEELINK	Open Grid Europe GmbH, Thyssengas GmbH	2023		No
TRA-N-755	CS Rimpar	GRTgaz Deutschland GmbH, Open Grid Europe GmbH	2023		No
TRA-N-809	Additional East-West transport	Gasunie Deutschland Transport Services GmbH	2020		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 Services GmbH	2021		No
TRA-N-1199	LNG Terminal Brunsbüttel – Grid Integration	Gasunie Deutsch-land Transport Services GmbH	2021		No
TRA-N-1267	Upgrade Sülstorf station	NGT GmbH, GUD GmbH & Co. KG, Fluxys D GmbH	2019		No
TRA-N-1200	Expansion MS Hetlingen	Gasunie Deutschland Transport Services GmbH	2022		No
TRA-N-1254	CS Elten	Open Grid Europe GmbH, Thyssengas GmbH	2022		No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.6: List of projects in Germany

HUNGARY

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP .

TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commission-ing year *	PCI (3rd list)
TRA-N-524	Enhancement of Transmission Capacity of Slovak-Hungarian interconnector	Magyar Gáz Tranzit Zrt.	2022		Yes
TRA-N-636	Development of Transmission Capacity at Slovak-Hungarian interconnector	Magyar Gáz Tranzit Zrt.	2022	2019	Yes
TRA-N-286	Romanian-Hungarian reverse flow Hungarian section 1st stage	FGSZ Ltd.	2019		Yes
TRA-N-325	Slovenian-Hungarian interconnector	FGSZ Ltd.	Phase 1: 2022 Phase 2: 2023	Phase 1: 2023 Phase 2: 2025	Yes
TRA-N-656	Eastring – Hungary	FGSZ Ltd.	2028		Yes
TRA-N-831	Vecsés-Városföld gas transit pipeline	Magyar Gáz Tranzit Zrt.	2022		Yes
TRA-N-123	Városföld CS	FGSZ Ltd.	2022		Yes
TRA-N-377	Romanian-Hungarian reverse flow Hungarian section 2nd stage	FGSZ Ltd.	2022		Yes

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.7: List of projects in Hungary

POLAND

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP.

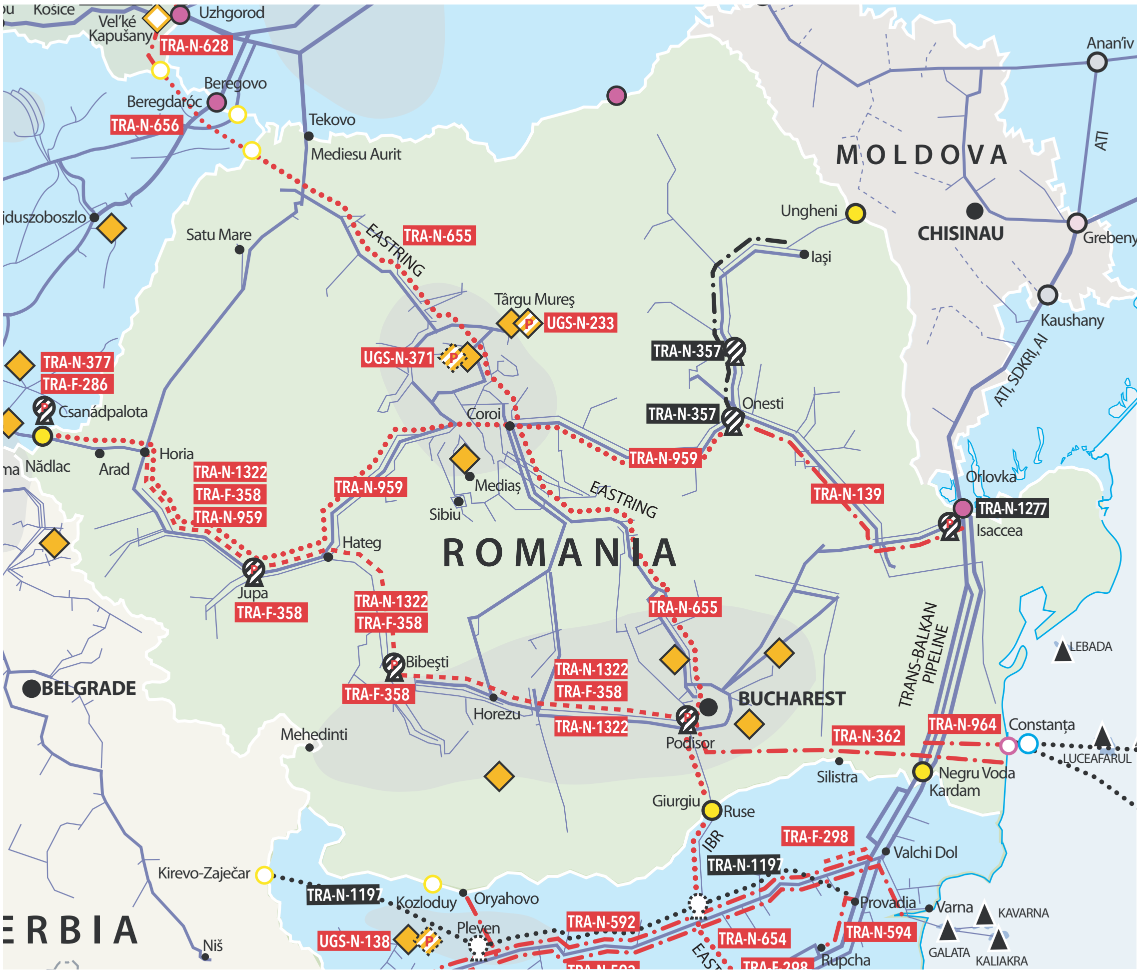
TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commissioning year *	PCI (3rd list)
TRA-F-212	Gas Interconnection Poland-Lithuania (GIPL) – PL section	GAZ-SYSTEM S.A.	2021		Yes
TRA-F-247	North-South Gas Corridor in Western Poland	GAZ-SYSTEM S.A.	2020	2021	Yes
TRA-N-273	Poland-Czech Republic interconnection (PL section)**	GAZ-SYSTEM S.A.	2022	2023	Yes
TRA-F-275	Poland-Slovakia interconnection (PL section)	GAZ-SYSTEM S.A.	2021		Yes
LNG-F-272	Upgrade of LNG terminal in Świnoujście	GAZ-SYSTEM S.A.	2023		Yes
TRA-N-621	Poland-Ukraine Gas interconnection (PL section)	GAZ-SYSTEM S.A.	2020	2022	No
LNG-N-947	FSRU Polish Baltic Sea Coast	GAZ-SYSTEM S.A.	2022	2025	No
TRA-N-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.	2022	2029	Yes
UGS-N-914	UGS Damasławek	GAZ-SYSTEM S.A.	2026		No
TRA-N-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.	2022	2023	No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.
** In the process of assessing demand for incremental capacity between the gas transmission systems of GAZ-SYSTEM and NET4GAS conducted in 2019, demand indication was submitted for incremental capacity in the direction from Poland to the Czech Republic. In order to meet the market demand for incremental capacity at this interconnection point, the operators decided to initiate technical analysis for the entry-exit system concerned. More information on plans to extend capacities at the Polish-Czech border will be provided by the project promoters under the ongoing incremental procedure.

Table 2.8: List of projects in Poland

ROMANIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP.



TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commission-ing year *	PCI (3rd list)
TRA-N-357	NTS developments in North-East Romania	SNTGN Transgaz S.A.	2019	2021	No
UGS-N-233	Depomures	Engie Romania S.A.	2023		Yes
TRA-N-139	Interconnection of the NTS with the DTS and reverse flow at Isaccea	SNTGN Transgaz S.A.	2019	2020	Yes
TRA-N-964	New NTS developments for taking over gas from the Black Sea shore	SNTGN Transgaz S.A.	2019	2021	Yes
TRA-F-358	Development on the Romanian territory of the NTS (BG–RO–HU–AT Phase 1)	SNTGN Transgaz S.A.	2020	2020	Yes
TRA-N-1322	Development on the Romanian territory of the NTS (BG–RO–HU–AT Phase 2)	SNTGN Transgaz S.A.	2022	2022	Yes
TRA-N-362	Development on the Romanian territory of the Southern Transmission Corridor	SNTGN Transgaz S.A.	2020	2021	Yes
TRA-N-655	Eastring – Romania	SNTGN Transgaz S.A.	2028		Yes
UGS-N-371	Sarmasel undeground gas storage in Romania	Societatea Națională de Gaze Naturale ROMGAZ S.A.	2024		Yes
TRA-N-959	Further enlargement of BG–RO–HU–AT transmission corridor (BRUA) phase 3)	SNTGN Transgaz S.A.	2023	2025	Yes
LNG-N-376	Azerbaijan, Georgia, Romania Inter-connector – AGRI	AGRI LNG Project Company SRL (RO)	2026		Yes
TRA-N-1268	Romania-Serbia Interconnection	SNTGN Transgaz SA	2020	2020	No
TRA-N-1277	Upgrading GMS Isaccea 1 and GMS Negru Voda 1	SNTGN Transgaz SA	2019	2021	No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.9: List of projects in Romania

SLOVAKIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP.

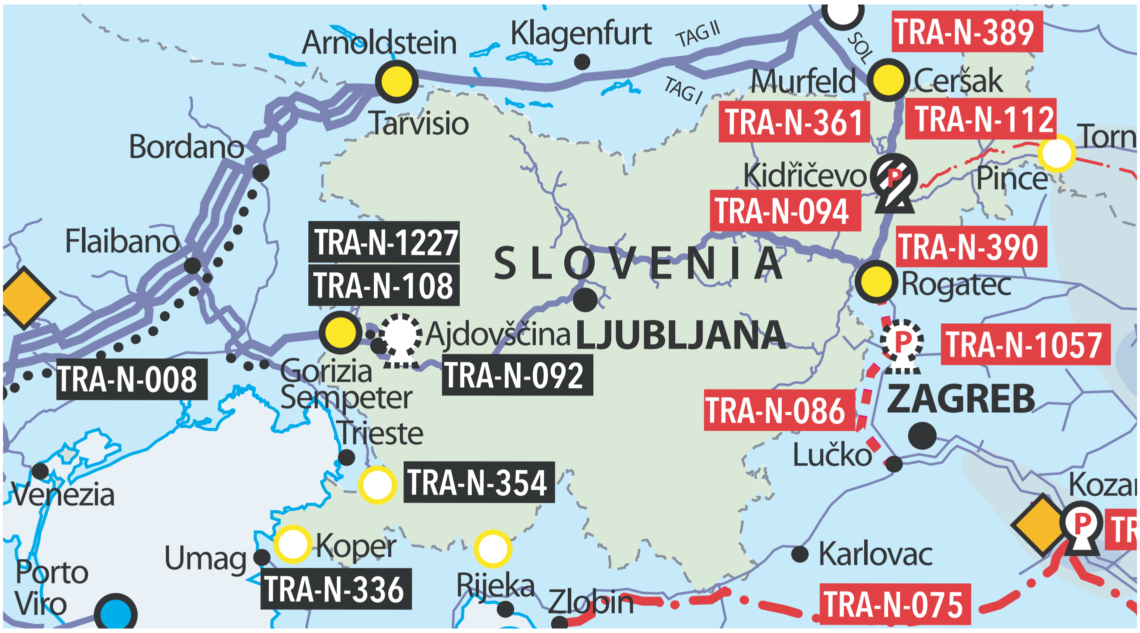
TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commissioning year *	PCI (3rd list)
TRA-F-190	Poland-Slovakia interconnection	eustream, a.s.	2021		Yes
TRA-F-902	Capacity increase at IP Lanžhot entry	eustream, a.s.	2019		No
TRA-N-628	Eastring – Slovakia	Eastring B.V.	2028		Yes
TRA-N-17	System Enhancements – Eustream	eustream, a.s.	2027		No
TRA-N-1235	Firm transmission capacity increase at the IP Veľké Zlievce	eustream, a.s.	2022		No
UGS-N-356	Underground Gas Storage Velke Kapusany	NAFTA a.s. (joint stock company)	2023		No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.10: List of projects in Slovakia

SLOVENIA

Map of projects in the specified country based on the ENTSOG TYNDP 2018 MAP .



TYNDP 2018 Code	Name	Promoter	Expected commissioning year (according to TYNDP 2018)	Update of expected commissioning year *	PCI (3rd list)
TRA-N-390	Upgrade of Rogatec interconnection (M1A/1 Interconnection Rogatec)	Plinovodi d.o.o.	2022	2023	Yes
TRA-N-94	CS Kidričevo, 2nd phase of upgrade	eustream, a.s.	2022	2023	No
TRA-N-108	M3 pipeline reconstruction from CS Ajdovščina to Šempeter/Gorizia	Plinovodi d.o.o.	2022	2025	No
TRA-N-112	R15/1 Pince - Lendava - Kidričevo	Plinovodi d.o.o.	2023	2023/2025	Yes
TRA-N-389	Upgrade of Murfeld/Ceršak interconnection (M1/3 Interconnection Ceršak)	Plinovodi d.o.o.	2022	2023	Yes
TRA-N-92	CS Ajdovščina, 1st phase of upgrade	Plinovodi d.o.o.	2022	2025	No

Notes: * Update of expected commissioning year reflects a situation as of 30 May 2019.

Table 2.11: List of projects in Slovenia

3 **ASSESSMENT** – INFRASTRUCTURE RESILIENCE IN THE CEE REGION

3.1 GENERAL NOTE

This assessment chapter focuses on the ability of the European gas system to meet the supply-demand balance under stress scenarios. The CEE GRIP provides a look at two different stress scenarios which were not presented in the TYNDP 2018. These stress scenarios are a simultaneous disruption of the gas supply routes via Ukraine and Belarus and a disruption of the Russian gas supply source. The situation under normal conditions is also presented in the chapter in order to provide a baseline comparison as to how the CEE region is affected by these two specific stress scenarios.

Assessment results for CEE GRIP specific simulations are based on the TYNDP 2018 methodology and data set. Specifically, all data serving as the basis for infrastructure modelling in the CEE region originate from the TYNDP 2018, and all relevant data were collected by ENTSOG in a dedicated collection process. The ENTSOG simulation tool was used to model the scenarios described, which ensures consistency with the TYNDP 2018.

The ENTSOG model works on a top-down approach where countries are used as the basic blocks interlinked by cross-border capacity. Applicable capacity is the sum of technical capacity at interconnection points between two neighbouring countries and the application of the "lesser-of-rule" to the values of the capacity at both sides of the border for each interconnection point (IP). Storage facilities, national gas production, and LNG terminals enter the model within the corresponding country and not according to their territorial location. Furthermore, the model assumes that each modelled country represents a single entry/exit zone. Therefore, the consideration of internal interconnections is limited. The European approach does not consider potential internal bottlenecks, gas quality issues, and the adaptation of national infrastructure to disruption scenarios. In the TYNDP 2018 the assessment is carried out from a European perspective, under the assumption of perfect market functioning. This ensures a focus on conclusions where solving the identified gap cannot be managed by market or regulatory rules and would presumably require infrastructure development with cross-border significance.

Regarding the planned infrastructure projects, only the total years of a project's operation are considered in the assessment. This means that the first full year of operation used in the assessment is the first full calendar year following the expected commissioning date (the expected capacity increment). All projects related to the CEE region are listed in Chapter 2 – Infrastructure Projects in the CEE Region. For more details concerning a particular infrastructure project, please see the TYNDP 2018 Annex A.

3.2 DISRUPTED DEMAND, REMAINING FLEXIBILITY AND PRECONDITIONS FOR ASSESSMENT

This analysis presents the evolution of a Curtailment Rate (CR) and a Remaining Flexibility (RF) indicator in the CEE region under the following stress scenarios modelled for the years 2020, 2025 and 2030:

- Simultaneous disruption of the gas supply routes via Ukraine and Belarus
- Disruption of the Russian gas supply source

The baseline reference scenario is the normal situation when there is no disruption. The target of this analysis is not to identify which projects might directly mitigate the risks of demand disruption or low Remaining Flexibility but to determine their impact under the stress scenarios described.

The preconditions for this assessment are based on the TYNDP 2018 methodology. The assessment is prepared under three demand scenarios[4]:

- Best Estimate, for the years 2020 and 2025
- Distributed Generation, for the year 2030
- EUCO 2030, for the year 2030
- Sustainable Transition, for the year 2030

For two climatic situations:

- 1-day Design Case (DC, Peak Day)
- 2-week high demand case (2W, 14-day uniform risk)

And three infrastructure levels which are considered in the assessment:

- LOW infrastructure level
- ADVANCED infrastructure level
- PCI 3rd list infrastructure level

All assessment results prepared for the CEE GRIP can be found in the CEE GRIP Annex A – Modelling Results. The following figure describes the differences between the infrastructure levels.

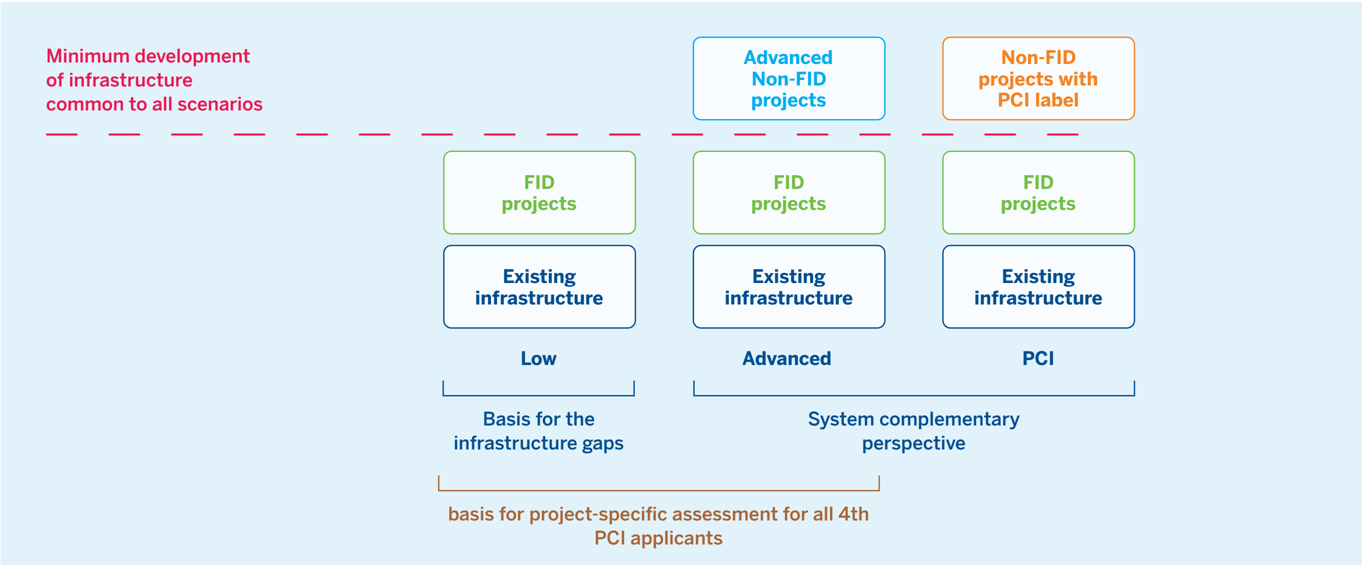


Figure 3.1: Infrastructure Levels (Source: TYNDP 2018)

According to the TYNDP 2018 methodology, the Remaining Flexibility (RF) indicator measures the resilience of a zone (at the country level). The indicator is calculated for high demand situations as the additional share of demand each country is able to cover before an infrastructure or supply limitation is reached. This calculation is made independently for each country, meaning that they do not share European supply flexibility. The higher the indicator value is, the better the resilience. In cases where countries experience disrupted demand, the Remaining Flexibility is equal to zero.

4 For detailed information about the methodology used, please see the TYNDP 2018 and its annexes which are available under the following link: https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2018

The Curtailment Rate (CR) represents the share of the gas demand that cannot be satisfied. It is calculated as a daily volume. The level of disruption is assessed assuming cooperative behaviour among European countries in order to mitigate its relative impact. This means that countries try to reduce the Curtailment Rate of other countries by sharing the load. Non-alignment of the Curtailment Rate between countries indicates an infrastructure bottleneck. The distribution of Curtailment Rate among countries is therefore a strong indication of infrastructure needs.

In this chapter, you will find a presentation of assessment results for the CEE region for the Peak Day of the Best Estimate for the years 2020, 2025, for the year 2030 of the demand scenarios Distributed Generation, EUCO 2030 and Sustainable Transition for the LOW, 3nd PCI, and Advanced infrastructure levels with and without a simultaneous disruption of the gas supply routes via Ukraine and Belarus and a disruption of the Russian gas supply source. Comprehensive results for all modelled specific disruption cases for CEE GRIP can be found in CEE GRIP Annex A – Modelling Results. The results are presented for the years 2020, 2025 and 2030.

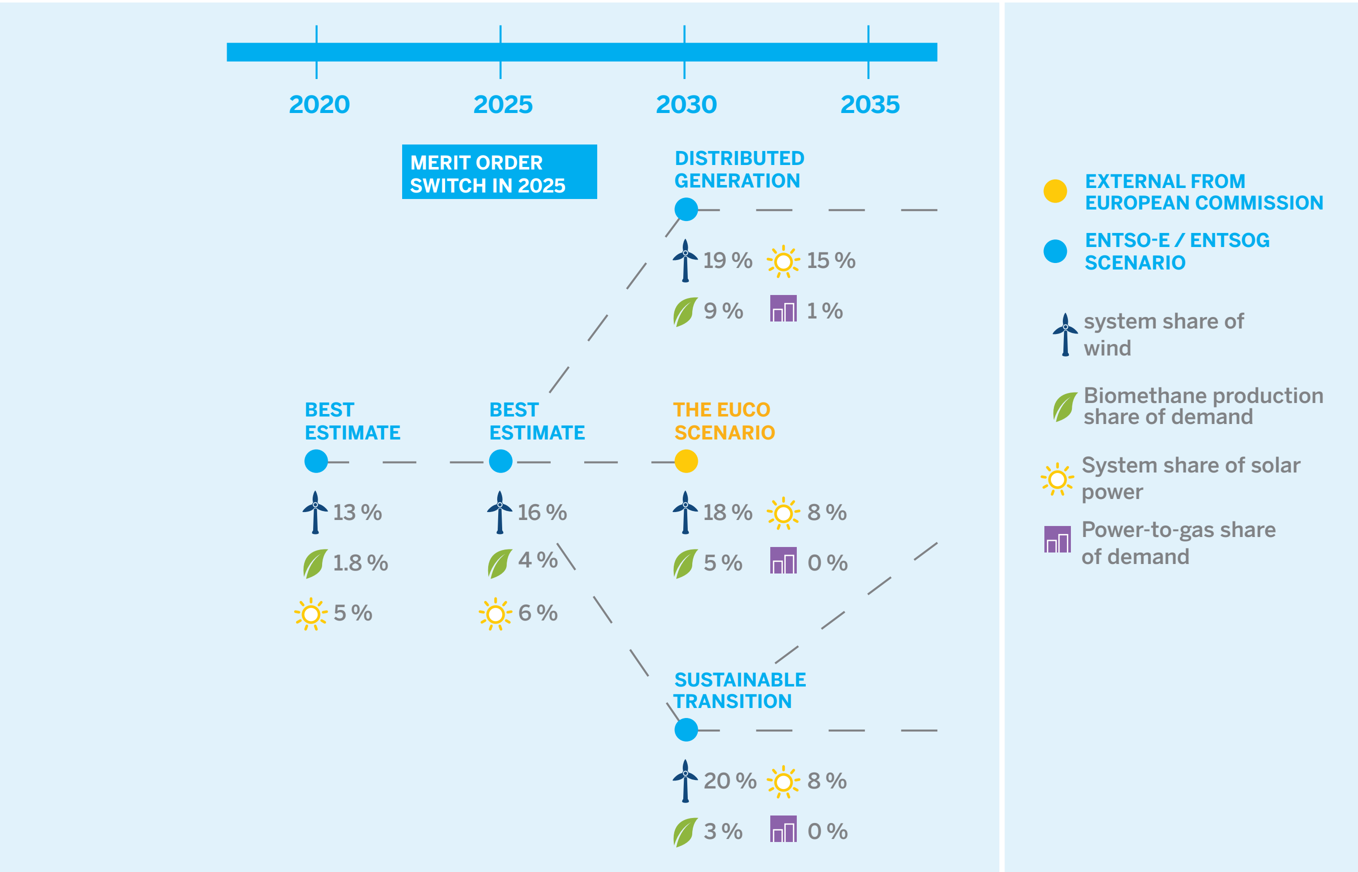


Figure 3.2: The scenario building framework for TYNDP 2018

3.2.1 PEAK DAY UNDER THE NORMAL SITUATION (WITHOUT DISRUPTION)

Assessment of the peak day under the normal situation is based on the results modelled and presented in the TYNDP 2018 (TYNDP 2018 Annex E) and serves as a baseline reference scenario for CEE GRIP specific disruption simulations.

Analysis of the normal situation is also part of the TYNDP 2018, and the results indicate that the European gas infrastructure, respectively in the CEE region, is able to cope with high demand situations.

Under the LOW infrastructure scenario assessment, Croatia is in the longer term though, from 2025 onwards, exposed to an increasing demand curtailment in all demand scenarios due to infrastructure limiting the flow from Slovenia and Hungary. This exposure is the result of an increasing demand in Croatia driven by the power generation and can be mitigated by the implementation of planned projects which belong to the PCI category.

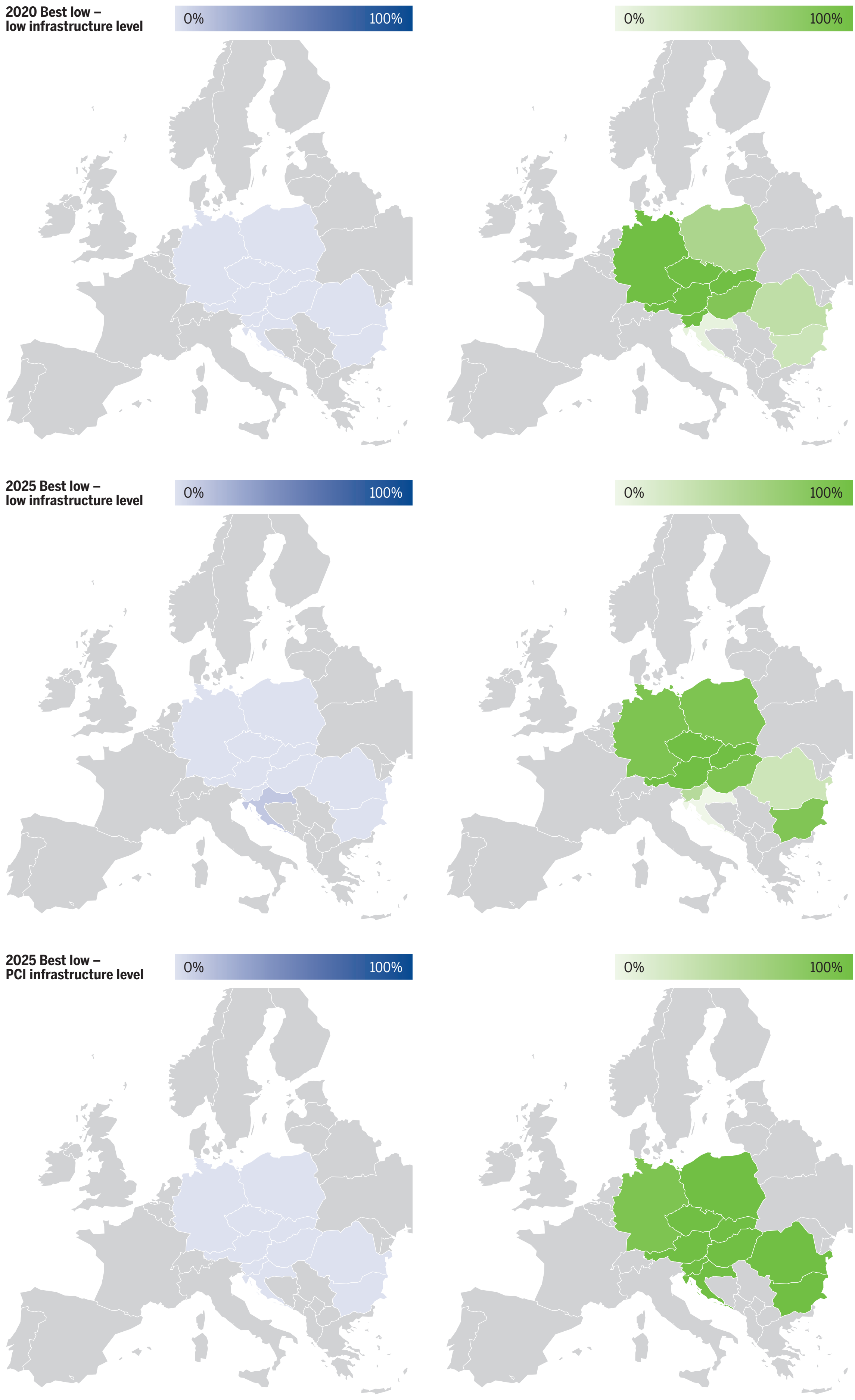


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

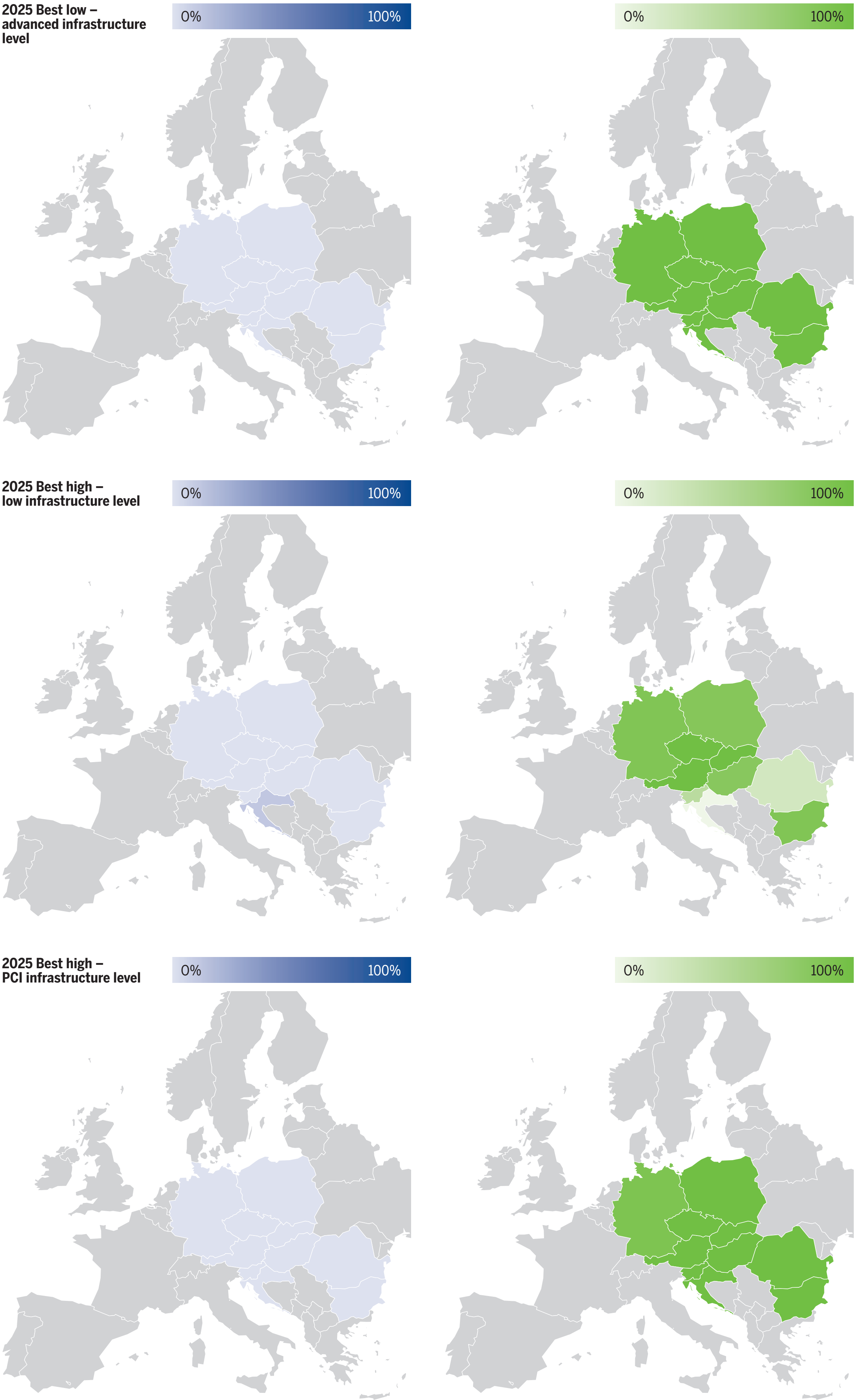


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

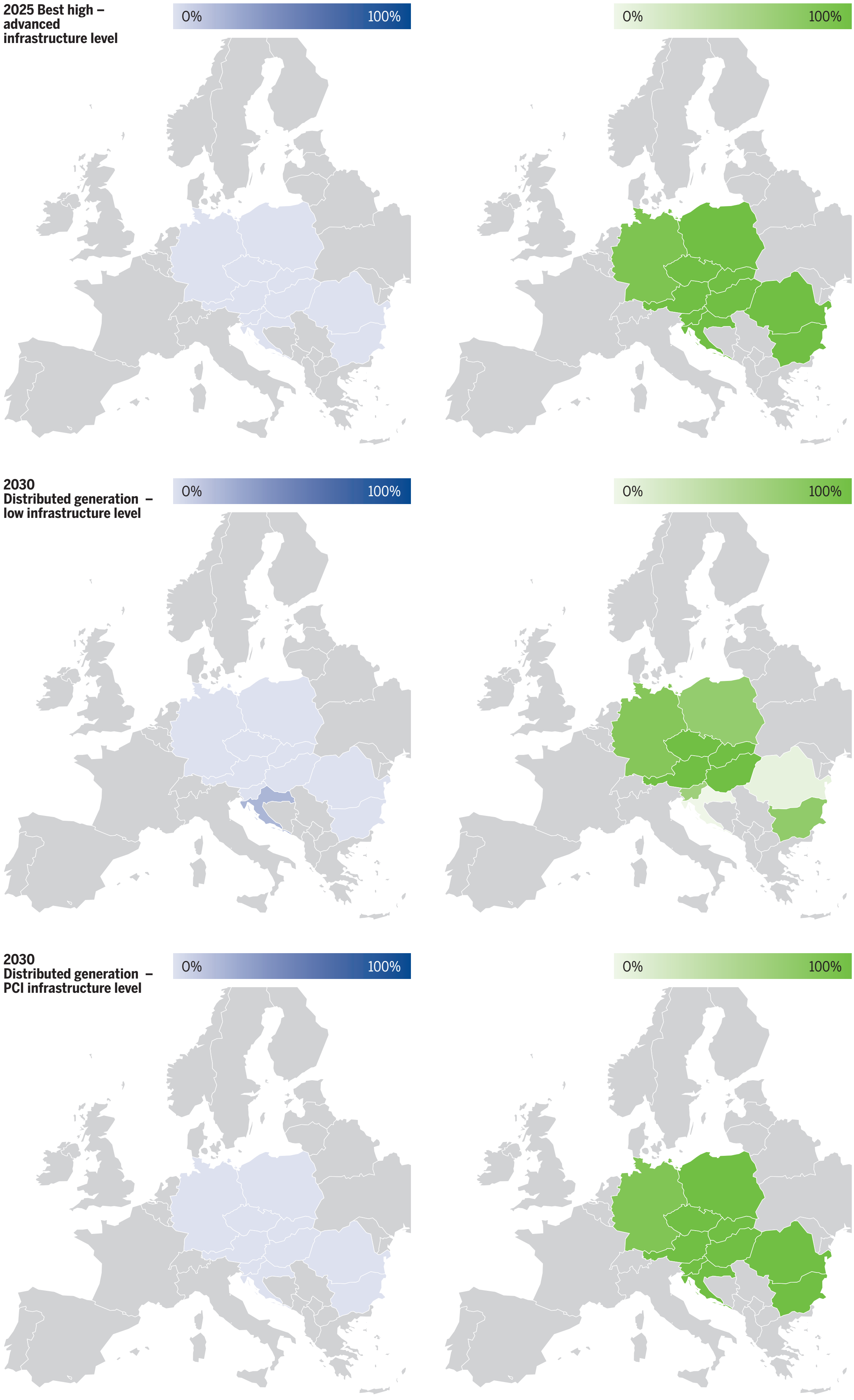


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

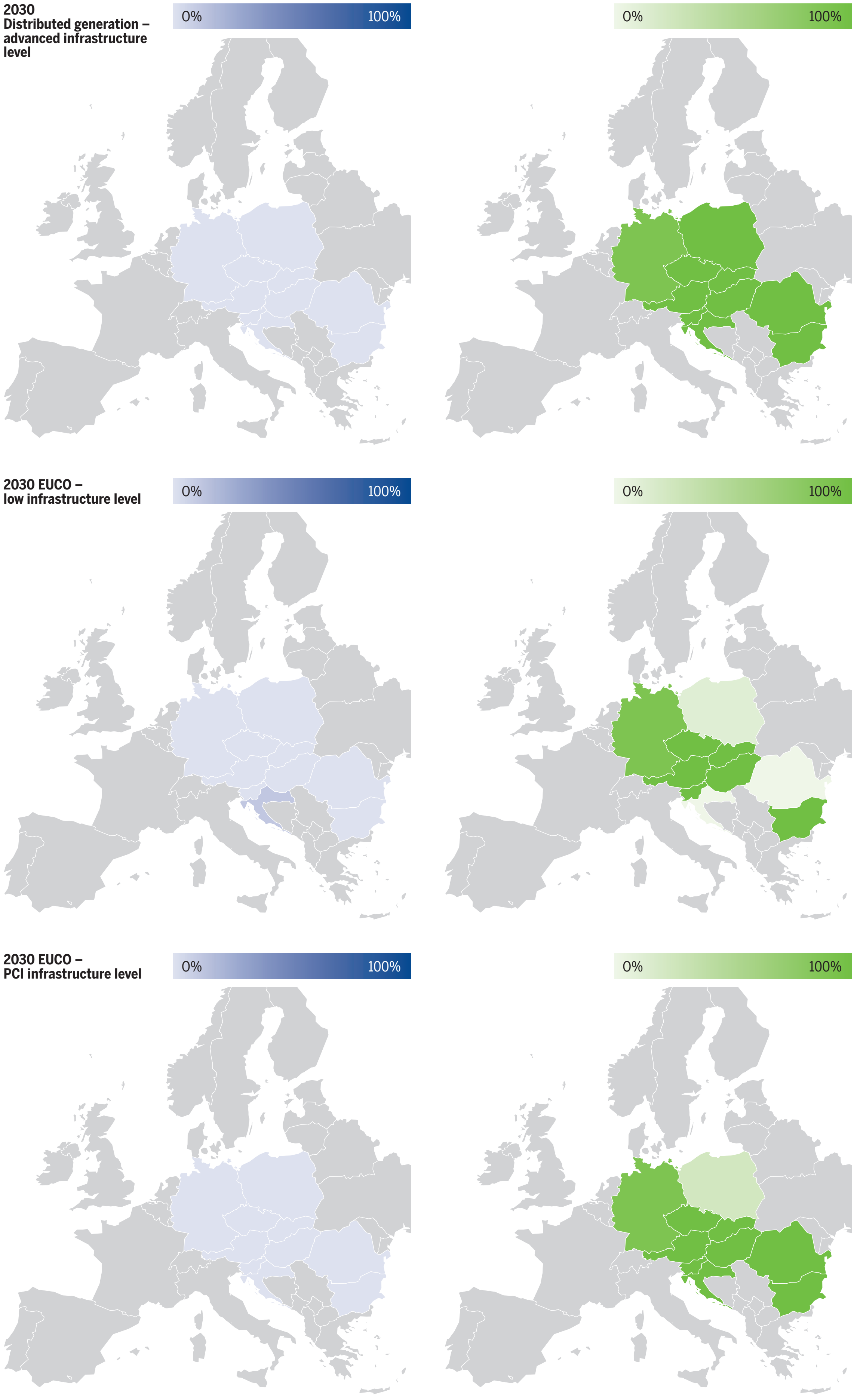


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

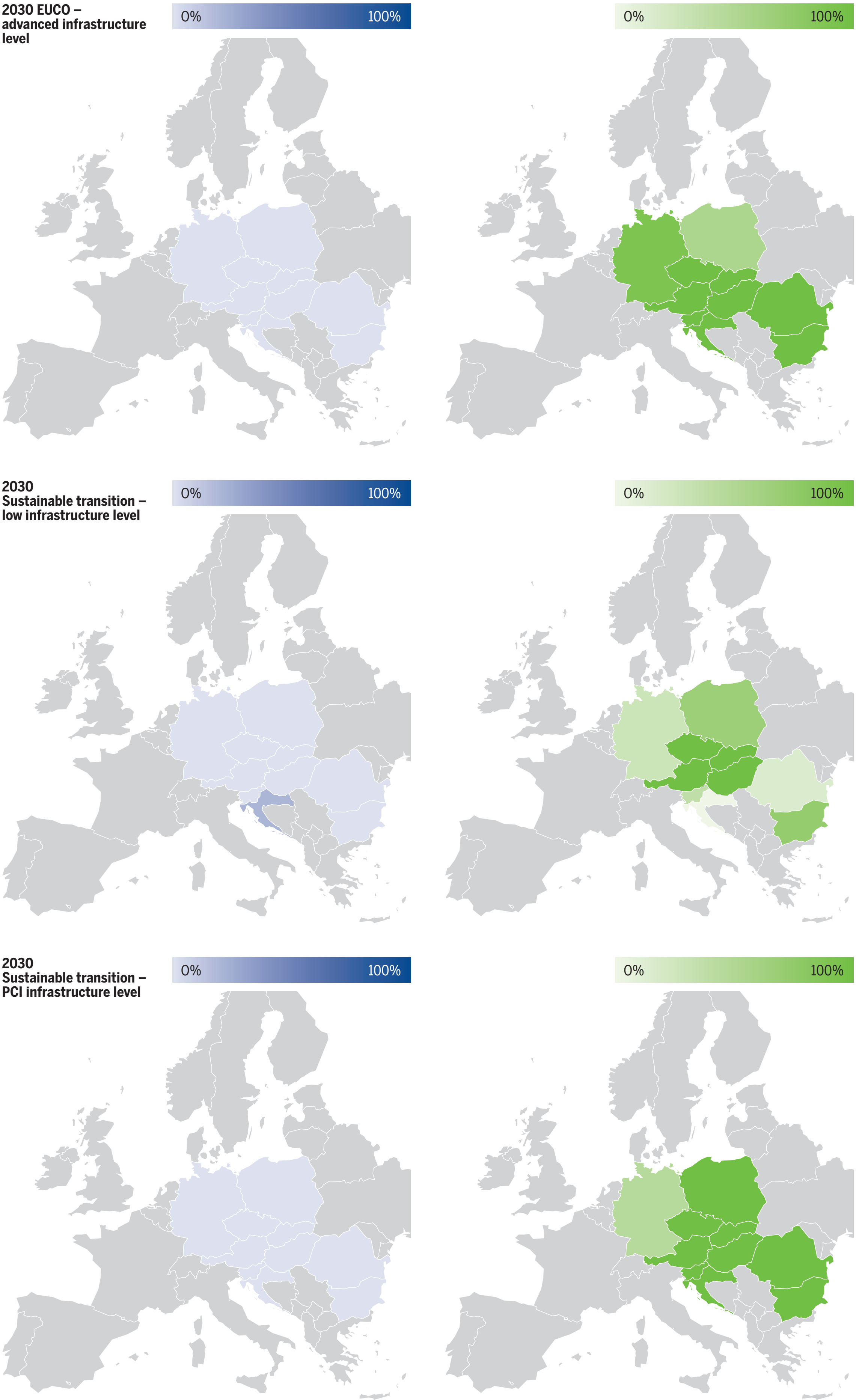


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

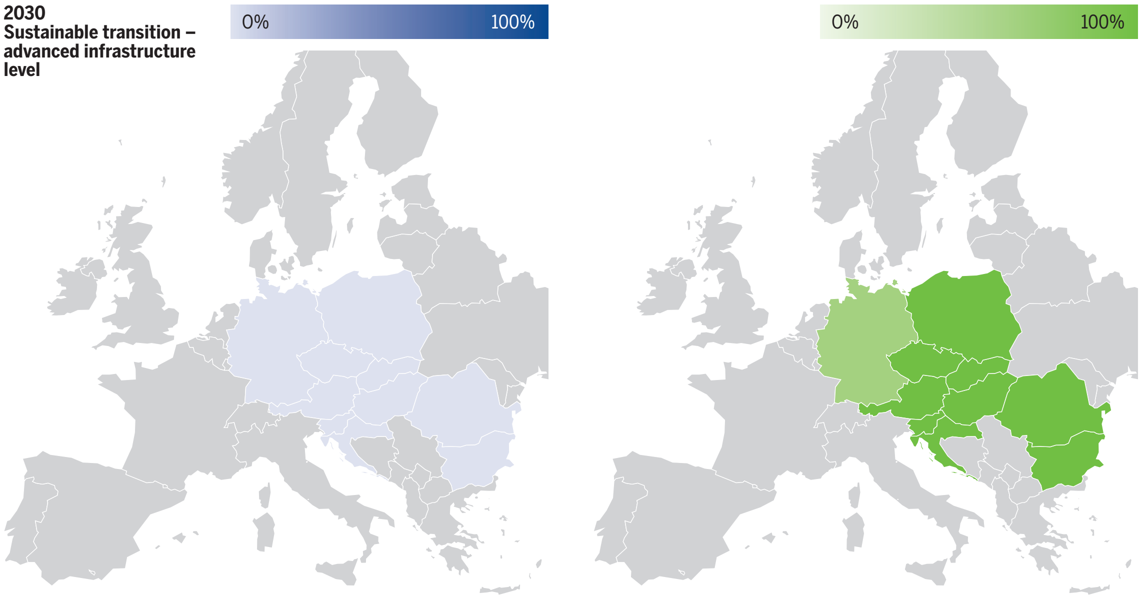


Figure 3.3: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Normal situation, Peak Day (DC),

3.2.2 PEAK DAY UNDER SIMULTANEOUS UKRAINIAN AND BELARUSIAN GAS ROUTE DISRUPTIONS

The simultaneous transit disruption of Russian gas imports via Ukraine and Belarus is one of two additional disruption cases which were specially performed for CEE GRIP purposes. Countries in the CEE region are generally the countries most dependent on the transit of Russian gas, and the gas supply routes through Ukraine and Belarus are historically the most important for supplying the region.

The simultaneous disruption of supply via Belarus and Ukraine would lead to the redirection of gas flows from Russia. Nord Stream would then be used as the only pipeline to transport Russian gas to the CEE region. The worst results can be found under the LOW infrastructure scenario and indicate that Romania and Bulgaria would be the most negatively affected countries by the disruption of gas supply routes via Belarus and Ukraine. However, these results are probably more related to disruption of the Ukrainian gas supply route than the Belarus one. The whole CEE Region faces demand curtailments under the LOW infrastructure scenario during years 2025 (Best Estimate High Scenario) and 2030 (Sustainable Transition Scenario). The results also show that all these findings could be solved by implementation of all currently planned PCI projects in the upcoming years.

The results under the LOW infrastructure scenario show the need for infrastructure to provide diversified supplies of gas and market integration that would benefit the CEE region as a whole and in particular Romania, Croatia and Bulgaria. This is illustrated by the improving situation once the planned infrastructure projects are implemented. In particular, projects which improve the security of supply and the diversification of gas sources and routes mitigate the effects of this disruption case.

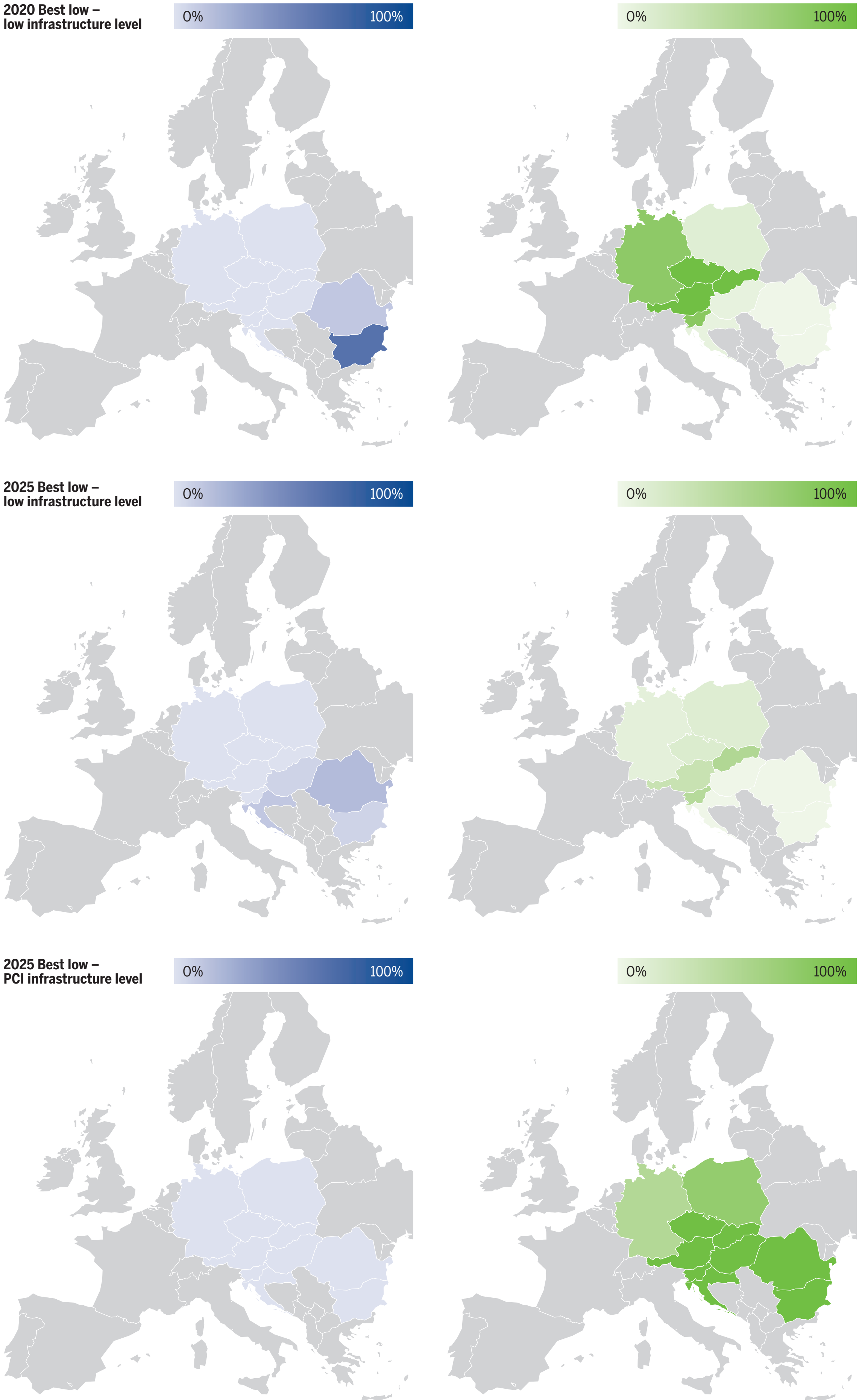


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Route gas disruption via Ukraine + Belarus, Peak Day (DC),

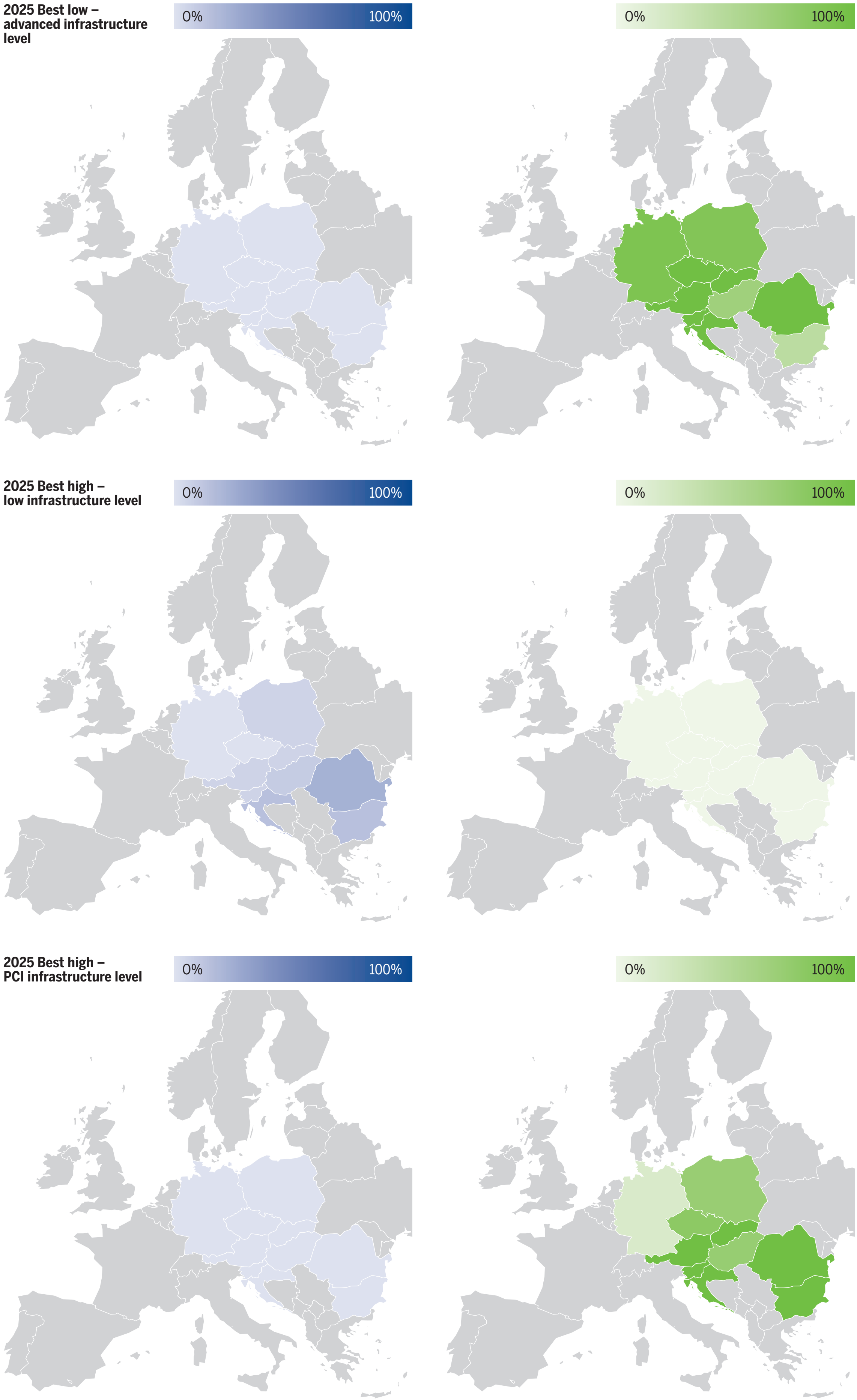


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Route gas disruption via Ukraine + Belarus, Peak Day (DC),

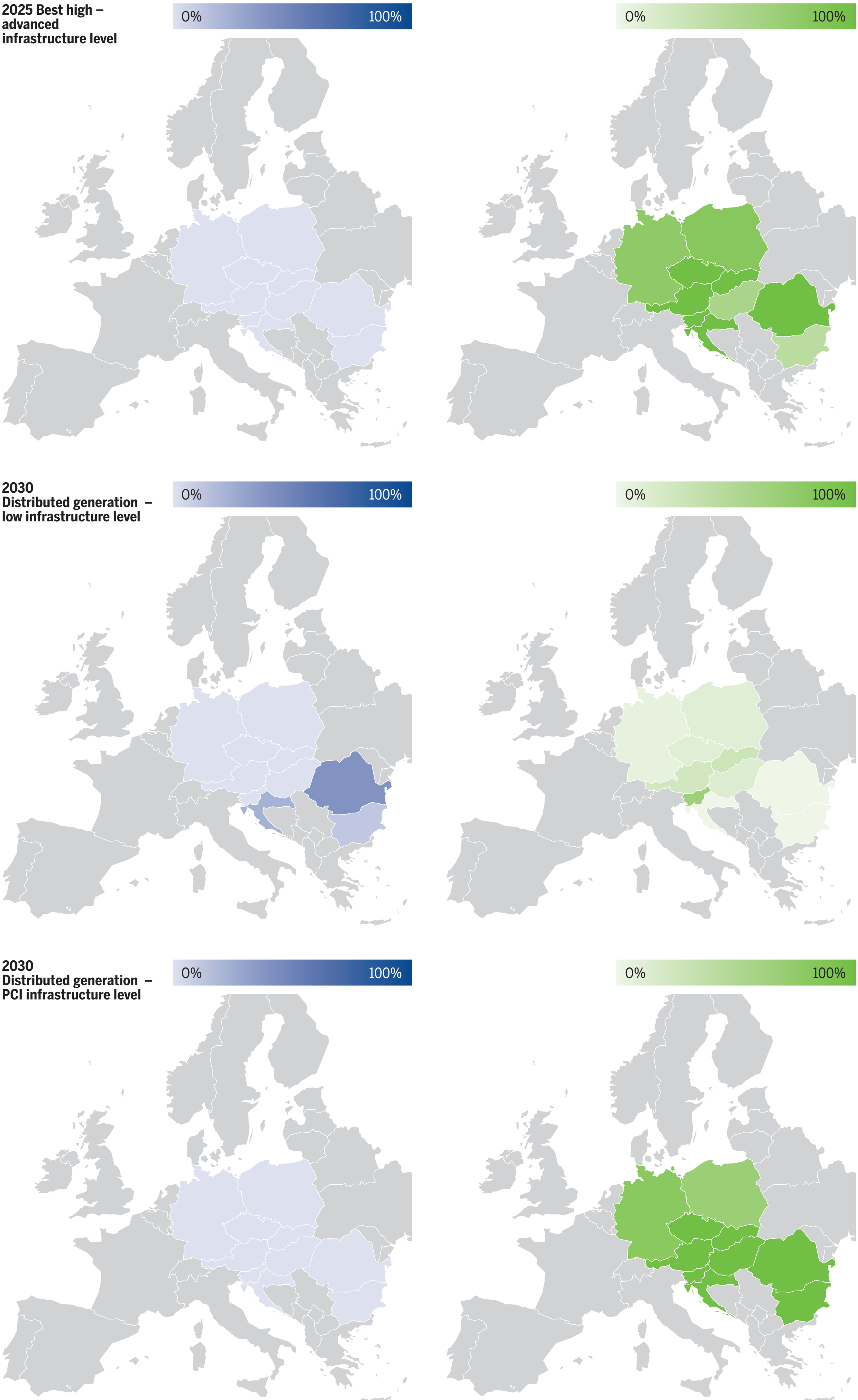


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Route gas disruption via Ukraine + Belarus, Peak Day (DC),

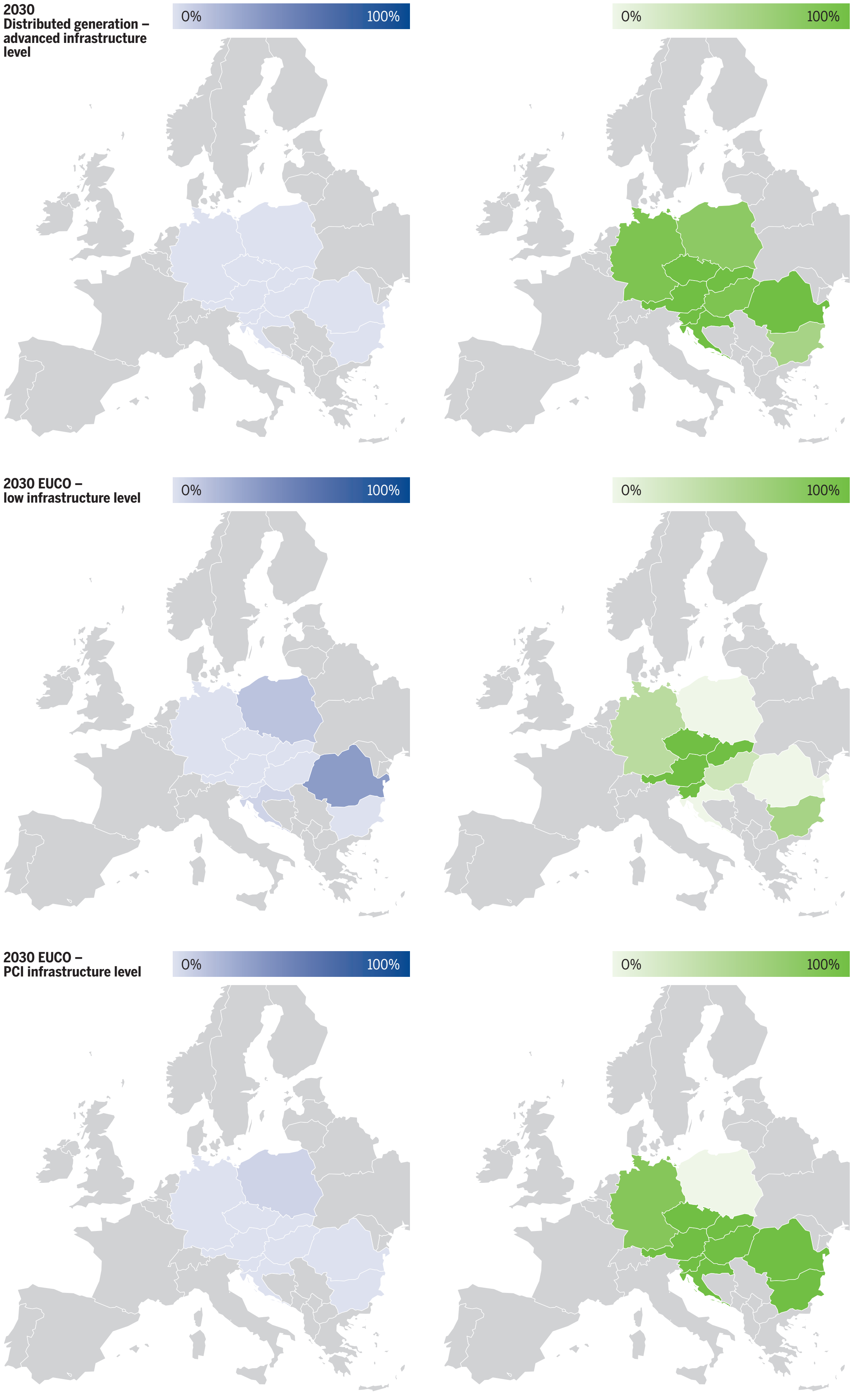


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture),
Route gas disruption via Ukraine + Belarus, Peak Day (DC),

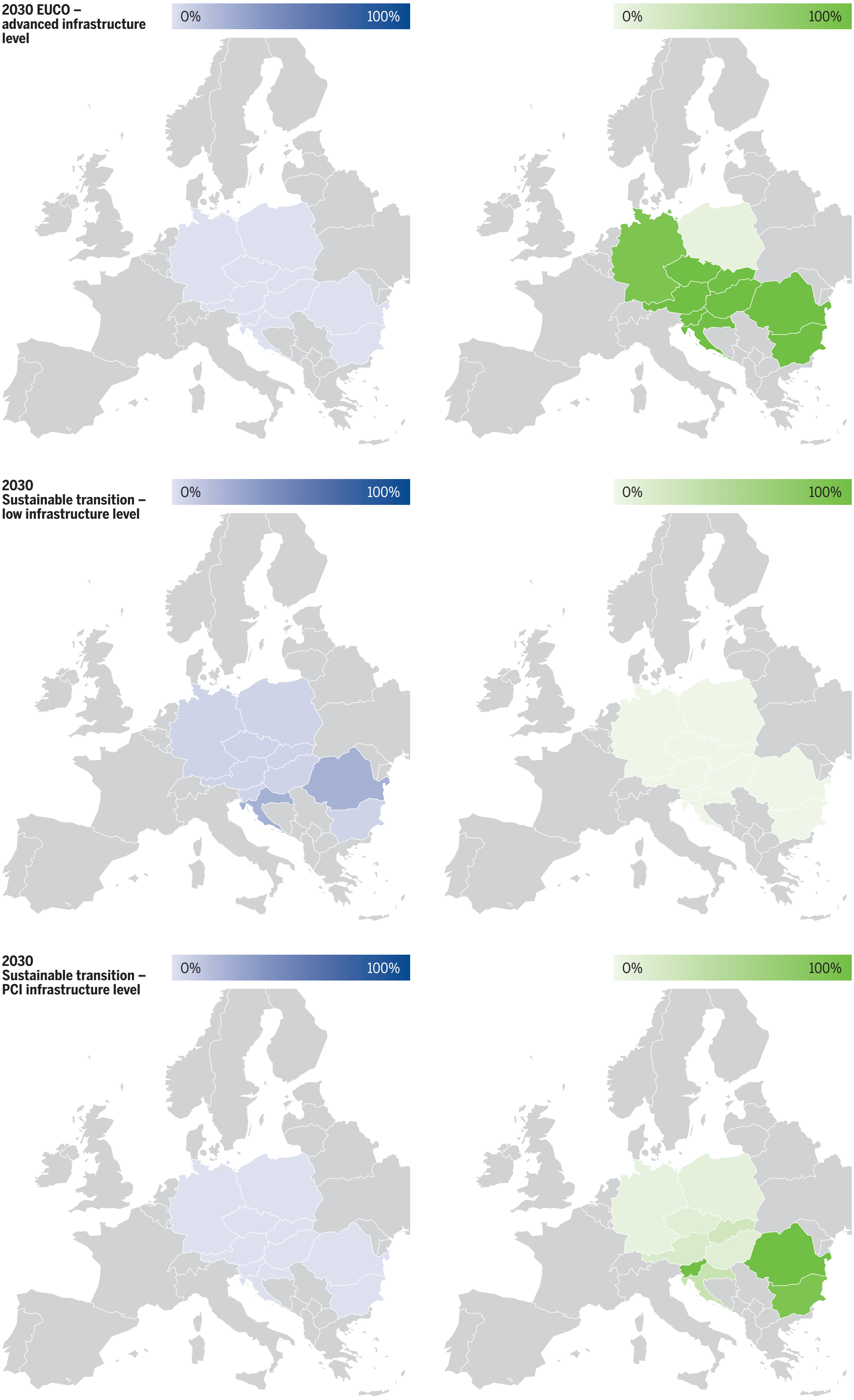


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Route gas disruption via Ukraine + Belarus, Peak Day (DC),

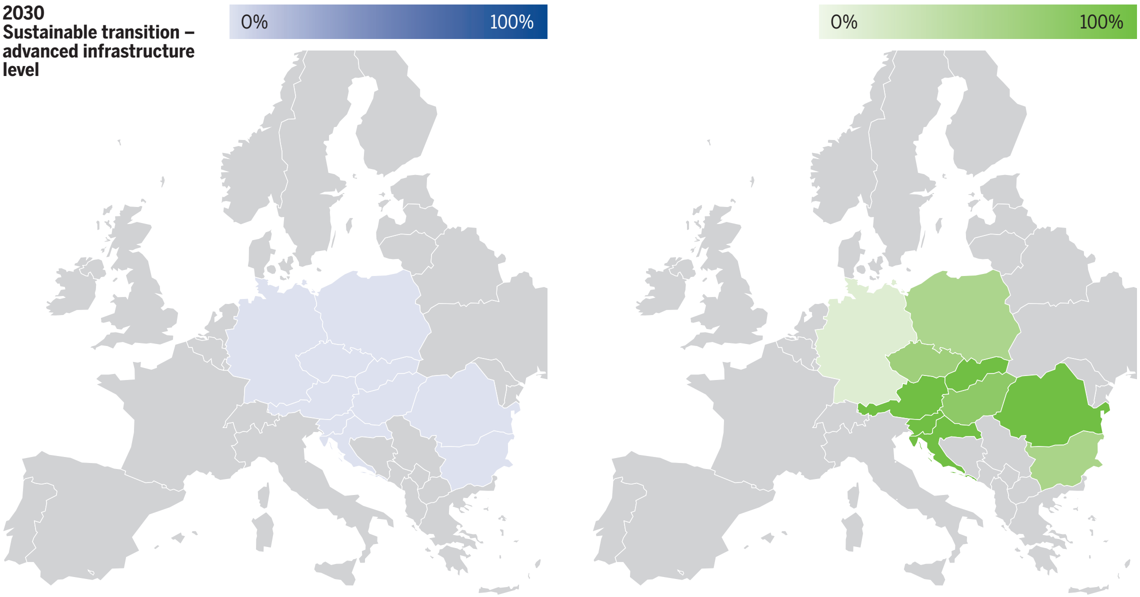


Figure 3.4: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture),
Route gas disruption via Ukraine + Belarus, Peak Day (DC),

3.2.3 PEAK DAY UNDER A RUSSIAN GAS SOURCE DISRUPTION

The case analysed of a Russian gas supply source disruption (no Russian gas flow to Europe) is the most extreme one and was also performed especially for CEE GRIP purposes. This simulation illustrates to what extent the CEE region is dependent on the gas source from Russia. It also shows that some planned infrastructure projects can mitigate this situation.

The results under this scenario show that all countries in the CEE region (including also Germany, the Czech Republic, Slovakia, Austria and Slovenia) are negatively affected by this disruption case.

The commissioning of planned infrastructure projects helps to remove the gas infrastructure bottlenecks in the CEE region by increasing the diversification of gas supply sources for the region (enhanced access to LNG, gas from the southern gas corridor and Norway) and improving cross-border interconnections between the CEE countries.

Implementation of projects with the PCI status between the years 2025 and 2030 has a positive effect on the countries in central and south-eastern Europe. These projects are able to slightly mitigate the negative impact of the analysed disruption case on these countries.

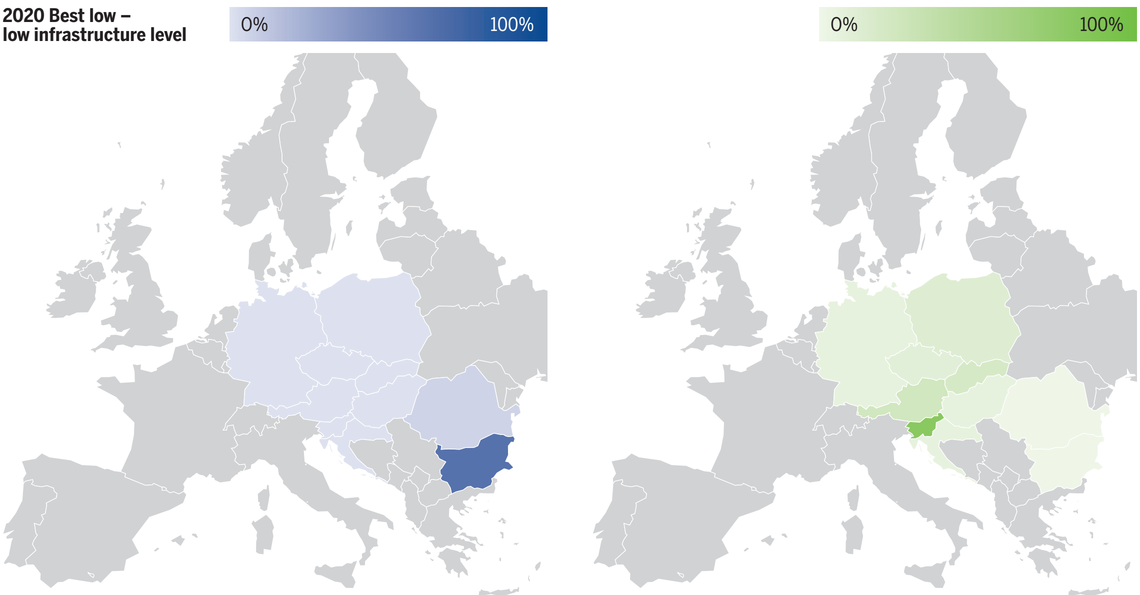


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture),
Russian gas source disruption, Peak Day (DC),

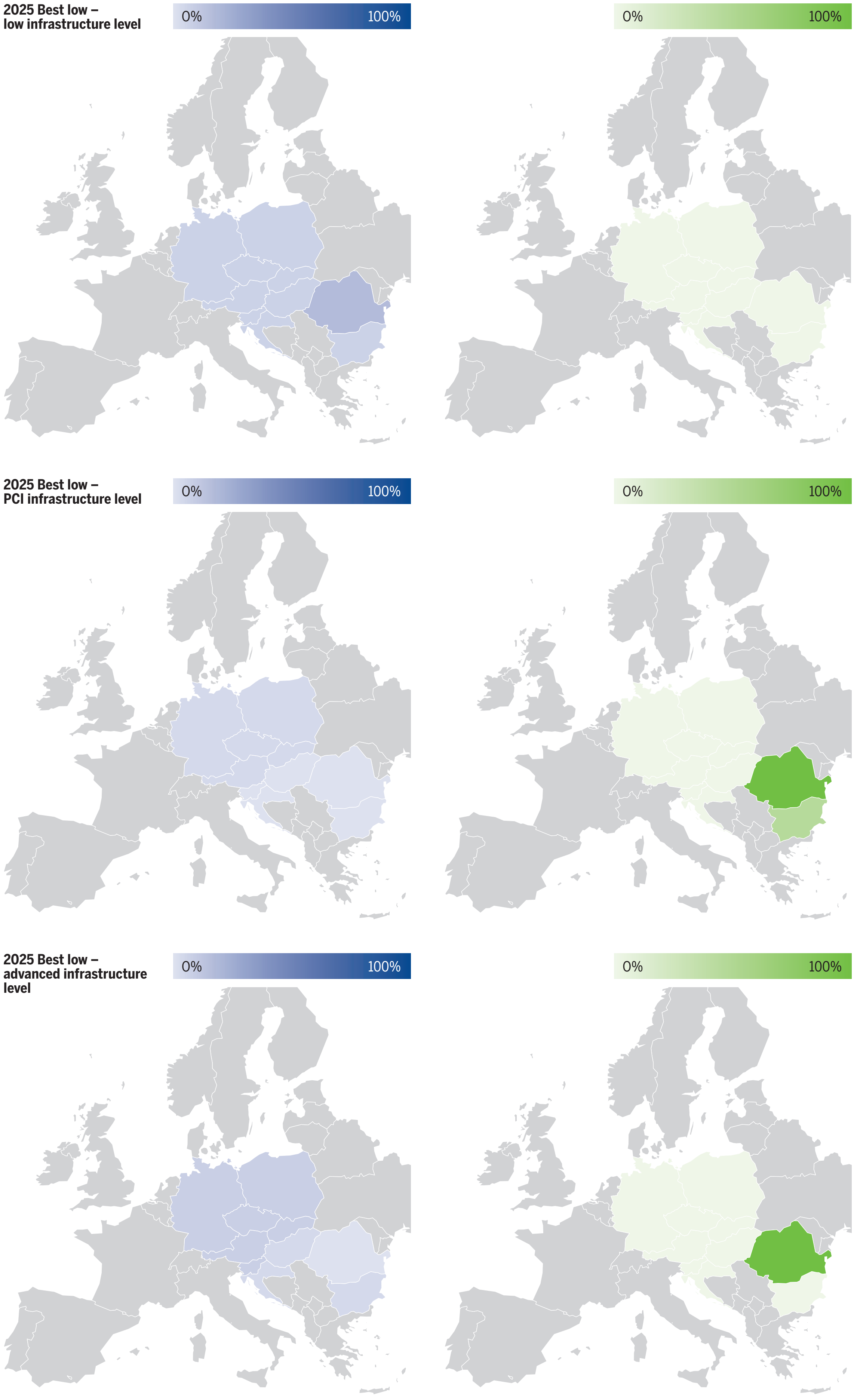


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Russian gas source disruption, Peak Day (DC),

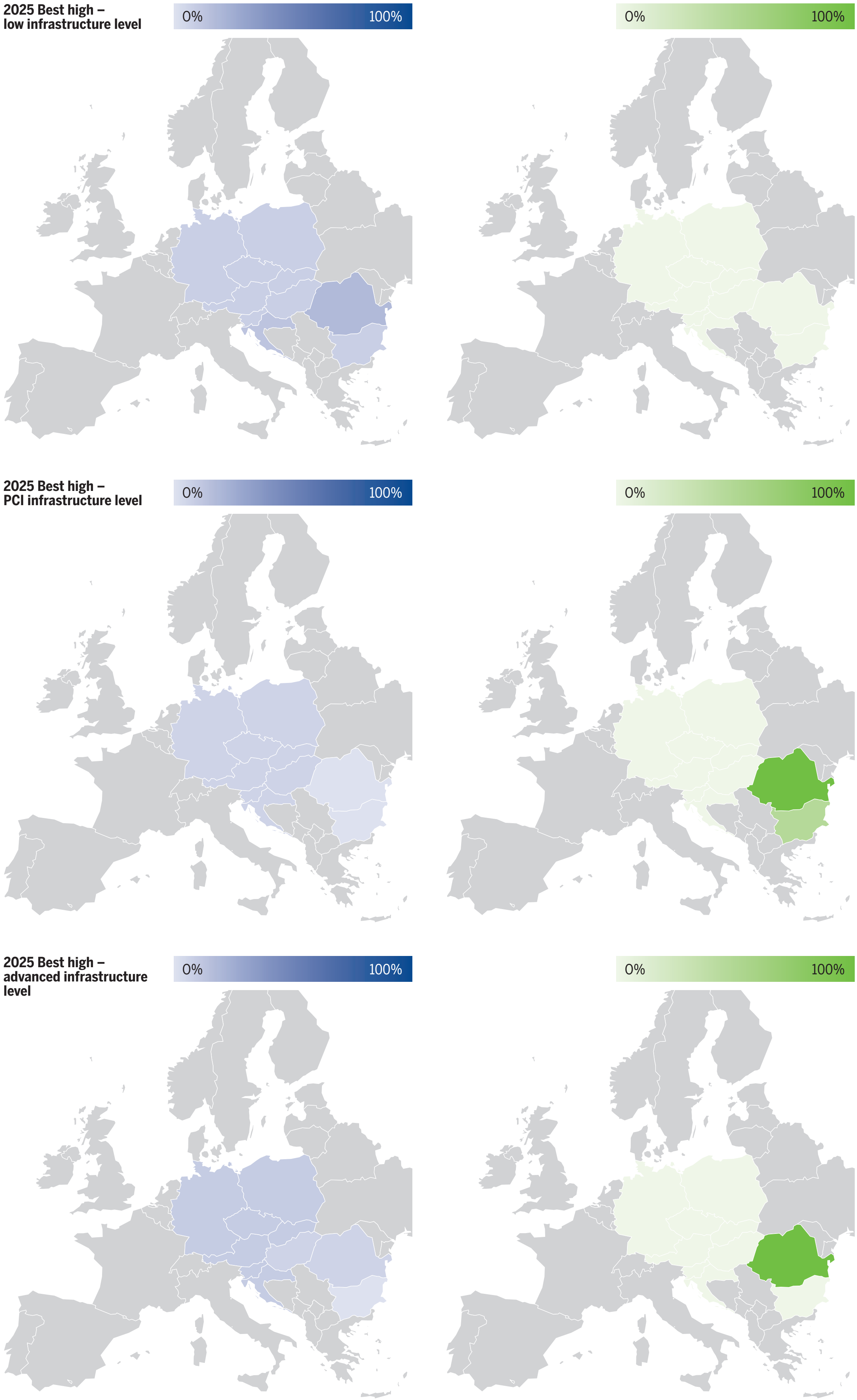


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Russian gas source disruption, Peak Day (DC),

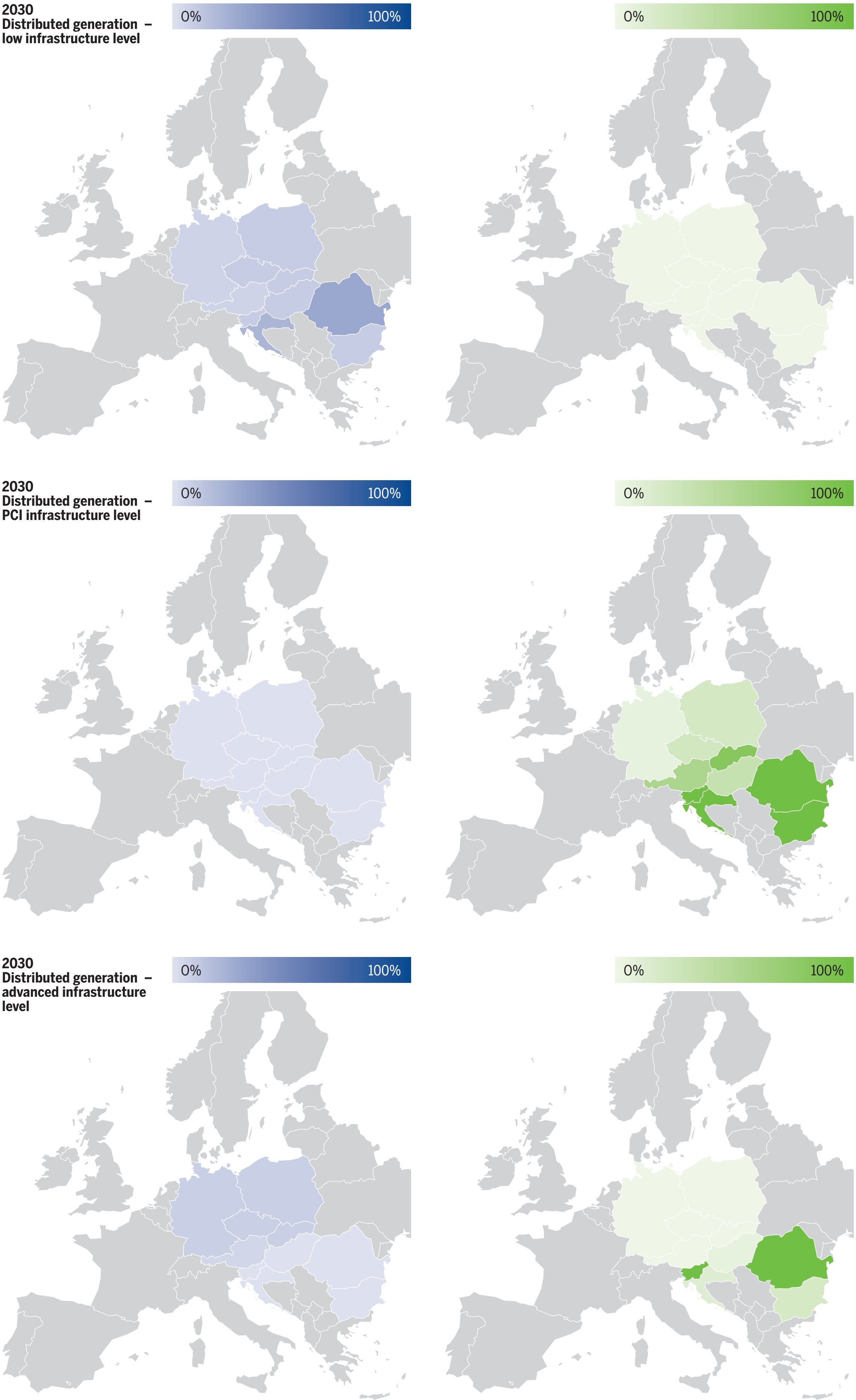


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Russian gas source disruption, Peak Day (DC),

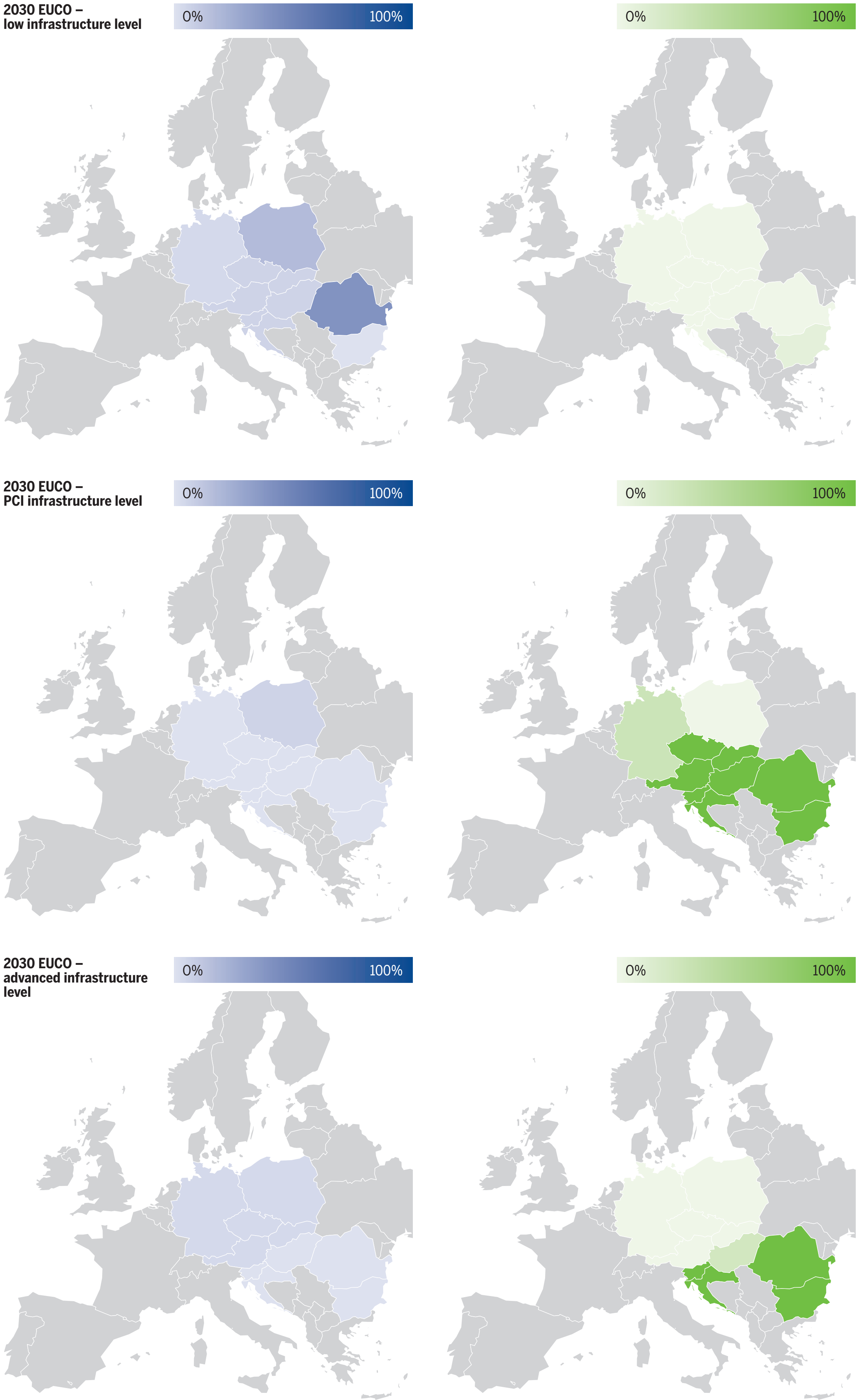
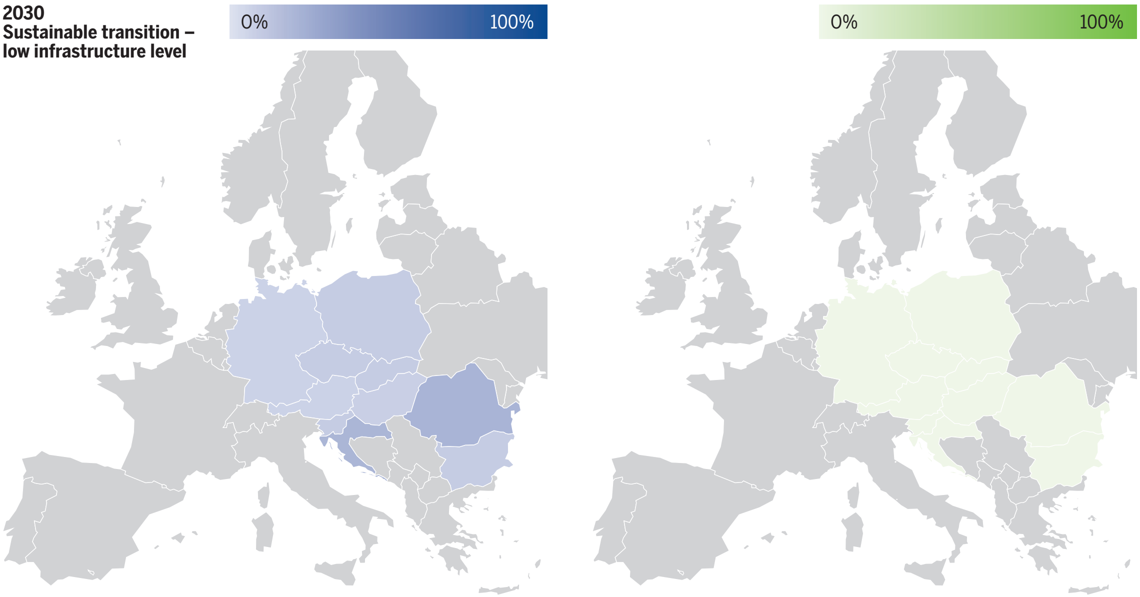
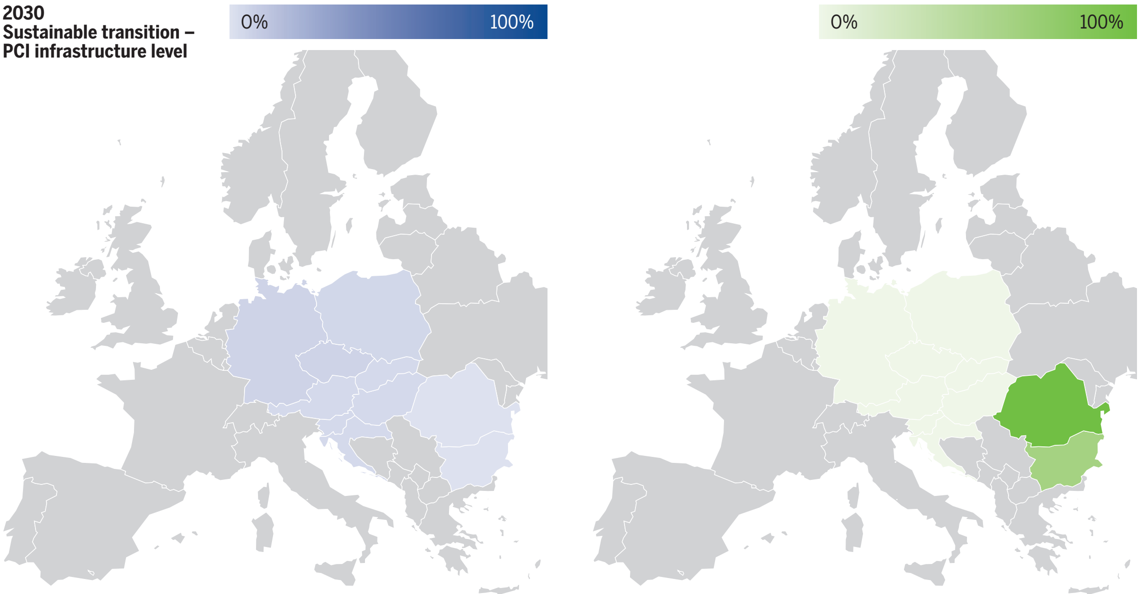


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Russian gas source disruption, Peak Day (DC),

2030
Sustainable transition –
low infrastructure level



2030
Sustainable transition –
PCI infrastructure level



2030
Sustainable transition –
advanced infrastructure
level

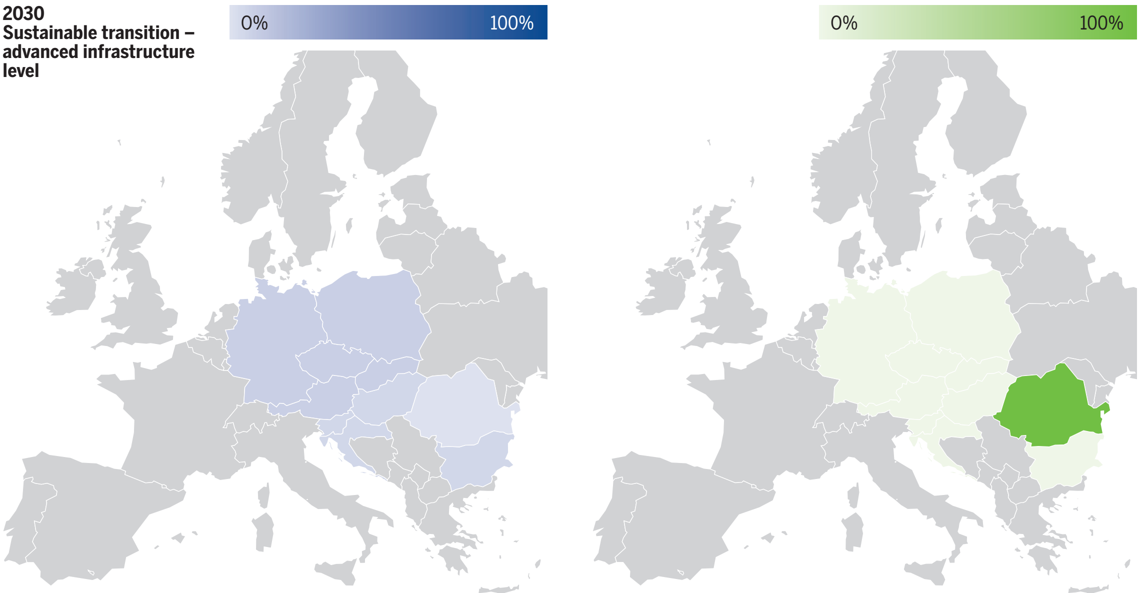


Figure 3.5: Evolution of Curtailment Rate (CR – left picture) and Remaining Flexibility (RF – right picture), Russian gas source disruption, Peak Day (DC),

4 CEE GRIP REGIONAL N-1 ANALYSIS

4.1 GENERAL NOTE

The countries in the CEE region are exposed to gas supply disruptions from the eastern supply. Some projects completed in the past have improved the situation in this respect, nevertheless as illustrated in the chapter on infrastructure resilience some challenges remain. Therefore, the participating TSOs decided to prepare the CEE GRIP 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 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. Special focus is put on the winter periods in the years 2020/2021, 2025/2026 and the summer periods in the years 2020, 2025. **If not stated otherwise, all input data for the analysis are in line with the TYNDP 2018.** The capacity data reflects currently existing infrastructure and FID and non-FID projects planned to be commissioned before 2025.

4.2 SUPPLY CORRIDORS

The CEE region 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.

4.2.1 AUSTRIA (AT)

The gas supply corridors in the following picture show the main supply corridor for Austria, which under normal conditions runs through Slovakia to the Austrian Entry IP Baumgarten (at the figure marked AT1). Other gas supply corridors from Germany to Austria (marked AT2), respectively from Italia to Austria (AT3), reinforce the interconnectivity of Austria under normal flow conditions and its security of supply in case of a supply disruption through Ukraine. The remaining gas in Austria under a Ukraine disruption scenario could be used for export to Slovakia, Hungary, Slovenia and the Czech Republic (currently pilot project 'Trading Regional Upgrade' between Austria and Czech Republic is ongoing, implementation of BACI as a PCI will depend on the outcome of this pilot project).

From 2024, 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.

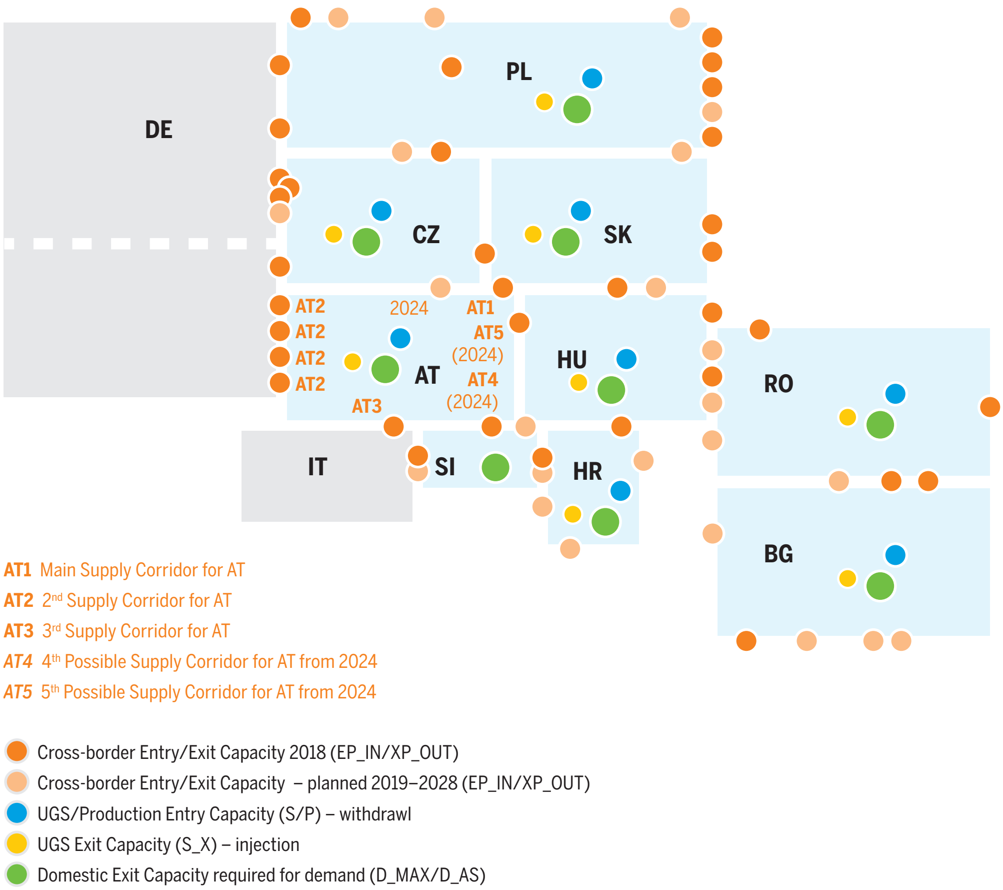


Figure 4.1: CEE Region N-1: AT

4.2.2 BULGARIA (BG)

The following picture shows the main supply corridor for Bulgaria which under normal conditions runs through Ukraine, Moldova, and Romania (at the figure marked BG1). Other gas supply corridors in case of supply disruption through Ukraine are through Greece (marked BG2; this connection is bidirectional) and through Romania (marked BG3). The four new cross-border interconnections within the CEE GRIP are planned from 2022 and beyond.

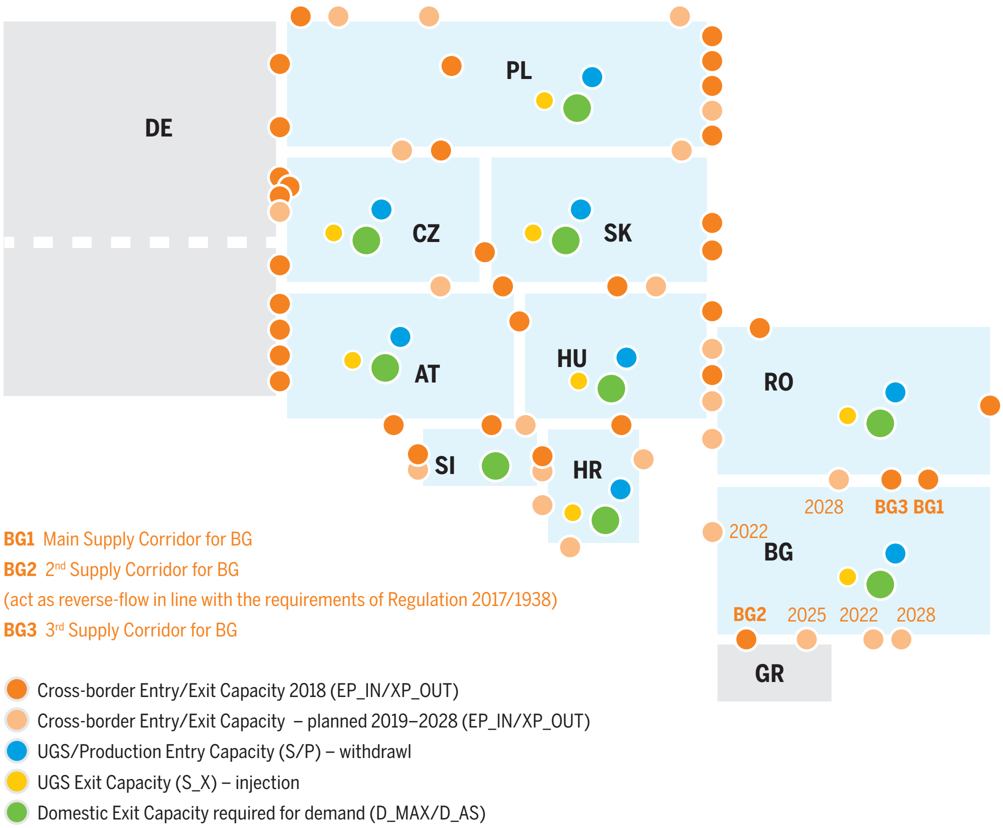


Figure 4.2: CEE Region N-1: BG

4.2.3 CROATIA (HR)

Croatia has two gas supply corridors. The main supply corridor is through Slovenia (at the figure marked HR1). The second one is through Hungary (marked HR2). Both supply corridors are for domestic demand currently. After the Croatian LNG terminal (2023) and the Ionian-Adriatic Pipeline (2023) are built, Croatia can then become a transit country.

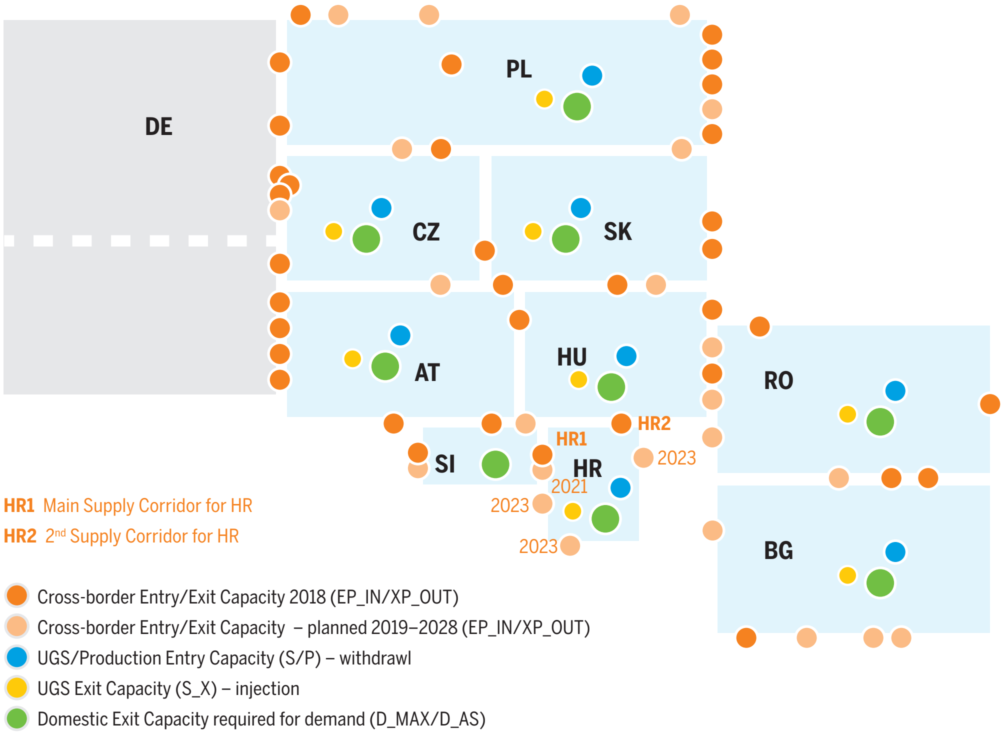


Figure 4.3: CEE Region N-1: HR

4.2.4 THE CZECH REPUBLIC (CZ)

Under ordinary conditions, the main supply corridor for the Czech Republic is through Germany via the Nord Stream and OPAL pipelines (at the figure marked CZ1), followed by the traditional route via Slovakia (marked CZ2). Another gas supply corridor for the Czech Republic can be made through Germany from the NetConnect market area (marked CZ3). In case of a gas supply disruption through Ukraine, the remaining gas in the Czech Republic imported through CZ1 and CZ3 could be used for export to Slovakia, Poland and Austria (via Slovakia). Two infrastructure projects are currently planned as a part of the north-south gas corridor and their realisation would establish a bidirectional connection with Poland with an enlarged capacity and the first direct bidirectional connection with Austria. An extension of the supply corridor from Germany (CZ1) is planned to be realised in two phases 1st: 2019 and 2nd: 2021.

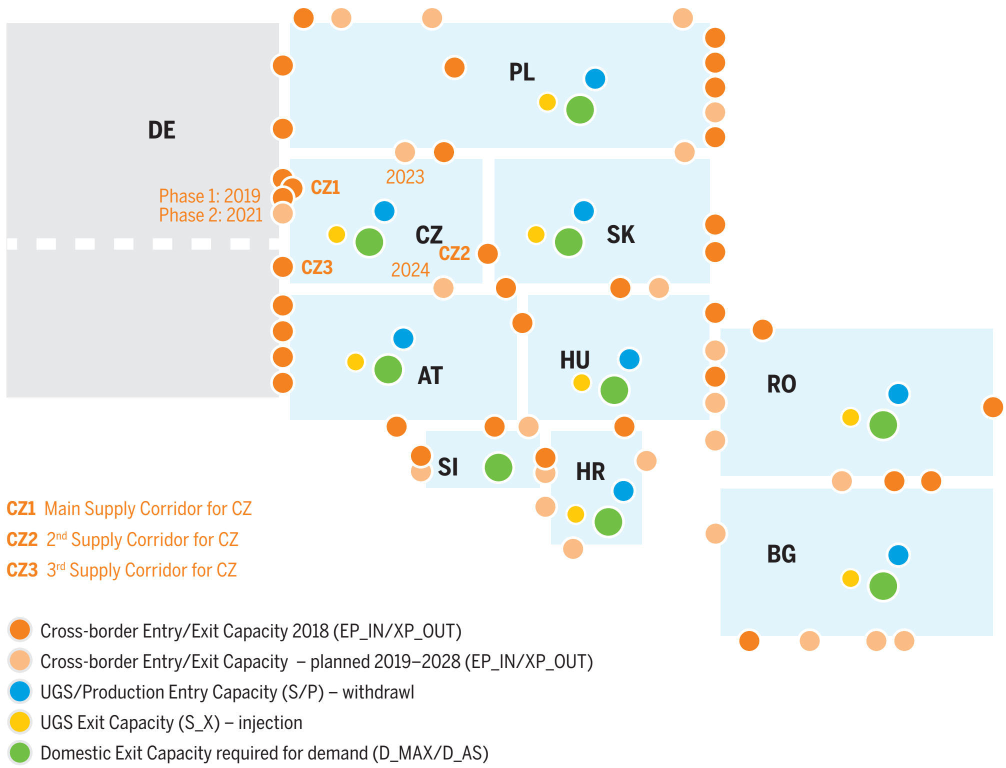


Figure 4.4: CEE Region N-1: CZ

4.2.5 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 HU1). The second supply corridor through Austria (marked HU2) and the third supply corridor through Slovakia (marked HU3) are also of great importance. The other gas supply corridors for Hungary can possibly be made through Romania (marked HU4) and Croatia (marked 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 time are between Slovenia and Hungary (2023,2025), the enhancement of transmission capacity of the Slovak-Hungarian interconnector (stage 1. permanent bidirectional capacity from 2019 and stage 2. enhancement capacity from 2022), and the planned capacity enhancement at the Hungarian/Romanian border (2019,2022).

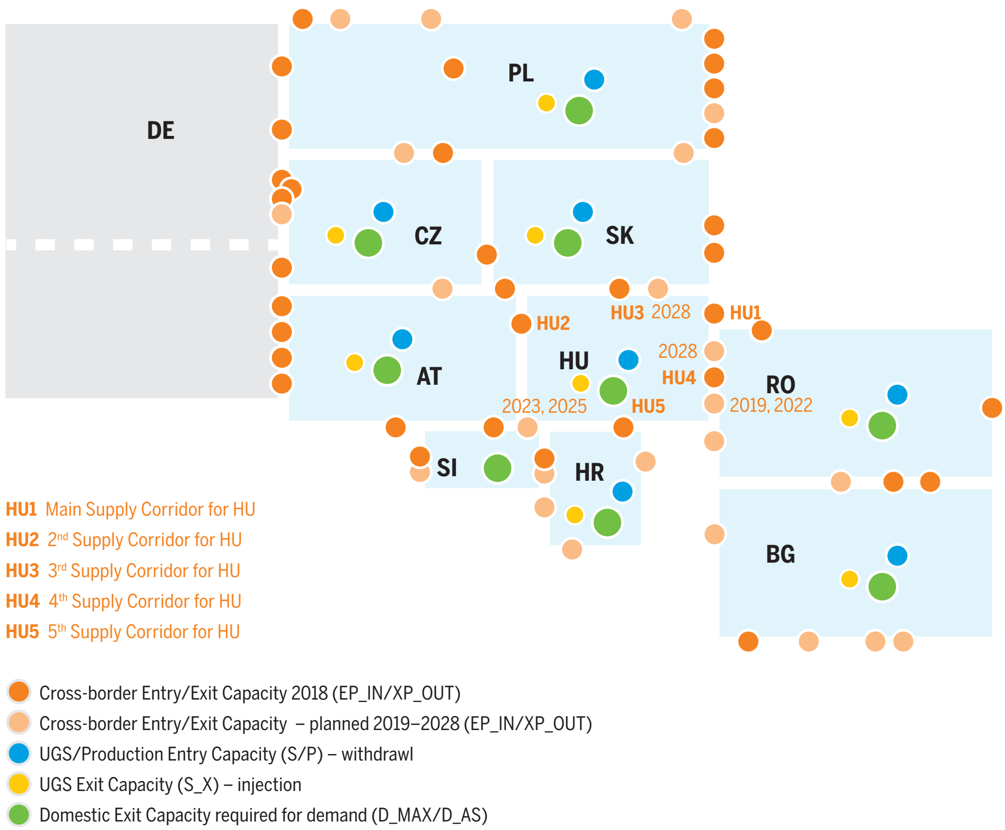


Figure 4.5: CEE Region N-1: HU

4.2.6 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 PL1), Belarus (marked PL2), and Ukraine (marked PL3). Other gas supply corridors for Poland run through Germany (marked PL4) and the Czech Republic (marked PL5). The with the Czech Republic, Slovakia, Ukraine and Lithuania are planned in the upcoming years. A capacity extension of the LNG terminal at Świnoujście is planned for 2023, a new supply corridor from Norway via Denmark is scheduled for 2022 and a floating LNG terminal (FSRU) is planned to be commissioned in 2025.

commissioning of new interconnection projects

Figure 4.6: CEE Region N-1: PL

4.2.7 ROMANIA (RO)

The following picture shows the main supply corridor for Romania, which under normal conditions runs through Ukraine (at the figure marked RO1). In case of a total Ukrainian supply disruption, the other supply corridors for Romania run through Hungary (marked RO2) and Bulgaria (marked RO3). 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.

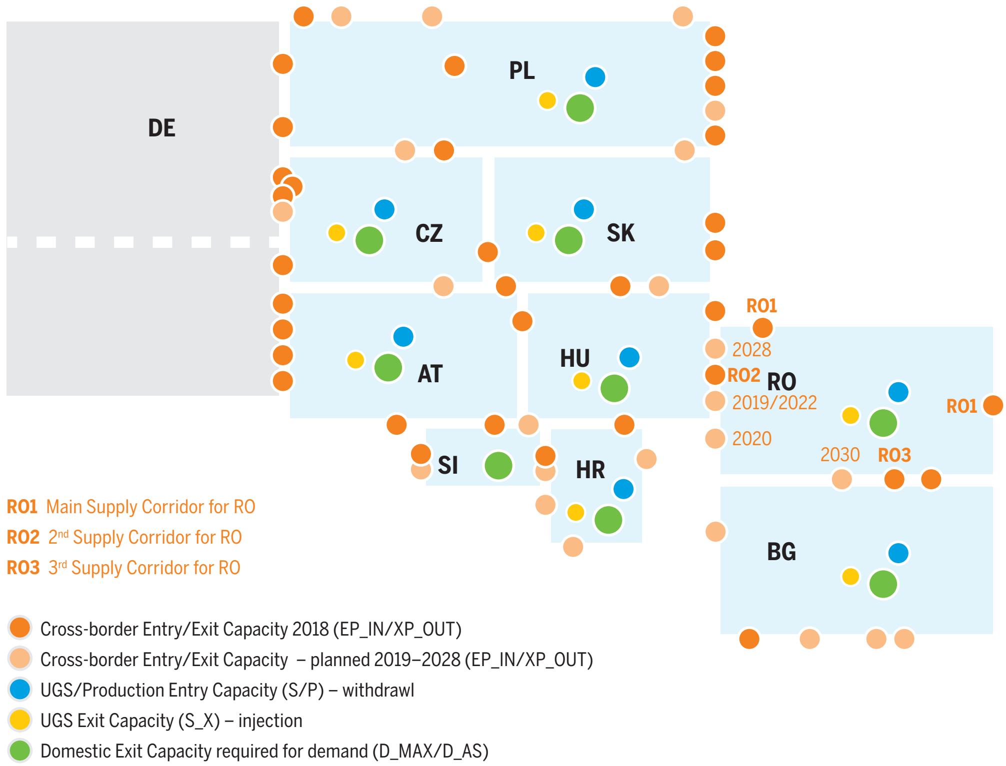


Figure 4.7: CEE Region N-1: RO

4.2.8 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 SK1). Other supply corridors, in case of a supply disruption through Ukraine, are through the Czech Republic (marked SK2), Austria (marked SK3), and Hungary (marked SK4). In 2021 the commissioning of cross-border project with Poland is planned.

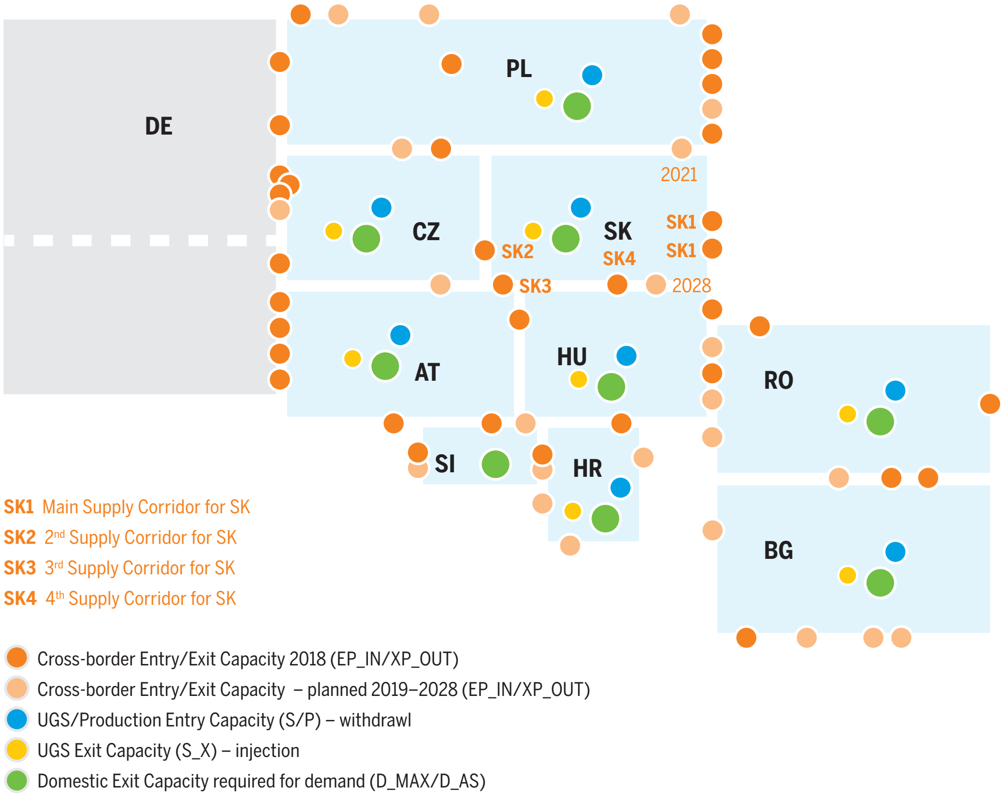


Figure 4.8: CEE Region N-1: SK

4.2.9 SLOVENIA (SL)

The picture below shows the main supply corridor for Slovenia, which under normal conditions runs through Austria (at the figure marked SI1). Other gas supply corridors, in case of a supply disruption through Ukraine, run through Italy (marked SI2) and through Croatia (marked SI3). The supply corridor through Croatia can possibly be used from 2022 when 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.

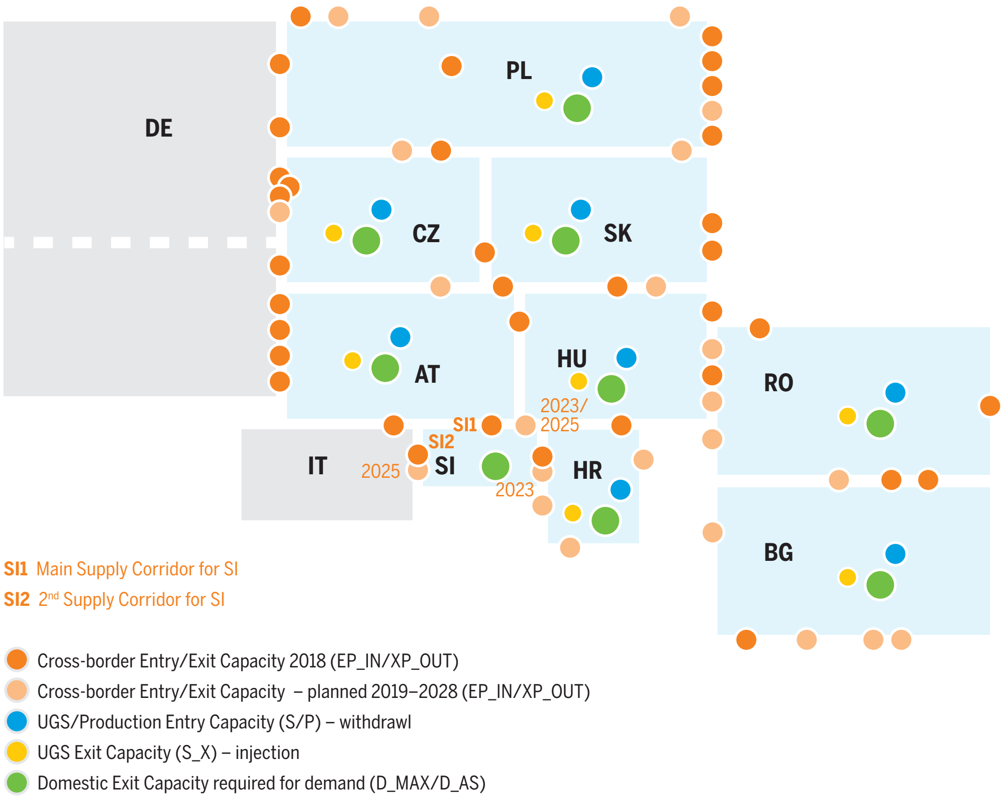


Figure 4.9: CEE Region N-1: SI

4.3 METHODOLOGY

4.3.1 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 Ukraine and Belarus. Only nine out of the ten countries involved in the CEE GRIP are considered to be 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[5]. 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:

- 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.
- 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.
- 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 two winter periods:

01.10.2020–31.03.2021, 01.10.2025–31.03.2026

and two summer periods:

01.04.-30.09.2020, 01.04.–30.09.2025.

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 2018. Input data used for the analysis are part of the CEE GRIP Annex B–Capacities for Regional N-1 analysis.

4.3.1.1 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

5 In the general rules of the calculation, there is one exception at the request of GAZ-SYSTEM. The exception concerns the Gas Interconnection Poland – Lithuania which is planned to bring SoS and market-related benefits mostly for the Baltic States. Therefore, the exit flows from Poland to Lithuania are assumed in the calculations.

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)

4.3.1.2 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.

4.4 DISRUPTION VIA UKRAINE

If planned infrastructure projects are implemented in time, then the Regional N-1 criterion for the winter of 2020/2021 will be met also for Bulgaria, Romania and Poland due to various reasons. Except of infrastructure gaps, in case of Poland it is due to increased daily maximum demand by almost 1/3 from 1013 GWh/d in 2017 to 1 361 GWh/d in 2019 (demand increase mostly in the power generation and heating sectors). In the analysed winter period 2025/2026 all 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	
	01.10.2020 – 31.03.2021	01.10.2025 – 31.03.2026
Austria	3,1144	3,3460
Bulgaria	0,8276	1,644
Croatia	1,9134	4,3862
Czech Republic	3,6879	4,5501
Hungary	1,49	1,4
Poland	0,8549	1,2627
Romania	0,9466	1,6029
Slovakia	4,7098	5,3580
Slovenia	2,6630	4,1985

Table 4.1: Results of CEE GRIP Regional N-1 Winter in case of a disruption via Ukraine

The analysis of the summer period concluded that all countries in the region are able to cover their demand and fill the storages in summer 2020 and 2025 for the upcoming winter seasons.

In the 2020 summer period, the potential issue linked to the injection of gas into underground storage facilities was detected in Hungary, Austria and Romania. In Hungary this potential issue would appear only if the gas supply disruption through Ukraine lasted longer than 66 days. A potential issue in Austria would raise in case the disruption last for more than 125 days, in Romania in case of more than 155 days of interruption.

The commissioning of projects in subsequent years will respond to all identified problems.

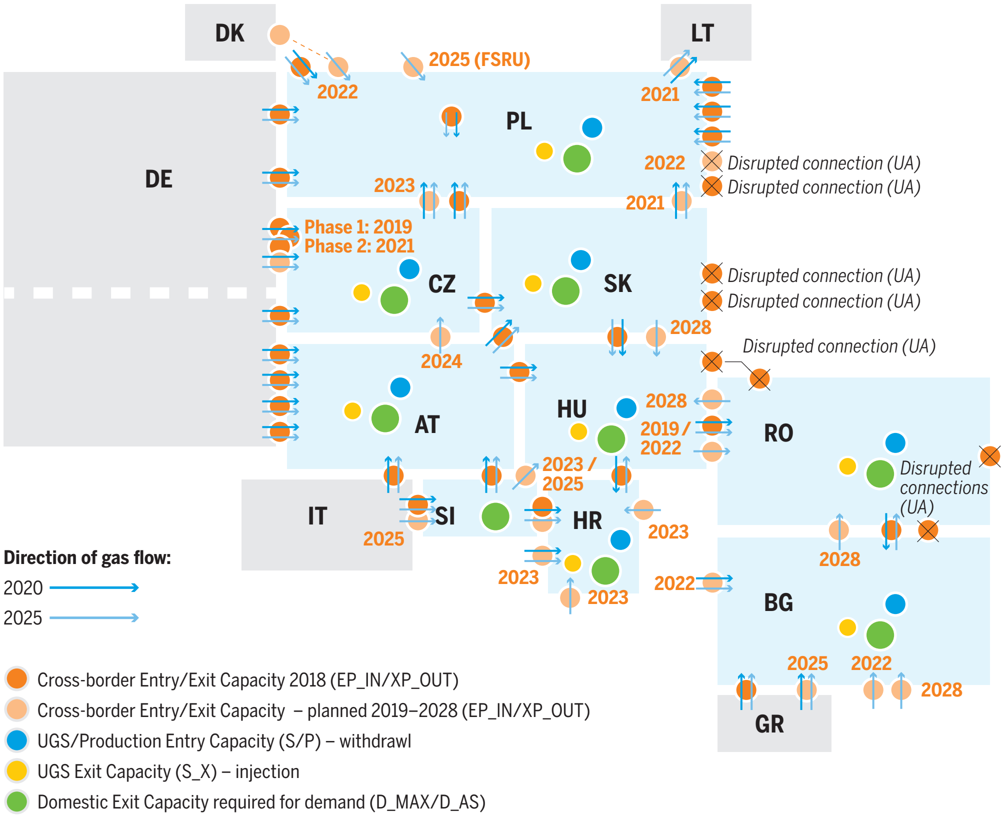


Figure 4.10: Direction of gas flow considered at each interconnection point under disruption via Ukraine

4.5 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 from Belarus to Poland) 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 2020/2021 due to expected increased of the Dmax. For the winter period 2025/2026 Poland meets the N-1 criterion and 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 the following tables.

Country	CEE GRIP Regional N-1 Winter	
	01.10.2020 – 31.03.2021	01.10.2025 – 31.03.2026
Austria	No effect	No effect
Bulgaria	No effect	No effect
Croatia	No effect	No effect
Czech Republic	No effect	No effect
Hungary	No effect	No effect
Poland	0,7436	1,2638
Romania	No effect	No effect
Slovakia	No effect	No effect
Slovenia	No effect	No effect

Table 4.2: Results of CEE GRIP Regional N-1 Winter in case of a disruption via Belarus

The analysis for the 2020 and 2025 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, except for Poland for summer 2020, if the disruption would last for more than 116 days.

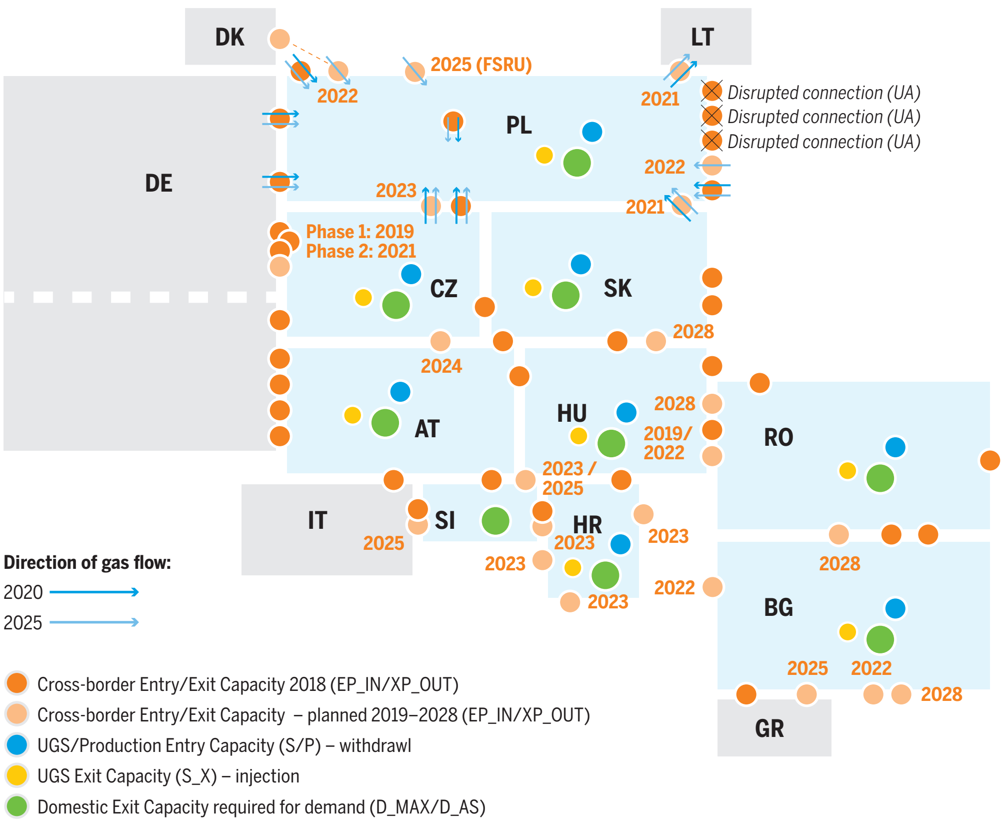


Figure 4.11: Direction of gas flow considered at interconnection points at Polish borders under a disruption via Belarus

5 **ROLE OF NATURAL GAS IN THE CEE REGION** IN THE LONG-TERM PERSPECTIVE

5.1 GENERAL NOTE

The EU energy and climate policy is based on three overarching objectives that include energy security, competition and sustainability. In recent years, the latter objective has gained growing importance. As a result, the currently applicable EU regulatory framework and ongoing legislative works are largely driven by the need to transform Europe's energy systems in accordance with EU commitments in the perspective of 2050. This requires taking firm actions to ensure that the energy consumers are provided with sustainable energy at affordable prices, low-carbon and climate-friendly economy is put in place and finally that energy security is maintained.

As the challenge is substantial, it is of paramount importance to fully exploit the potential of infrastructures and assets available in the EU and meet the EU climate and energy objectives in an efficient and affordable manner. In this context it is worth noting that the EU Member States share the same climate and energy objectives in the long run. However, they do have different starting points in their paths towards the energy transition depending on local circumstances. There are a number of factors that determine how climate objectives may be implemented by individual countries and regions. The current energy mix, political choices, potential of RES deployment, the role of natural gas in the energy mix, the state of gas infrastructure development, regional opportunities and challenges and competition with other energy carriers may be considered as the most important aspects.

Against this background, the TSOs from the CEE GRIP region have decided to take a closer look at the role of natural gas in the CEE region in the long-term perspective. To this end, this chapter presents an analysis of the EU regulatory framework in the field of energy and climate. A special emphasis is put on those legislative acts that support the reduction of greenhouse gas emissions and other pollutants. The next part of the chapter is focused on the energy markets in the CEE region to verify what has been achieved so far, what is the current outlook of the energy markets in order to capture a snapshot of the path of the CEE region towards the EU objectives in the long run. This is followed by case studies to evaluate how the natural gas sector may contribute to the transition of energy markets on a regional level.

Overview of the EU regulatory set-up

The current **EU climate policy objectives for 2020** include:

- 20 % cut in greenhouse gas emissions (from 1990 levels),
- 20 % of EU energy from renewables,
- 20 % improvement in energy efficiency.

Binding **EU targets for 2030** are formulated as follows:

- at least 40 % cut in greenhouse gas emissions (from 1990 levels),
- at least 32 % share of renewable energy,
- at least 32.5 % improvement in energy efficiency.

The **EU climate and energy policy towards 2050** is currently under discussion. This relates in particular to the level of ambition and the means to achieve the emission reduction targets. In this context, the following documents deserve special attention:

- Energy Roadmap 2050 that proposed a long-term goal of reducing greenhouse gas emissions by 80-95 %, when compared to 1990 levels, by 2050. This is planned to be achieved by undertaking significant investments in new low-carbon technologies, renewable energy, energy efficiency and energy infrastructure.

- A European strategic long-term vision for a prosperous, modern, competitive and climate-neutral economy by 2050 that aims at confirming Europe's commitment to lead in global climate action. The vision is underpinned by seven long-term strategy options assuming differentiated targets ranging from 80 % emission cuts up to reaching climate neutrality through a socially-fair transition and in a cost-efficient manner. Natural gas, renewable gases (i.e. synthetic methane, biomethane), hydrogen and sector coupling (i.e. integration of electricity, gas, heating/cooling and mobility systems) are recognized as contributing to these objectives.
- Paris Agreement that aims to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius.

The above framework documents are implemented via a number of concrete regulatory measures. To tackle climate change and reduce greenhouse gas emissions, the EU introduced in 2003 an Emissions Trading System (EU ETS). The ETS system may be considered as the basic tool for reducing emissions of carbon dioxide and other greenhouse gases from large power plants and combined heat and power plants, industrial installations and air transport in the EU.

In line with the adopted objectives, the level of emissions covered by the EU ETS in 2020 are planned to be lower by 21 % compared to 2005, and by 2030 the respective emission levels should be reduced by 43 % compared to 2005.

The annual limits of available EU ETS emission allowances are gradually reduced in order to support EU Member States in the switch from carbon intensive sources (e. g. coal, lignite) to low emission fuels (e. g. natural gas) and renewable sources (e. g. wind, solar PV). In the present third phase of the ETS system (covering the years 2013–2020), the annual reduction coefficient of the total emission allowance (linear reduction factor) is set at the level of 1.74 %. Pursuant to Directive 2018/410 to enhance cost-effective emission reductions and low-carbon investments, the annual reduction coefficient will be increased up to 2.2 % in the 4th phase of the ETS covering 2021–2030.

In addition, a market stability reserve is in operation since January 2019 to transfer unallocated allowances to the reserve and release them if the number of allowances drops below a predefined level.

Considering the market nature of setting prices for CO_2 emission rights and the dynamic situation in the regulatory and system environment it is difficult to forecast allowance prices in the future. However, having in mind the subsequent ETS reforms a further increase in the price of CO_2 emission allowances above the current level of 25–30 EUR/ton is likely.

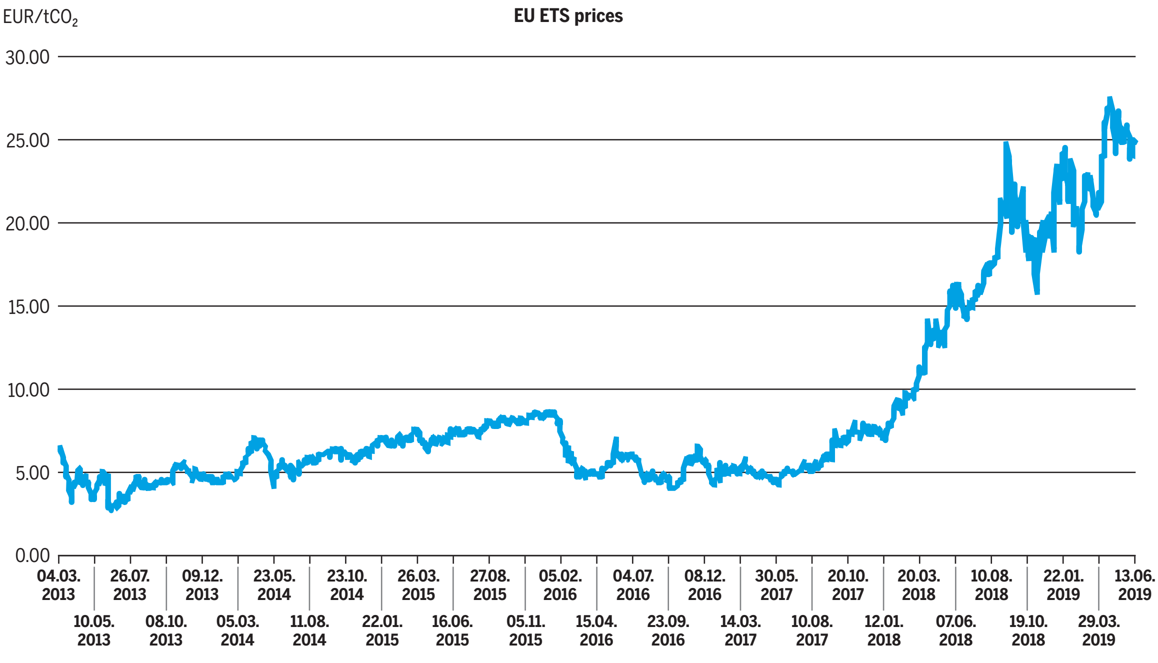


Figure 5.1: Historical price of CO_2 emission allowances under the EU ETS in the period from January 2013 to June 2019 (Source: EEX platform)

It is estimated that the ETS system covers around 45 % of all greenhouse gas emissions of EU Member States. Therefore, a separate so called non-ETS Decision[6] established annual, binding greenhouse gas emission targets until 2020 for each Member State for sectors not included in the EU ETS such as transport (except aviation and international maritime shipping), buildings, agriculture and waste. Targets were set separately for each EU Member State, taking into account the level of economic development of individual countries measured by the GDP indicator. The overall EU-wide emission levels in non-ETS sectors should be 10 % lower in 2020 than in 2005 and 30 % lower in 2030.

As the significant share of greenhouse gas emissions is produced by industrial activities, industrial installations have been subject to EU legislation. Industrial Emission Directive[7] is one of the key legal acts in this respect. The directive sets standards for emissions of sulphur dioxide, nitrogen oxides and particulate matters from combustion plants with a total rated thermal input greater than 50 MW. It also regulates the application of the Best Available Techniques (BATs) in the field of environmental protection by placing a strong emphasis on taking BATs into account when setting emission limit values in the permit granting process and significantly limiting the possibilities to deviate from the BAT requirements in specific cases. Around 50,000 installations undertaking the industrial activities listed in Annex I of the IED are required to operate in accordance with a permit granted by relevant authorities in EU member states.

Despite the use of transitional periods and providing an additional timeline for existing facilities for technical adaptation to stricter emission requirements the implementation of IED Directive is equivalent to the need to raise significant investment expenditures to put in place modern installations for dust removal, desulphurisation and denitrification. In case of ageing power plants retrofitting may not be economically viable compared to building a new power plant that meets all environmental requirements.

Medium Combustion Plant Directive[8] (MCP Directive) also deserves attention as it regulates pollutant emissions (sulphur dioxide, nitrogen oxides and particulate matters) from the combustion of fuels in plants with a total rated thermal input equal to or greater than 1 MW and less than 50 MW. The emission limits vary according to the type of the plant and the fuel used. The limits already apply from 20 December 2018 in case of new plants while for existing plants, they will be applicable, depending on their size, from 2025 or 2030.

On a similar principle as the IED Directive, new requirements set in MCP Directive result in the need to install flue gas cleaning equipment by medium-sized energy facilities operators (which often include local heat and power plants, as well as many industrial CHP plants), or change the fuel used if modernization costs outweigh the benefits.

Renewable Energy Directive[9] is another legal act that needs to be considered. It establishes an overall policy helping the EU to meet its long-term emissions reduction commitments by promoting the roll-out of renewable sources in the EU. What is important from the perspective of the gas sector, the recast of the directive provides the room for guarantees of origin which are currently in place for renewable electricity to be extended to cover renewable gases. Furthermore, the directive also incentivises Member States to assess the need to extend existing gas network infrastructure to facilitate the integration of gas from renewable sources.

5.1.1 ENERGY MARKETS IN THE CEE REGION

The structure of gross inland consumption is closely linked with significant resources of raw materials that are located in Central-Eastern Europe. This means that hard and brown coal constitute the key sources of energy supply in the whole region. Back in 1990, solid fossil fuels covered approx. 41 % of gross inland consumption. Since then, the share of hard and brown coal has decreased to the level of 28 %. This trend was offset by the enhnaced role played by renewables and biofuels (increase up to 13 %) as well as natural gas (increase up to 22 %). In addition, oil and petroleum products have a stable share at the level of approx. 30 %.

6 Decision no 406/2009/EC of the European Parliament and of the Council of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020

7 Directive 2010/75/EU of the European Parliament and the Council on industrial emissions.

8 Directive (EU) 2015/2193 of the European Parliament and of the Council of 25 November 2015 on the limitation of emissions of certain pollutants into the air from medium combustion plants.

9 Directive (EU) 2018/2001 of the European Parliament and of the Council of 11 December 2018 on the promotion of the use of energy from renewable sources.

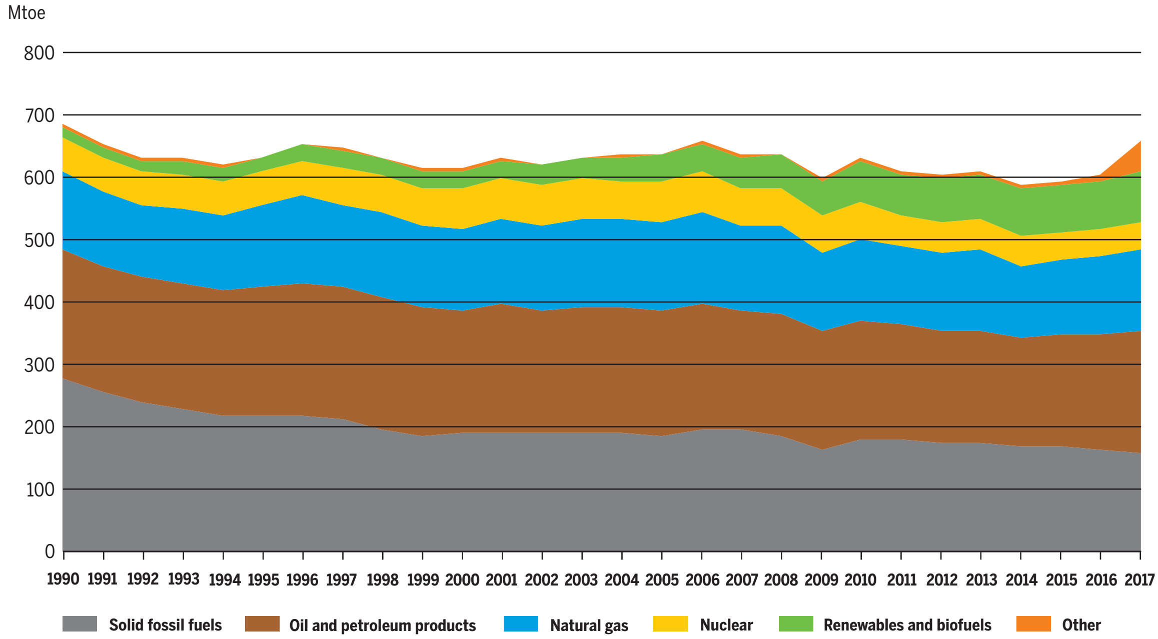


Figure 5.2: Evolution of gross inland consumption in the CEE region (Source: Eurostat)

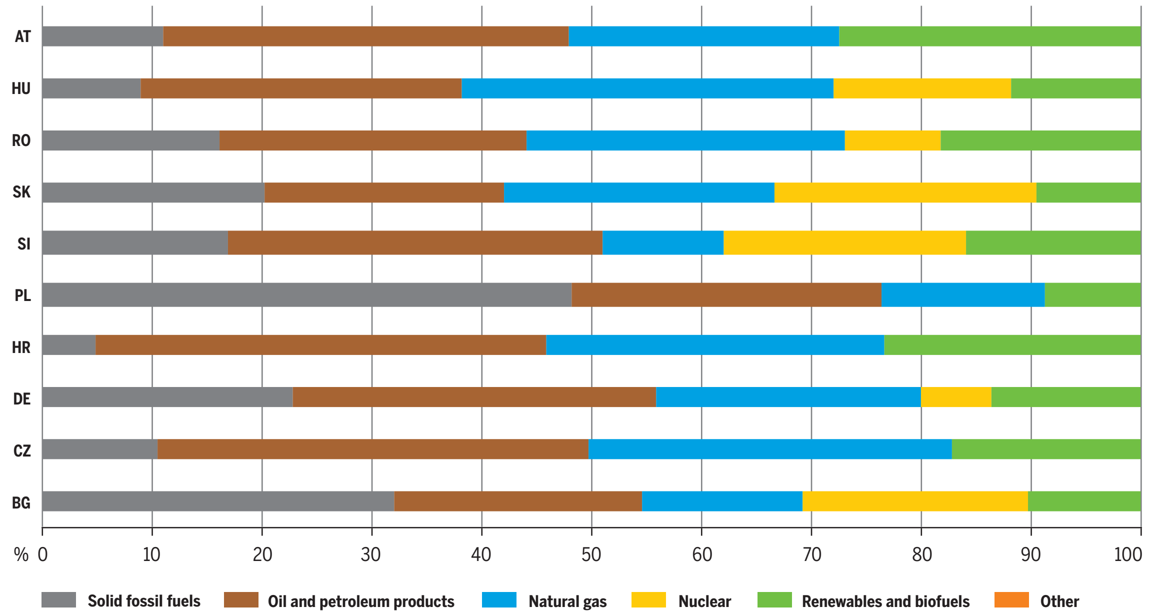


Figure 5.3: Gross inland consumption in the CEE countries in 2017 (Source: Eurostat)

The outlook in Central-Eastern Europe is very much different when compared with other EU Member States. The share of hard and brown coal is marginal or very limited in non-CEE countres while low and zero-emission sources of energy such as renewables, nuclear and natural gas play a bigger role.

Figure 5.3 illustrates the data on gross inland consumption on a country level. The share of solid fossil fuels is substantial. In case of most CEE countries it amounts for at least 15 %, reaching the level of 22 % in Germany, 32 % in Bulgaria and 47 % in Poland. A combined share of natural gas, renewables and biofuels is limited.

The CEE region is largely dependent on solid fossil fuels in the electricity generation sector. 30 years ago the majority of electricity was mostly produced from coal and lignite power plants. In recent years, a gradual switch from solid fuels is visible considering

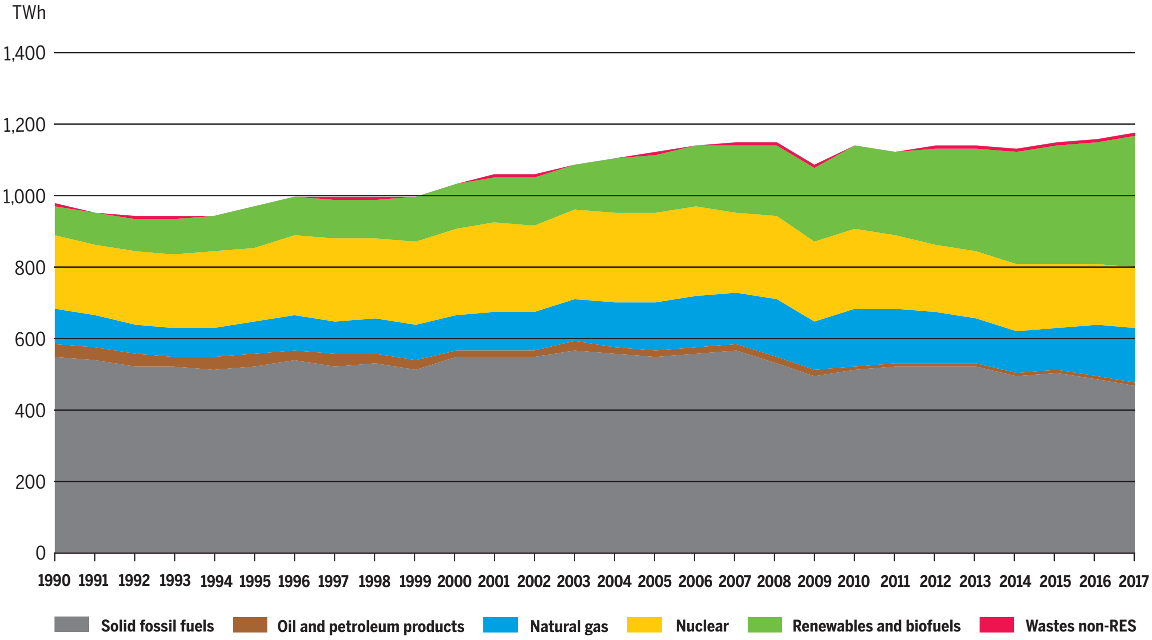


Figure 5.4: Evolution of gross electricity generation in the CEE region (Source: Eurostat)

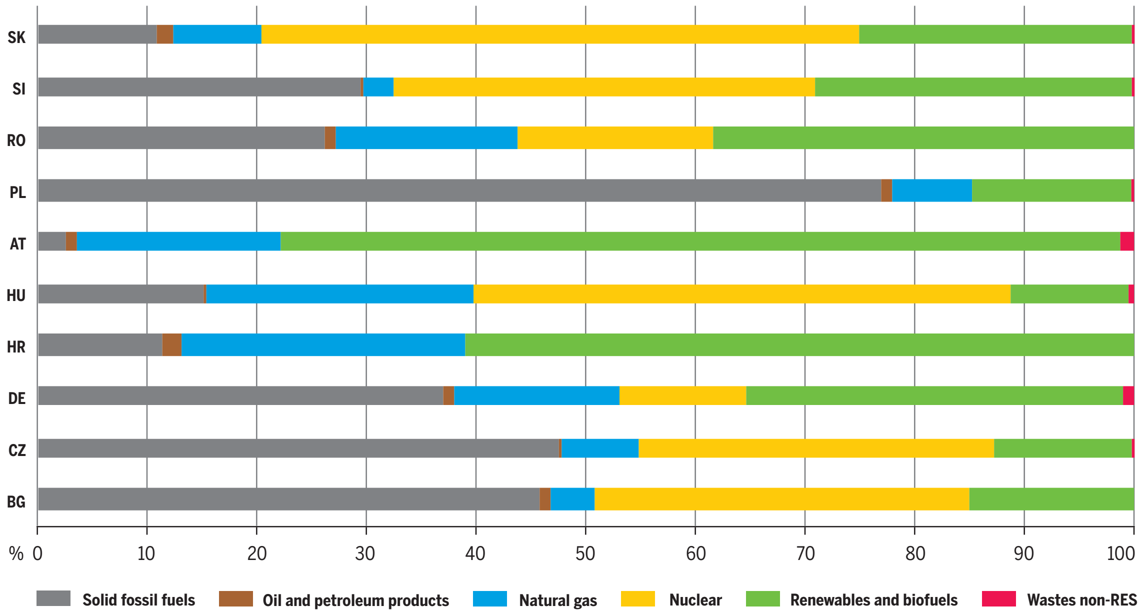


Figure 5.5: Gross electricity generation in the CEE countries in 2017 (Source: Eurostat)

that their share decreased to the level of 40 %. The historical data indicate also a declining use of nuclear power plants across the whole region (reduced use from 21 % to 14 %). Natural gas plays a limited – yet increasing – role (an increase up to 13 %). Renewables have been dynamically developing in the last decade and now their share amounts for 31 %.

Figure 5.5 presents the electricity generation in individual CEE countries in 2017. In most of the CEE countries the share of hard and brown coal is at least at the level of approx. 30 %, with the highest contribution visible in Germany (37 %), Bulgaria (46 %), the Czech Republic (48 %) and Poland (77 %). In some CEE countries, including Hungary, Slovakia, the Czech Republic and Bulgaria, nuclear energy is largely present, while renewables and biofuels are developed to a different extent across the region. Significant share of renewables and biofuels is visible above all in Austria and Croatia.

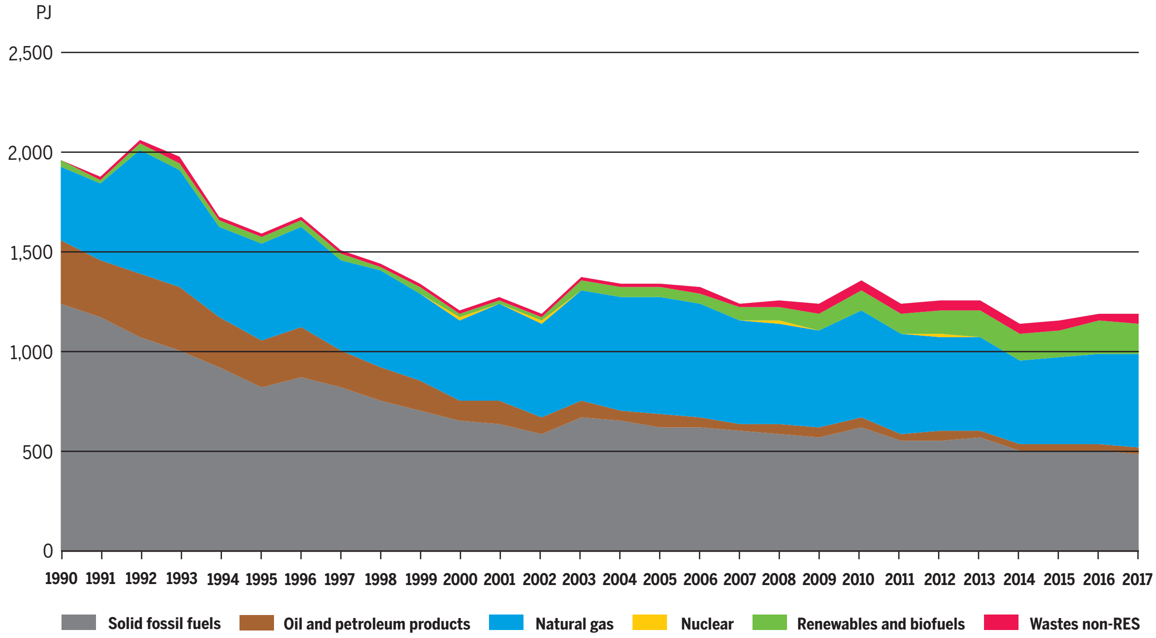


Figure 5.6: Evolution of the gross heat generation in the CEE region (Source: Eurostat)

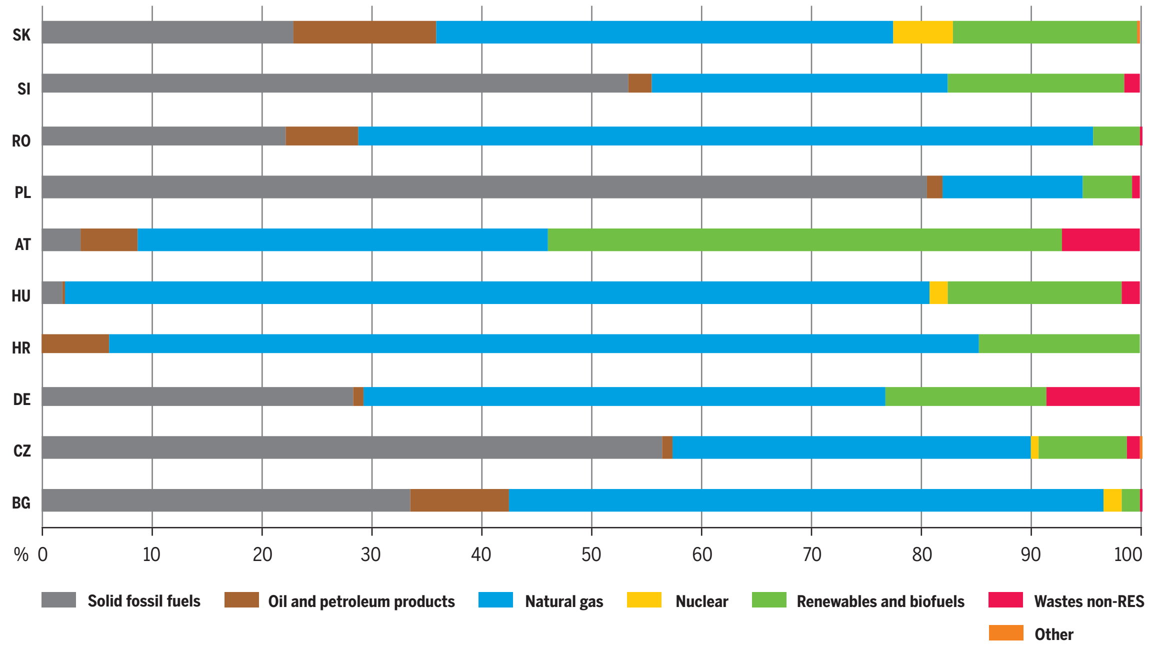


Figure 5.7: Gross heat generation in the CEE countries in 2017 (Source: Eurostat)

High emission sources of energy are also largely present in the heating sector. In 1990, a combined share of solid fossil fuels together with oil and petroleum products was at the level of approx. 79 %. Since then the share of both sources halved. Solid fuels generate nowadays approx. 41 % of the heat, while the use of oil and petroleum products is marginal. Natural gas dynamically developed its position in the heating sector and it now is responsible for 39 % of the generation. The use of renewables and biofuels slowly develops across the region as their share reached 13 %.

On a country level, a high share of high emission sources is mostly visible in the nothern part of the CEE region where the heat demand is the highest. In this context it is worth noting that solid fuels still contribute to meeting a large part of the demand in Poland (81 %), the Czech Republic (56 %), Slovenia (54 %), Bulgaria (34 %) and Germany (28 %). Natural gas plays already now a key position in a number of the CEE countries, including Croatia (79 %), Romania 67 %), Bulgaria (54 %), Germany (48 %) and Slovakia (42 %). Renewables and biofuels are mostly developed in Austria (47 %).

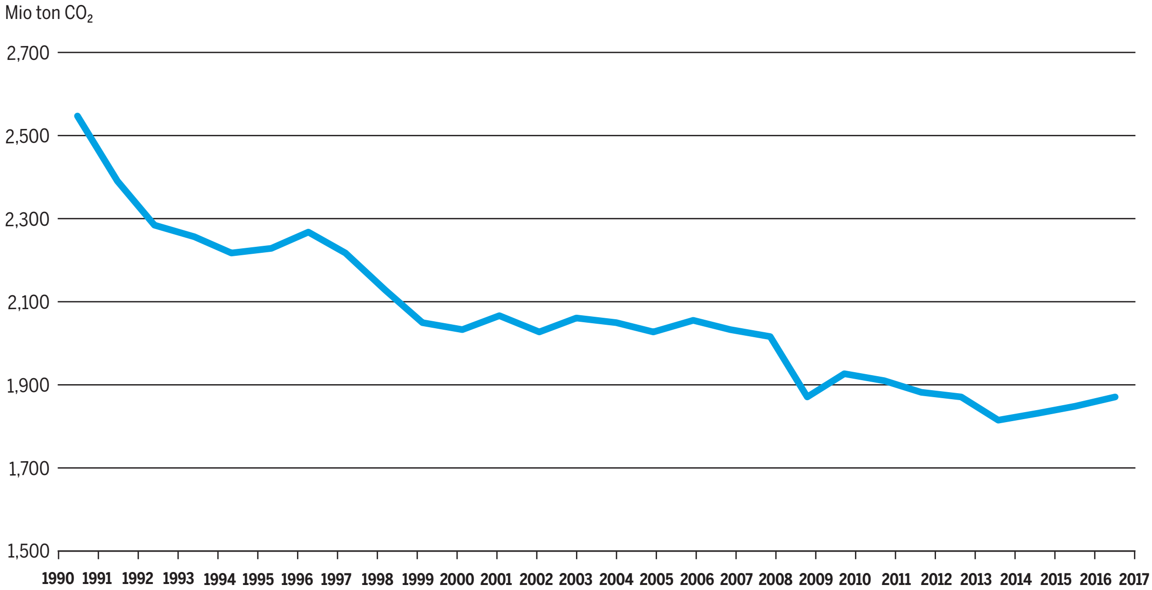


Figure 5.8: Evolution of the GHG emissions in the CEE region (Source: Eurostat)

Thanks to a partial switch from a high to low and zero-emission sources of energy and the application of energy efficiency measures the CEE countries have reduced greenhouse gas emissions by 27 % since 1990. For comparison, other EU Member States have achieved a result at the level of 18 % in the same time frame. In 2017, greenhouse gas emissions in the CEE region were responsible for 42 % of total greenhouse gas emissions in the whole EU. Electricity and heat production as well as the residential sector significantly contributed to the greenhouse gas emissions in the CEE region.

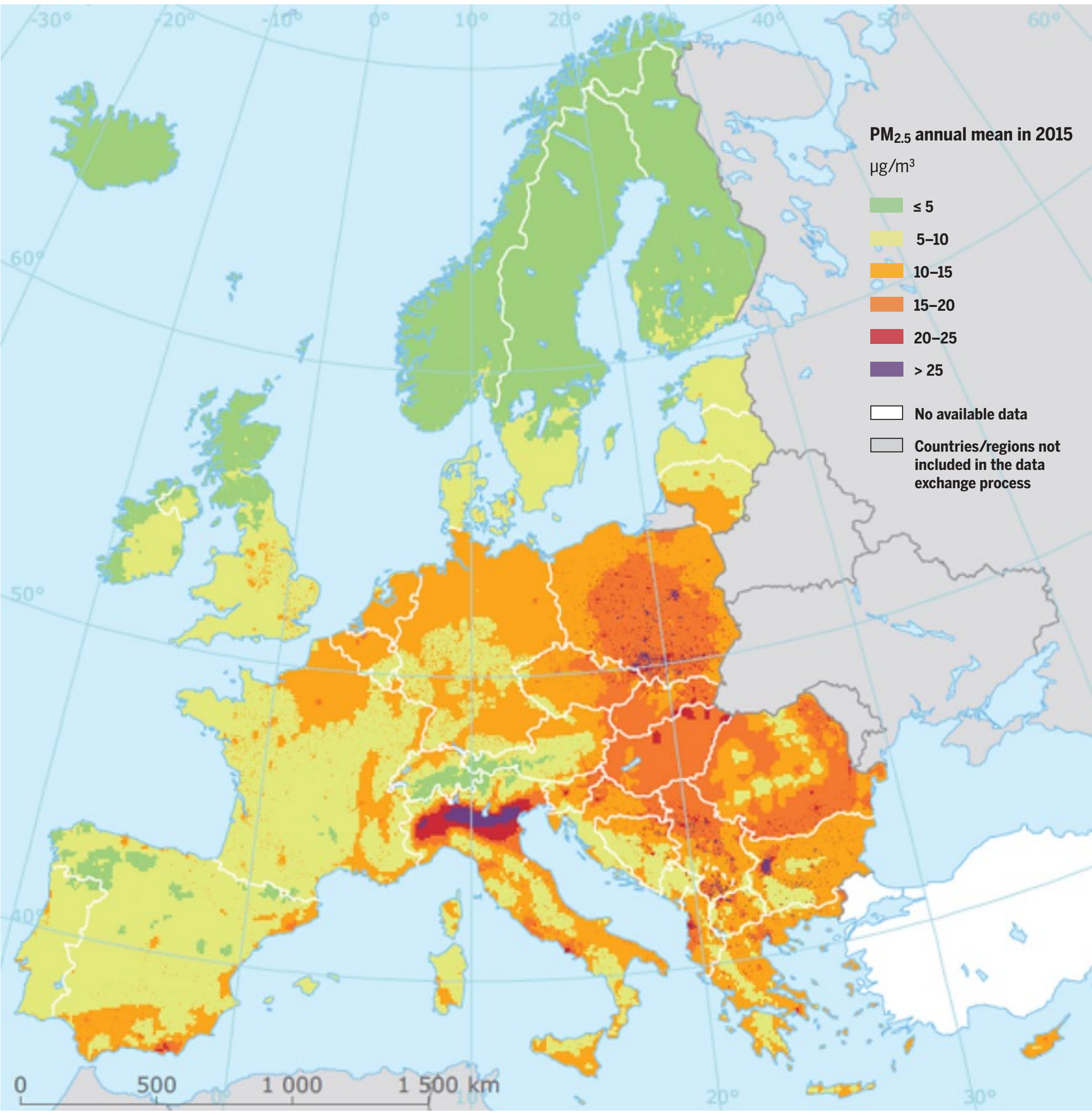


Figure 5.9: $PM_{2.5}$ in the EU in 2015 (Source: European Environment Agency)

5.1.2 AIR QUALITY

Air pollution is a global environmental health problem that is especially relevant in urban areas. Considering the importance of the air quality on human health and standard of living, air pollution constitutes the subject of interest for institutions and authorities. A number of valuable studies have been released recently. One of those is a report on "Air Quality in Europe" as published by the European Environment Agency in 2018.

The study concludes that air pollution resulting from burning high emission and low-quality fuels, especially in the winter period, constitutes a serious problem in many communities and adversely affects people's health. It is a particular concern in the CEE region where the concentrations of particulate matter (PM_{10}, $PM_{2.5}$), benzo[a]pyrene and other pollutants such as sulphur dioxide continues to often exceed the EU limit values. This in turn has considerable economic impacts, cutting lives short, increasing medical costs and reducing productivity through working days lost across the economy.

Figure 5.9 illustrates concentration of $PM_{2.5}$ in the EU in 2015.

5.2 COUNTRY CASE STUDIES

5.2.1 AUSTRIA

Introduction

The European Union (EU) has committed itself to a clean energy transition, which will contribute to fulfilling the goals of the Paris Agreement. Austria's contribution to deliver on this commitment is currently enshrined in the Austrian climate and energy strategy (#mission2030) and the draft national energy- and climate plan ("NECP") in form of governmental strategies and initiatives.

In May 2018 the Austrian Federal Government adopted its climate and energy strategy #mission2030, which aims to meet the sustainable development goals in the areas of greenhouse gas reduction, renewable energy and energy efficiency by 2030, in line with the objectives of the EU. Security of supply, competitiveness, affordability and research and development complete the aims of the strategy. Long-term decarbonisation must be used in the best possible way in terms of the eco-social market economy, as well as from an economic, environ-mental and social standpoint. Accordingly, the implementation of these long-term objectives does not denote a loss of prosperity, but must be shaped in such a way as to result in a highly successful economic, environmental and social model of a resource-efficient economy.

Decarbonisation

The Austrian strategy #mission2030 states, that Austria will reduce its greenhouse gas emissions of 36 % compared to 2005. This reduction should be mostly achieved through measures in the transportation and space heating sectors. The transportation sector is with a share of 46 % (outside the emissions trading) the biggest pollutant of greenhouse gases. The reduction should be achieved by expansion of public transport as well as e-mobility and alternative propulsion systems. In the building sector, the reductions should be achieved primarily through the thermal rehabilitation and the abandonment of fossil fuels in new buildings.

As a long-term goal by 2050, the Federal Government plans to implement a consistent decarbonisation path. As a first step, the total national electricity demand by 2030 should be covered by 100 % renewable energy sources (on balance nationally). In order to achieve this, it is necessary to expand all renewable energy sources, the infrastructure, storage facilities and in-vestments in energy efficiency.

In the long term, natural gas should be replaced by renewable gas (e. g. biomethane from bio-genic sources, hydrogen and synthetic methane) in the gas system. Additionally, feeding bio-methane produced in biogas plants directly into the gas system "Greening the gas" instead of generating power should improve the resilience of the entire system at the interface between electricity and gas, by utilizing the offset between generation and consumption through the storage flexibility of the gas system.

Security of energy supply

In transforming the energy system, the top priority is to maintain the high level of security of supply at all times. In addition, efforts are being made in order to increase the extent of the decentralized domestic energy supply and to strengthen the regional supply concepts.

Furthermore, the goal is to increase investments in the storage infrastructure (short-term to seasonal) and the transmission and distribution network as well as to adapt it to the increased demand. Existing efficient plants and already made investments such as pipelines, storage facilities or power plants actively contribute to the transformation of the energy system. Existing energy infrastructures must take over additional tasks (e. g. power-to-gas, power-to-heat, wind-to-hydrogen, power-to-liquids, storage of renewable green surplus energy, etc.).

The very well developed and modern Austrian gas infrastructure, which had been realized by economic investments, already plays an essential part today. The highly efficient and fast responding Austrian gas-fired power plants already make an irreplaceable contribution to the immediate network stabilisation of the electricity network as well as providing balance and control to energy capacities. This is achieved by the high infrastructure standard due to the large and very well connected Austrian gas storage facilities to the distribution system and the high flexibility due to the large capacities of the gas grid. In order to achieve energy security the already available infrastructure must be maintained or expanded as needed.

Research, innovation and competitiveness

By developing key technologies to modernise the energy system, successful technical achievements and solutions have to be developed. This enables Austria to position itself as an innovative leader on the global technology markets.

Gas Connect Austria is currently commissioning studies to analyse the hydrogen fitness of the systems in order to make our infrastructure hydrogen fit for the future. In addition, Gas Connect Austria is engaged in studies on the real implementation of "Power to Gas" projects and on projects for own power generation (sector coupling).

Other development possibility for TSOs are toward the development of the gas market for the mobility. TAG GmbH started 2018-2019 to explore the potential opportunities in the field of sustainable LNG mobility in Austria such as the construction of a small-scale LNG liquefaction plant, the framework for a later LNG supply agreement, and the development of a LNG market.

Regulatory requirements

Decarbonised gases like hydrogen could benefit from setting a regulatory framework, which would be modelled on the existing regulatory framework in the gas sector (e. g. third-party ac-cess). The significant investment costs and increased operating costs for hydrogen projects will require to develop a support scheme at EU level as well as on national level. Furthermore, funds (added to TSOs allowed cost base) will be needed for analyzing to what extent the al-ready existing infrastructure can cope with hydrogen already.

The support systems should not be limited to hydrogen pipeline networks but rather include the whole value chain of hydrogen (e. g. electrolysis, fuel-filling infrastructure, hydrogen buses, etc.) When comparing different projects, a multitude of factors (e. g. cost per saved unit CO_2, sustainability et al) have to be taken into consideration for the final ranking.

Sources:

- Draft Integrated National Energy and Climate Plan for Austria; Version: December 2018
- Austrian coordinated network development plan "CNDP" 2019 for the period 2020–2029 (Consultation version)

5.2.2 CZECH REPUBLIC

Introduction

The State Energy Policy (SEP) is a key strategic document, which contains policies and measures in the field of energy and, therefore, across all five dimensions of the Energy Union. The State Energy Policy is adopted for a period of 25 years and is binding for the performance of State administration in the field of energy management. It is prepared by the Ministry of Industry and Trade, which evaluates it at least once every 5 years and informs the Government of the evaluation. The current Czech Republic's State Energy Policy was approved by the Government on 16 May 2015 and has an outlook until 2040.

The long-term vision of the Czech Republic's energy sector is a reliable, affordable and sustainable energy supplies for households and the economy. This vision is summarised into three top-level objectives of the Czech Republic's energy sector: security – competitiveness – sustainability. The SEP contains the following strategic energy priorities: (i) a balanced energy mix / transformation of the energy industry; (ii) energy savings and energy efficiency improvements; (iii) infrastructure development; (iv) research in the field of energy and industry, human resources; (v) energy security.

The Czech Republic's State Energy Policy provides the target level of share of individual fuels in total

	2016 level	2040 target level
Coal and other solid non-renewable fuels	40 %	11–17 %
Oil and petroleum products	20 %	14–17 %
Gaseous fuels	16 %	18–25 %
Nuclear energy	15 %	25–33 %
Renewable and secondary energy sources	10 %	17–22 %

Source: Czech Republic's State Energy Policy (2015)

Table 5.1: Share of individual fuels in total primary energy sources (excluding electricity)

	2016 level	2040 target level
Coal and other solid non-renewable fuels	50 %	11–21 %
Nuclear energy	29 %	46–58 %
Natural gas	8 %	5–15 %
Renewable and secondary energy sources	13 %	18–25 %

Source: Czech Republic's State Energy Policy (2015)

Table 5.2: Share of individual fuels in gross electricity generation

primary energy sources (TPES) and gross electricity generation using relative corridors (see Tables 5.1 and 5.2).

In the gas sector, there are following main targets of the Czech Republic included in the SEP:

- Ensure the diversification of gas sources and routes, as well as efficient operation of domestic gas storage facilities.
- Ensure effective access to transit capacity for natural gas supplies to Czech consumers.
- Permanently ensure the ability to reverse flow and restoration and development of the gas pipeline transmission system. Ensure capacity to increase gas supply (due to increase of gas demand for heat, electricity production and transport).
- Maintain and possibly further strengthen the Czech Republic's transit role in the area of natural gas transmission.
- Support of projects ensuring the capacity of gas storage facilities in the Czech Republic in the amount of 35–40 % of the annual gas consumption and withdrawal performance guaranteed for two months of at least 70 % of the peak daily consumption in the winter. Provide conditions for the operation of the gas transmission system in the reverse flow and in capacity for gas supplies from north or west at a level of at least 40 million m^3/day.
- Support financially and institutionally the transformation of existing biogas plants for production of biomethane as well as new biomethane stations, including their connection to the gas system.
- Ensuring of connection and possible transport and distribution capacities for possible switch from coal to gas for large customers (heating plants).
- In the context of the decarbonisation targets, prepare the gas transmission and distribution system for a higher share of new types of gas and convergence of the electricity and gas sectors (i.e. sector coupling).

The future of natural gas in the Czech Republic

The consumption of natural gas in the Czech Republic has been oscillating around 8 bcm/y. Since 2010 the consumption has been decreasing until 2014 and after this year there was a very modest growth.

As visible in Table 5.1 there is a big potential for an increase of share of gaseous fuels (including natural gas) in TPES. This is mainly due to expected decrease of consumption of liquid and solid fuels in the Czech Republic in accordance with energy and environmental policies and targets.

Energy transition to low-carbon economy is being increasingly recognised as a means to achieving reductions of greenhouse gas emissions in accordance with set targets, for example under the Paris Agreements or binding targets for the EU Member States for 2030. The energy transition will be a challenging task and gases and gas infrastructure can play a very important role in achieving it. Besides use of natural gas as a low emission fuel than liquid and solid fossil fuels there is a significant potential for low-carbon gases such as biogases, bio-methane and hydrogen. The deployment of renewable and decarbonised gases, green mobility or innovative heating solutions using gas is at the moment in the beginning in the Czech Republic. These above-mentioned technologies are not mature enough yet to be deployed on a large scale and on a commercial basis. The legislative and regulatory framework needs to be adapted to recognize the existence of these technologies in energy markets and to incentivize their development.

Therefore, interest of stakeholders in these technologies is currently low in the Czech Republic. Implementation of the technologies is very expensive

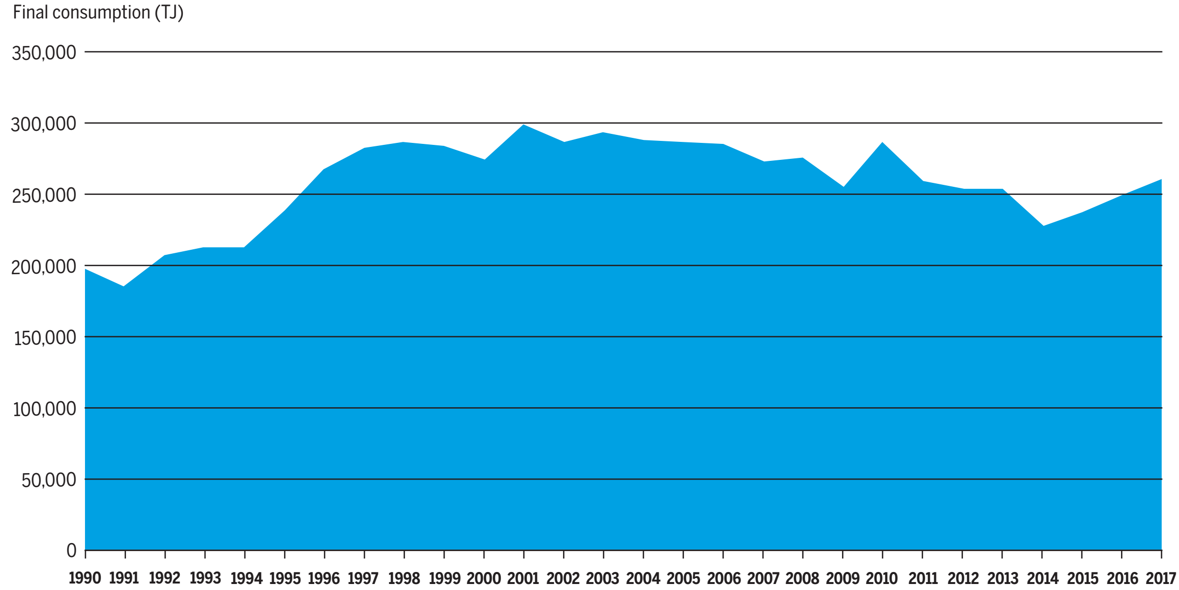


Figure 5.10: Natural gas final consumption in the Czech Republic during years 1990–2017 (Source: International Energy Agency)

with low cost recovery. In the Czech Republic there is currently no experience in this area. The national energy legislation is going to be amended in a way to enable and support development of low-carbon technologies in the gas sector as the current legislation is insufficient and presents rather an obstacle to further development.

Moreover, there are many technological questions that need to be addressed before implementing the low-carbon technologies in gas sector and energy sector as a whole. One of these main questions is the production, transmission and use of hydrogen.

This and future challenges arising mainly from EU decarbonisation targets, NET4GAS, s.r.o. (TSO) together with GasNet, s.r.o. (DSO) currently cooperate at a project preparation which aims to build and connect to the Czech gas system a facility to demonstrate the operational and industrial feasibility of energy transition projects and prove the future role of gas infrastructure.

The joint project "Greening of Gas" is prepared as a pilot project which aims to produce renewable gases using the unique Power-2-Gas technology. The project consists of a combination of two technologies. One is the production of hydrogen by water electrolysis from renewable electricity and the second one is biogas purification technology (bio methanation) with a subsequent production of a synthetic methane. The project also aims to test injection of methane and possibly hydrogen into the transmission and/or distribution gas systems in the Czech Republic.

The project is currently in the feasibility study phase. The current schedule expects its commissioning in 2023. The operator of the facility has not been decided yet due to legislative requirements, including the requirements for unbundling of the transmission system operator. It is the first project of its type to be developed in the Czech Republic. Therefore, it faces potential difficulties related to its innovative nature, the fact that the technology is untested in the current environment and the lack of an applicable legal framework.

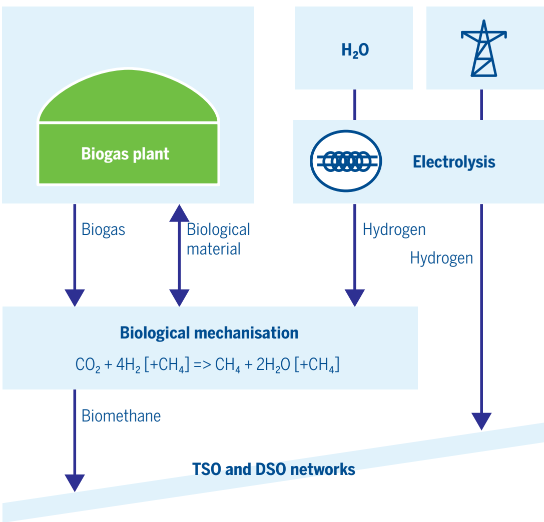


Figure 5.11: Schematic description of the prepared Power-2-Gas facility

5.2.3 POLAND

Introduction

The EU member states in Central-Eastern Europe remain dependent on solid fossil fuels. This concerns Poland where the electricity and heating generation are largely based on coal and lignite. This can be illustrated on the below graphs that provide information on the share of individual energy sources in both sectors.

Poland struggles with air quality problems that are caused by pollutants, in particular particulate matter and benzo[a]pyrene, emitted in home furnaces and local coal-fired boiler plants where coal is combusted in an inefficient way. Smog occurs in Poland mainly in the heating season (from September until April) due to the so called low emission that is caused by numerous sources introducing small amounts of pollutants into the air. However, due to the large number of emission sites that release pollutants into the air at a low altitude this phenomenon is very onerous. Pollution accumulates around the place of origin, and these are usually areas with compact housing. The problem of smog is relevant in many parts of Poland but it is the most intense in the south of the country (e. g. Lower and Upper Silesia, Lesser Poland).

The recently published framework documents (draft of Poland's National Energy and Climate Plan, draft of Poland's Energy Policy towards 2040) put an emphasis on reducing environmental impact of the energy and transport sectors and the industry. To this end, the role played by solid fossil fuels is planned to be successively reduced, whereas the share of low emission sources of energy (such as natural gas), renewables and nuclear energy is expected to increase.

Quantification of environmental impact of gas investment projects

Against this background GAZ-SYSTEM commissioned a study conducted by Ernst & Young Business Advisory to analyse in an independent way the impact of GAZ-SYSTEM investment projects on protection of environment and mitigation of climate change. The assessment captures a wide range of environmental issues in a qualitative and quantitative way.

The study focuses on four key sectors of the economy including energy, heating and industry, households and transport. The energy sector covers 29 gas power plants and combined heat and power plants, mostly qualified as large combustion plans, which are planned to be commissioned in larger cities or in the vicinity of the transmission network. The need for new electricity generation capacity to

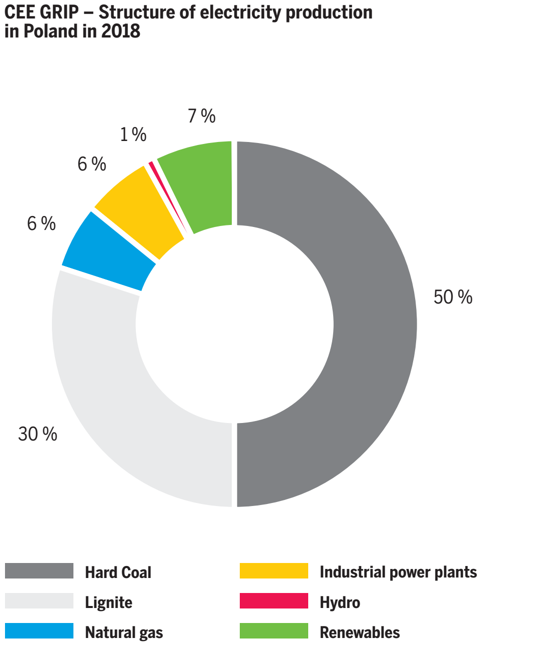


Figure 5.12: Structure of electricity production in Poland in 2018 (Source: Report on the activities of the President of the Energy Regulatory Office in 2018, Energy Regulatory Office)

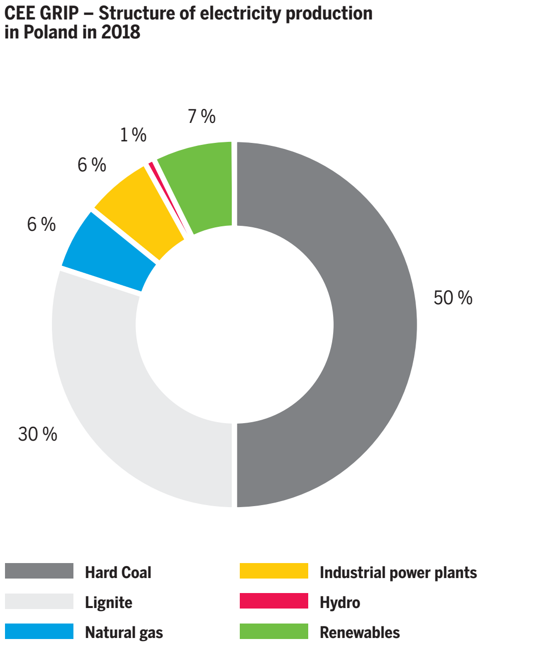


Figure 5.13: Structure of heat production in Poland in 2018 (Source: Report on the activities of the President of the Energy Regulatory Office in 2018, Energy Regulatory Office)

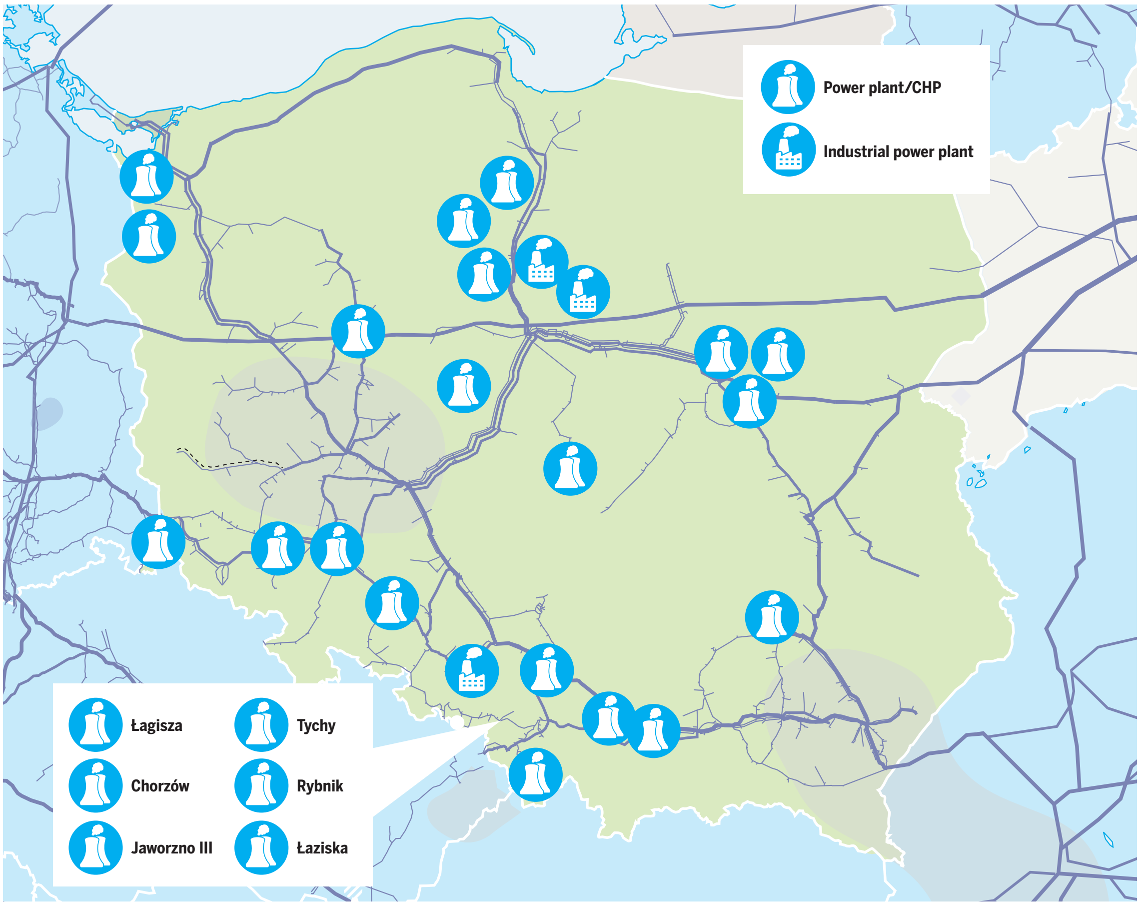


Figure 5.14: Prospective gas power plants in Poland

replace ageing coal and lignite based units was taken into consideration. The scope of assumptions comprised also the capacity of a given plant, the commissioning year, efficiency of electricity production and utilization per annum.

Figure 5.14 illustrates gas power plants and combined heat and power plants that were considered in the study.

Heating and industry includes local heating plants and industrial combined heat and power plants, mostly qualified as small and medium combustion plants. The development of high-efficiency gas cogeneration and decommissioning of old units will be the main factor influencing the role of natural gas in this sector.

Individual customers and small enterprises (services) were recognised as the households in the report. Fuel switching from coal and firewood towards natural gas in existing building and the perspectives for connection of new buildings were considered.

Lastly, the transport sector focuses on CNG and LNG vehicles (passenger cars, buses, trucks) that may be put into operation as part of actions to promote alternative fuels.

The evolution of the EU and domestic regulatory framework, including in the area of emission standards, was considered to all the above sectors.

The impact of market and regulatory conditions on natural gas in each sector was evaluated based on four demand scenarios that include: Reference Scenario, Poland's Energy Policy towards 2040 Scenario (PEP 2040), Gas Scenario and Renewables Scenario. The results of demand analysis indicate that the demand for natural gas in the energy sector may increase considerably (increase of 203 % from 3.2 bcm/y under the Reference Scenario), while the growth in the heating & industry sectors and the households may be more moderate (with the projected growth at the level of 131 % in the heating & industry sectors and of 84 % in the households). Most of the scenarios foresee a limited increase of the role played by CNG and LNG in the transport sector with the exception of the PEP 2040 Scenario as it assumes the implementation of government's objectives in the area of LNG and CNG vehicles in the future.

The quantification of environmental impact that results from the implementation of GAZ-SYSTEM investments, was conducted for the following pollutants: CO_2, NO_x, SO_x and particulate matter (PM). The results of quantification for all sectors are provided in an aggregated form below.

According to the data of the National Centre for Emissions Management (KOBiZE) the total domestic CO_2 emissions in Poland amounted for 348 million tonnes in 1990. Despite accelerated economic growth CO_2 emissions in Poland decreased to the level of 282 million tonnes in 2015. Under the Reference Scenario GAZ-SYSTEM investments may contribute to the decrease of CO_2 emissions by 808 million tonnes between 2015 and 2050. This corresponds to the amount of CO_2 absorbed through forest equal in size to the territory of Poland.

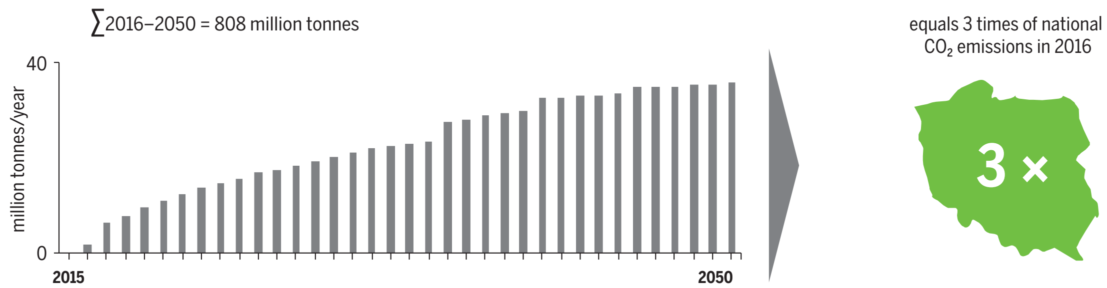


Figure 5.15: CO_2 emission reduction – reference scenario

In line with KOBiZE data the total domestic emission of NO_x in Poland amounted to 1,052 thousand tonnes in 1990. Since then it was reduced to the level of 705 thousand tonnes in 2015. Under the Reference Scenario GAZ-SYSTEM investments may contribute to further reduction of NO_x emissions with the aggregated impact in the perspective of 2015-2050 of over 1,184 thousand tonnes.

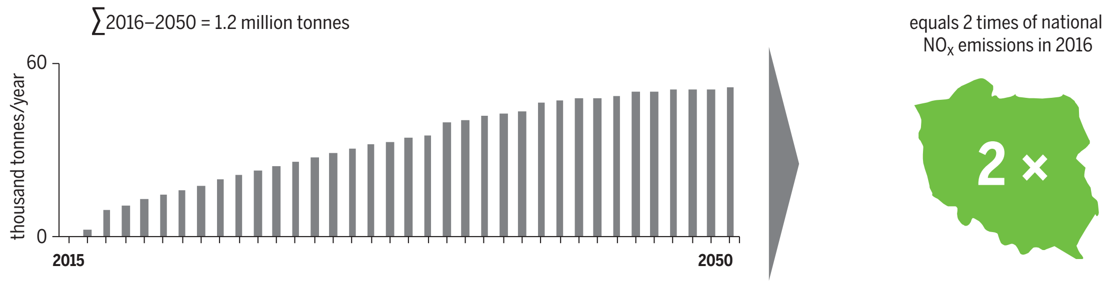


Figure 5.16: NO_x emission reduction – reference scenario

Total domestic emissions of SO_x in Poland back in 1990 were at the level of 2,649 thousand tonnes. With the modernisation of the economy SO_x emissions were cut significantly and they amounted for 702 thousand tonnes in 2015.

Under the Reference Scenario the impact of gas investments on sulphur oxide emissions is considerable with the cumulative emissions of over 3,892 thousand tonnes in the analysed period.

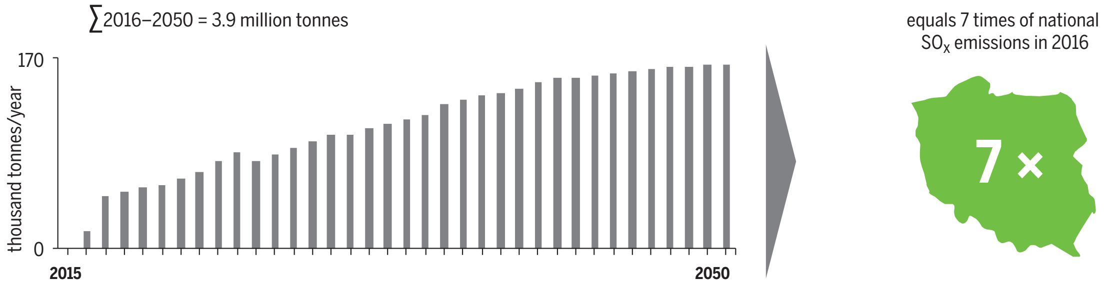


Figure 5.17: SO_X emission reduction – reference scenario

The total emissions of PM in Poland decreased from the level of 991 thousand tonnes in 1990 to 342 thousand tonnes in 2015. The assessment conducted in the report indicate that the aggregated PM emission reduction in the period of 2015 and 2050 are expected to total 1,847 thousand tonnes.

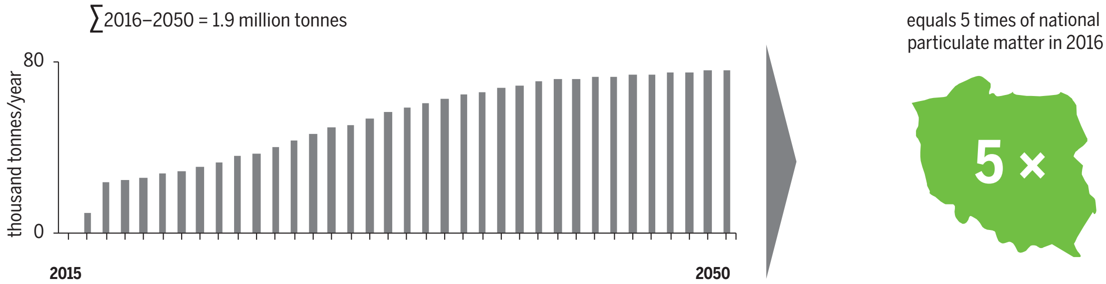


Figure 5.18: Particulate matter emission reduction – reference scenario

As illustrated above the switch from carbon intensive fuels towards low emission sources of energy such as natural gas contributes towards significant emission reductions in Poland both in mid and long-term perspective. In addition, the ongoing activities to roll out renewables in Poland (mostly offshore wind in the Baltic Sea and solar PV) reinforces the need for efficient back-up capacities. Gas infrastructure and gas power plants are well placed to fill in the generation gap. This will in consequence ensure stability and security of the electricity system, mitigate price volatility and support the development of renewables in Poland.

Activities in the area of renewable gases and new technologies

Further climate and environmental gains may be achieved by using gas infrastructure as a solution to integrate renewable gases and to store electricity produced from renewables. GAZ-SYSTEM is involved in a number of initiatives aimed to roll out these new technologies. The company was a member of European Power to Gas Platform and now it is also active in Hydrogen Europe to cooperate with fellow TSOs and other market participants on performing hydrogen-related R&D activities and pilot projects. GAZ-SYSTEM contributes to the HY-READY project that aims at defining guidelines for preparation of TSO and DSO networks for the accommodation of hydrogen-natural gas mixtures. Furthermore, GAZ-SYSTEM took part in the Dom-Hydro project with other GERG members to analyse the impact of hydrogen admixtures on selected appliances burning gaseous fuel.

On a national level, GAZ-SYSTEM together with other consortium members[10] initiated the Hestor project that explored the possibilities of storing renewable electricity in the form of hydrogen in salt caverns and its further utilisation in the energy and transport sectors. Moreover, the project also considered technical and economic aspects of the use of hydrogen as a fuel in transport, aspects related to the development of the hydrogen market, modern hydrogen energy storage services, and possibilities of electricity generation, trade and the use of hydrogen in the technological processes at a refinery.

GAZ-SYSTEM also explores the possibilities and impact of hydrogen-natural gas mixtures on gas transmission system elements operated by the company.

10 LOTOS Group S.A., University of Science and Technology in Cracow, Research and Development Centre for Chemical Raw Materials Mining CHEMKOP, Silesian University of Technology and Warsaw University of Technology.

5.2.4 SLOVAKIA

The energy mix of the Slovak Republic can be considered balanced, with a uniform representation of the various types of energy, where each of the sources has its merits and contributes to the energy security of the country and the long-term sustainability.

The energy system of the Slovak Republic is characterised by a high share of nuclear energy, which accounts for roughly 60 % of domestic energy production and the largest part of the total supply of primary energy (TPES). Domestic electricity production from the nuclear energy, combined with the diversification of natural gas transport routes and sources, contributes significantly to the energy security of the Slovak Republic, which is dependent on imports of natural gas and oil from the Russian Federation.

On the consumption side the largest energy consumer in the Slovak Republic is the industrial sector, with a share of roughly 40 % of total final energy consumption (TFC). Of this, 21 % is constituted with natural gas and petroleum products used for non-energy purposes in industrial processes. The main source of energy is natural gas, oil and electricity, representing three quarters of TFC.

The consumption of natural gas and electricity has a high share in most sectors, with the largest demand in the industry, while in the transport sector naturally dominates oil. The Slovak Republic also has an extensive system of district heating, which, primarily for the production of heat, burns mainly natural gas and partly also biofuels.

TFC represents final energy consumption (electricity, heat and fuel, such as natural gas and oil products) by end users, but does not include the processing industry (e. g. energy production).

Industry has more than 40 % of total final energy consumption in the country. The remaining energy consumption is in the transport sector (24 % TFC), the residential sector (20 %) commercial sector (14 %). Although energy consumption in transport has increased by 11 % over the last decade, energy consumption in the housing sector has decreased by 12 %, and in the commercial sector by 28 %.

In transport, oil is dominant, while natural gas and electricity represent the largest share of TFC in other sectors (figure 5.19).

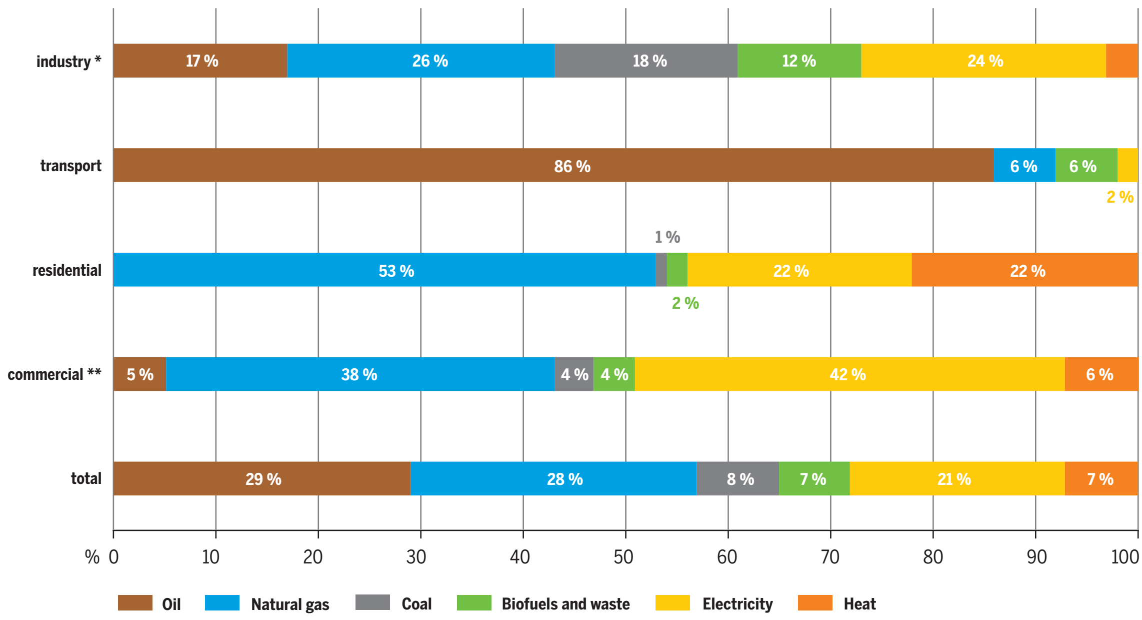


Figure 5.19: TFC by sector and source, year 2016
* industry includes non-energy consumption
** commercial includes commercial and public services, agriculture and forestry

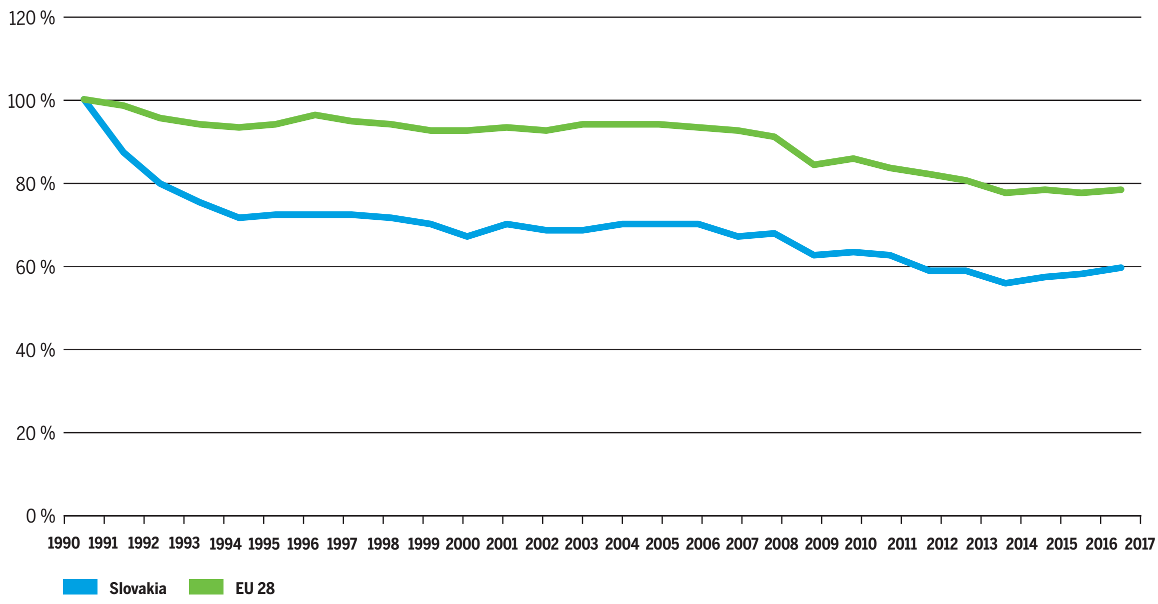


Figure 5.20: Development of the GHG emissions in Slovakia since 1990

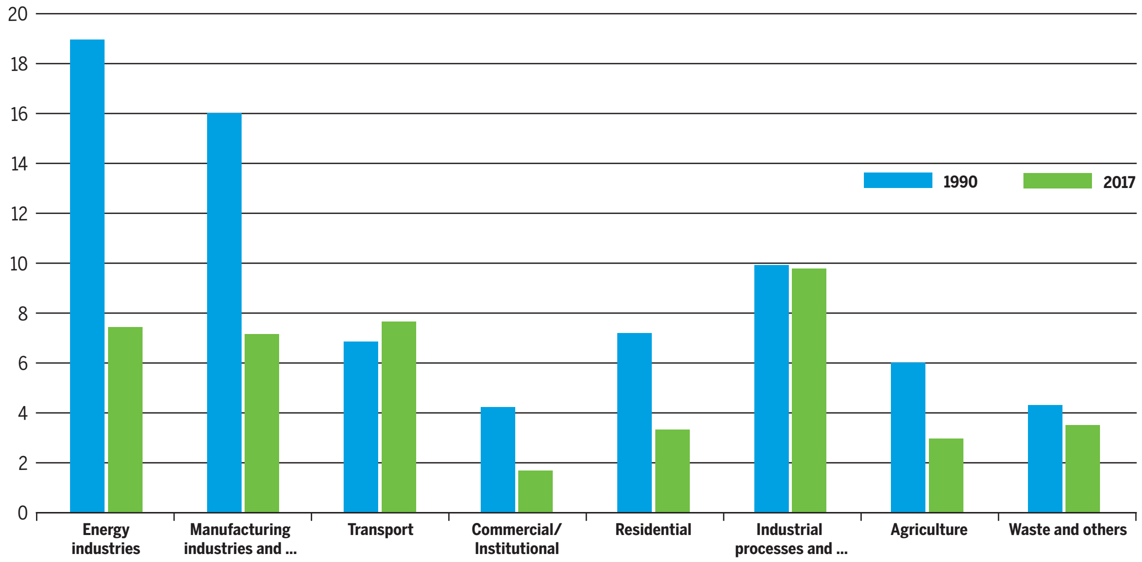


Figure 5.21: GHG emissions – sectoral split; 1990 vs. 2017 (Source: Eurostat)

Currently natural gas has approximately 24 % share of the energy mix in Slovakia with 40 TWh. The length of the Slovak gas network is 33,300 kilometres and 77 % of municipalities with more than 94 % of inhabitants connected to the gas network thus having access to the natural gas. Natural gas is a highly accessible fuel, which is now available to more than 1.5 million consumption points in Slovakia.

Renewable energy sources (RES) are welcome additional parts to the energy mix, and natural gas can provide the necessary back-up solution when they are "off". At the same time, it is important not to look at increasing share of RES as a target in itself, but rather assessing them in terms of real benefits and effectiveness in tackling environmental problems. In the case of Slovakia, the problem of greenhouse gas emissions is not so prevalent also due to the high share of nuclear power in the energy mix, but it is much more threatened by polluted air.

Slovakia has achieved significant decrease of GHG emissions by more than 40 % since 1990. (Source: Eurostat, index 1990)

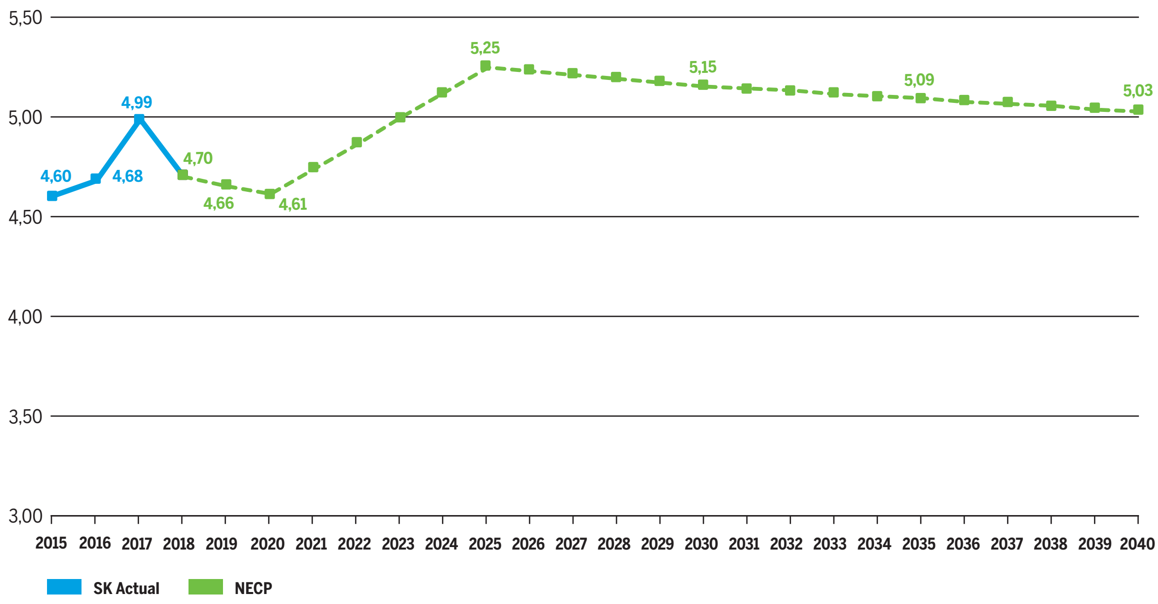


Figure 5.22: SK natural gas demand (actual & forecasts)

The energy sector and manufacturing industries decreased its GHG emissions by half.

Slovakia has an above-average incidence of respiratory diseases and smog mortality due to air pollution. Slovakia is at the third place in the EU as regards air pollution. Air pollution causes respiratory diseases and high mortality. The main reasons for reduced air quality and dustiness in Slovakia are solid fuels – based local heating (approximately 80 % of pollution in Slovakia with PM2.5 particles) and in smaller scale transport and construction activities. More than 5,000 premature deaths are connected with reduced air quality and dustiness annually (Source: Slovgas 06/2018).

High premature mortality is a problem that should be at the centre of the Slovak environmental and energy policy. It is important to choose the appropriate instruments to reduce CO_2 emissions, while helping to improve national air quality for reasonable value of money.

The document "Environmental Policy Strategy of the Slovak Republic until 2030" being approved by the Slovak Government in February 2019 presents significant basic solutions in this area. The air quality in 2030 is expected to be improved and will not have a significant negative impact on human health and the environment. This will be achieved by a sharp reduction in emissions compared to 2005 – SO_2 by 82 %, NO_X by 50 %, NMVOC by 32 %, NH_3 by 30 % and $PM_{2.5}$ by 49 %. Domestic heating and urban transport will move towards more environmentally acceptable alternatives.

Integrated National Energy and Climate Plan to be submitted to the European Commission by 31 December 2019 will also bring solutions in order to tackle with this issue.

Based on this, one of the solutions, from the economic and environmental point of view is the natural gas, the most affordable response to the poor air quality in Slovakia and to emissions reduction. If natural gas and biomass replaced all coal sources, it would not only help to enhance the air quality, but relatively cheaply it would reduce CO_2 emissions by almost 10 %. There is also room for energy savings that would synergistically help further reduce greenhouse gas emissions. Compared to solid fuels, the combustion of natural gas produces significantly less pollutants and produces a negligible amount of dust particles, which in higher concentrations endanger the health of the population. Natural gas is more environmentally friendly than biomass, which is considered to be RES. Heating with natural gas can save up to 50 % of CO_2 emissions compared to coal and up to 60 % by means of cogeneration. Sulphur oxides are not present in its flue gas, and carbon monoxide (CO) and hydrocarbon emissions are also negligible.

However, awareness of the environmental and economic benefits of natural gas is relatively low and solutions that are non-ecological (solid fuels), expensive (several types of RES), or both, are also at the forefront.

Natural gas in terms of its versatility, price, performance characteristics and existing large-scale gas infrastructure in the Slovak Republic is a fuel with a significant position and a reliable partner to renewable energy sources, for several reasons:

1. Natural gas is the solution of seasonal and daily unstable performances of RES, in particular to wind solar energy and to the questionable availability of biomass having negative effect on the health of the population due to the issue of fine cancerous dust and CO.
2. Robust gas infrastructure with lots of connections to different gas sources and sufficient storage capacities may allow its wider use with a view to ensuring the security of gas supply at affordable prices.
3. Natural gas provides clean, reliable energy for households, businesses industry. Natural gas does not produce almost any coarse particulate matters of PM_{10} and fine particulate matters $PM_{2.5}$, which at higher concentrations endanger the health status of the population, especially pregnant women, young children, elderly people, allergy sufferers, asthmatics and people with cardiovascular problems.

There are also reasons why the proposal of the Integrated National Energy and Climate Plan (09/2019) considers gas to be a sustainable energy source as it follows from a model projection of its consumption.

6 CONCLUSIONS

This is the fourth edition of the Gas Regional Investment Plan for Central and Eastern Europe (CEE GRIP). It provides a specific regional view emphasizing the gas infrastructure outlook, assessments, and the basis for the identification of potential future gas infrastructure needs in the CEE region.

The EU-wide Ten-Year Network Development Plan 2018 (TYNDP 2018) 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 2018[11].

Generally, the CEE region is mostly characterized by its high dependence on Russian gas, its vulnerability to Ukrainian or partially Belarusian gas transit disruptions, and limited competition. The CEE GRIP provides other analyses beyond the ones performed in the TYNDP 2018 by more deeply exploring these regional characterisations. The ability of the transmission network in the CEE region was stressed with extreme scenarios represented by the simultaneous disruption of the gas supply routes via Ukraine and Belarus and a disruption of the whole Russian gas supply source.

The assessment results show that the region is dependent on the Russian gas source. The assessment also shows that the countries in south-eastern Europe (Croatia, Romania, and Bulgaria) and Poland are the most vulnerable countries when the region is confronted with simulated gas disruptions. The mitigation or elimination of these findings will depend on the implementation of projects that will enhance the diversification of gas sources and will strengthen the gas interconnections between countries in the region in the upcoming decade.

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 potential impact on Bulgaria, Romania and Poland during the winter period 2020/2021. However, if planned infrastructure projects are implemented in subsequent years, it will have a positive effect on the N-1 value which will be above one in these countries. Due to geographical reasons, a disruption of gas supplies via Belarus only affects Poland, but the assessment shows positive results over the entire time range.

Regarding the summer period, the analysis resulted in the identification of a potential problem in Romania, Hungary and Austria for a gas supply disruption via Ukraine in summer 2020, 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) 125 days (Austria), or 155 days (Romania). 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.

A special part of this report a whole chapter tackles the role of natural gas in the region in the long-term perspective. Based on the presented case studies, 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. In addition, natural gas will replace more polluting energy sources (coal, lignite, waste) by affordable cleaner energy sources and therefore contribute towards meeting long-term EU climate objectives. In the region there are number of projects at various project development stages to contribute to decarbonisation efforts.

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.

11 The EU-wide Ten-Year Network Development Plan 2017 is available under the following link: https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2018

ABBREVIATIONS

BG	Bulgaria
CEE GRIP	Gas Regional Investment Plan for Central and Eastern Europe
CEE region	Central and Eastern Europe region
CR	Curtailment Rate
DC	1-day Design Case (Peak Day)
DSO	Distribution System Operator
ENTSOG	European Network of Transmission System Operators for Gas
EU	European Union
ESW-CBA	Energy System Wide Cost-Benefit Analysis
FID	Final Investment Decision
GHG	Greenhouse Gas
GWh/d	Gigawatt hour per day
IP	Interconnection Point
LNG	Liquefied Natural Gas
LSO	LNG System Operator
Non-FID	Without Final Investment Decision
NP	National Production
PCI	Projects of Common Interest
PM	Particulate Matter
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
RF	Remaining Flexibility
RussiaAll	Disruption of the Russian gas supply source
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
UkraineBelarus	Simultaneous disruption of the gas supply routes via Ukraine and Belarus

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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