TEN-YEAR NETWORK DEVELOPMENT PLAN

2020

SYSTEM ASSESSMENT REPORT

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1 INTRODUCTION: TYNDP 2020

ROLE OF SCENARIOS IN THE TYNDP

The resilience of the European gas system is dependent on the future development of the gas demand and the gas supply. As the conventional Natural Gas indigenous production is declining in Europe, the infrastructure will be exposed to different stress cases depending on the decarbonisation pathways and therefore how the demand will evolve and where the new renewable and decarbonised gases will develop over time. By building different and contrasted scenarios, ENTSOG, jointly with ENTSO-E, make it possible to assess the infrastructure needs for contrasted situations with the aim of encompassing all possible developments and delivering the most comprehensive assessment of the European gas system.

NATIONAL TRENDS, THE POLICY SCENARIO

In the National Trends scenario, the development of the gas demand follows the recommendation of the National Energy and Climate Plans of the respective Member States. In general, the overall gas demand for final use generally decreases over time while the gas demand for power increases, partly resulting from the coal to gas switch in the power sector. On the production side, the European natural gas production is declining and biomethane and, to a limited extent, power to gas production is developing. However, the development of renewable gases is not sufficient to compensate the decline of the conventional gas production and Europe relies more and more on imports. Therefore, the use of the gas infrastructure is based on the principle of main supply corridors to satisfy the European gas demand.

COP 21 SCENARIOS: CONTRASTED PATHWAYS TO ACHIEVE THE SAME CLIMATE OBJECTIVES

The Distributed Energy scenario considers the decarbonisation of the European energy system from a distributed and local perspective. The gas demand reflects an evolution of the energy demand towards higher electrification and locally produced energy. Therefore, the gas imports are decreasing, and gas flows are less following the traditional import supply corridors but also new intra-European routes from areas with a high potential of renewable gas production.

The Global Ambition scenario considers the decarbonisation of the European energy system as part as a global transition where Europe produces indigenous renewable and decarbonised gases in a more centralised way with large scale solutions and also participates to a global market of renewable and decarbonised gases resulting in a relatively higher import share and a use of the infrastructure being a combination of import routes and new intra-European routes to transport renewable and decarbonised gases produced locally.

2 FEEDBACK SECTION

2.1 FROM DRAFT TO FINAL TYNDP 2020

2.1.1 WHAT HAS HAPPENED SINCE THE DRAFT TYNDP PUBLICATION?

ENTSOG released the draft publication of TYNDP 2020 on 25 November 2020 and launched a public consultation which was opened to 15 January 2021 to continue the focus on stakeholder engagement and continual improvement of the report.

On 16 December, within the public consultation period, ENTSOG hosted a TYNDP Presentation Day open to all stakeholders organised as webinar. This was designed to give a high-level introduction to the TYNDP and its role as part of EU regulation, a summary of the content provided and more insight into the results produced in the 2020 edition. This offered a wide range of stakeholders an open forum where they could ask questions and participate in discussions regarding any aspect of the TYNDP process. The TYNDP Presentation is available on ENTSOG website[1].

On 10 February 2021, the draft TYNDP 2020 was submitted to ACER, together with the results of the public consultation, for its Opinion. The Opinion was published on 3 May 2021. It indicates where ACER sees improvements from the previous edition of TYNDP, and provides recommendations for improvement, split between the short and the medium to long-term.

2.1.2 WHY A FEEDBACK SECTION?

This section aims at gathering the feedback received from both ACER and the stakeholders. It handles what from this feedback could already be addressed in the final TYNDP 2020. Handling of such feedback is covered in the feedback section itself, rather than in the related sections of the TYNDP, to facilitate the overview. For further feedback that could be taken into consideration for future editions of the TYNDP, this section indicates into to which process it will feed.

The section has been structured to first respond to the ACER Opinion, covering both the short-term recommendations relating to TYNDP 2020 and the medium to long-term recommendations for future editions of the TYNDP. This is followed by an analysis of the public consultation.

1 https://entsog.eu/sites/default/files/2021-01/20201216_ENTSOG_TYNDP.pdf
https://entsog.eu/sites/default/files/2021-01/201216_TYNDP2020 Scenarios.pdf

2.1.3 REVIEW SECTION COMPARING PAST ASSUMPTIONS AND PROJECTIONS OF GAS DEMAND AND SUPPLY AND THEIR ACTUALLY OBSERVED LEVELS

From one TYNDP edition to the next, ENTSOG critically review the TYNDP input data, in particular the demand scenarios and supply potentials. For each new TYNDP edition ENTSOG develop elements that are discussed as part of the stakeholder engagement process, and this comparison is a way to better formalise its usual critical review of assumptions.

Supply

Figure 2.1 compares the TYNDP 2020 supply potentials for year 2020 with the actual historical EU imports. For Russia, LNG and Libya those imports have materialised in the range of the potentials as expected in TYNDP 2020. Norway has shown actual imports above expected potential. Algeria has shown actual imports slightly below expected potential.

As part of the TYNDP 2020 process, the supply potentials were amended again to better correlate with the historical EU import. In particular, ENTSOG has used information from the IEA World Energy Outlook. During the stakeholder's engagement process for TYNDP 2020, the new supply potentials were presented and discussed, resulting in further adjustment of some of the sources.

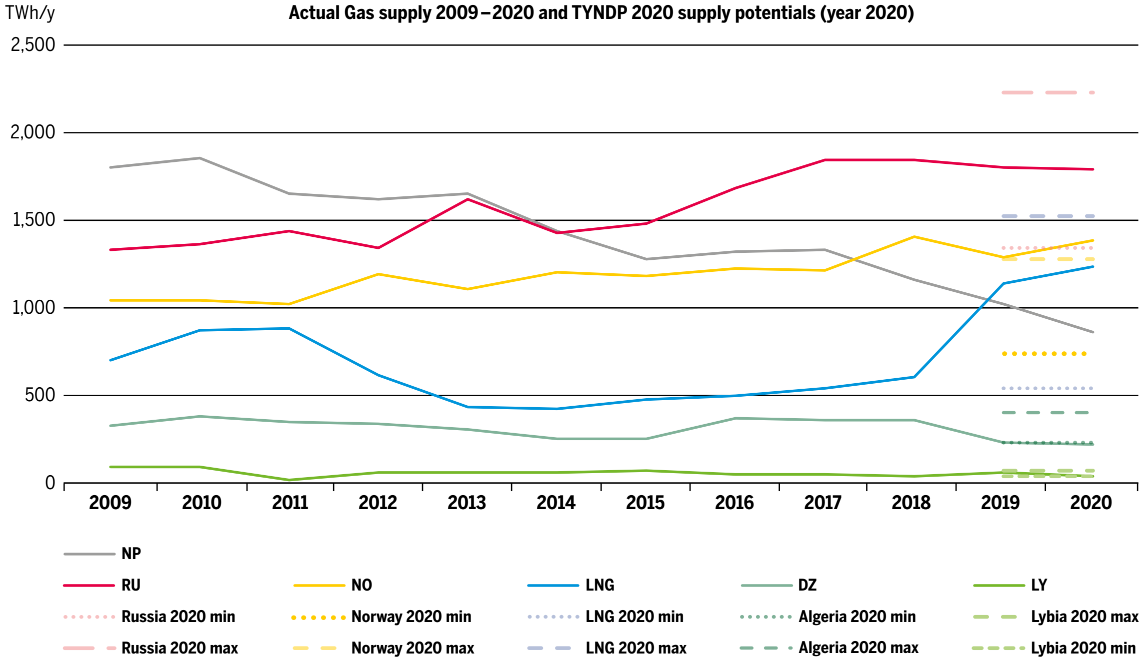


Figure 2.1 Actual Gas supply 2009–2020 and TYNDP 2020 supply potentials (year 2020).

Demand

TYNDP 2020 has three scenarios: National Trends, which is developed based on the collection of data from TSOs, and two COP 21 scenarios - Global Ambition and Distributed Energy - which are developed by the scenario building process.

As for TYNDP 2018, total gas demand was made up of Final Gas Demand (defined as Residential & Commercial, Industrial and Transport sectors) and Gas Demand for Power Generation. Gas for power generation for all scenarios was the result of the ENTSO-E modelling results. During the data collection phase, gas and electricity TSO worked together to discuss gas installed capacity on a country level basis. Yearly gas demand for power generation averages is calculated from the average of all approved models across all climate years.

The Best Estimate scenarios for 2020 and 2025 were based on TSO perspective, reflecting all national and European regulations in place, whilst not conflicting with any of the other scenarios. A sensitivity analysis regarding the merit order of coal and gas in the power sector was included for 2025 following stakeholder input regarding the uncertainty on prices, even in the short term.

National Trends is the central policy scenario, designed to reflect the most recent EU Member States' National Energy and Climate Plans (NECP), submitted to the EC in line with the requirement to meet current European 2030 energy strategy targets.

In addition, ENTSO-E and ENTSOG have created two scenarios in line with the COP21 targets (Distributed Energy and Global Ambition) with the objective to understand the impact on infrastructure needs against different pathways reducing EU-28 emissions to net-zero by 2050.

Global Ambition is a scenario compliant with the 1.5 °C target of the Paris Agreement also considering the EU's climate targets for 2030. It looks at a future that is led by development in centralised generation. Economies of scale lead to significant cost reductions in emerging technologies such as offshore wind, but also imports of energy from competitive sources are considered as a viable option.

Distributed Energy embraces a de-centralised approach to the energy transition. A key feature of the scenario is the role of the energy consumer (prosumer), who actively participates in the energy market and helps to drive the system's decarbonisation by investing in small-scale solutions and circular approaches.

Figure 2.2 shows the progression of EU level actual demand, versus the result of the TYNDP 2020 under National Trends, Global Ambition and Distributed Energy scenarios. TYNDP 2017 scenarios were considering lower demand for 2017 than actually observed. In TYNDP 2018 scenarios starts with a lower demand than any of TYNDP 2017 scenarios (in 2020).

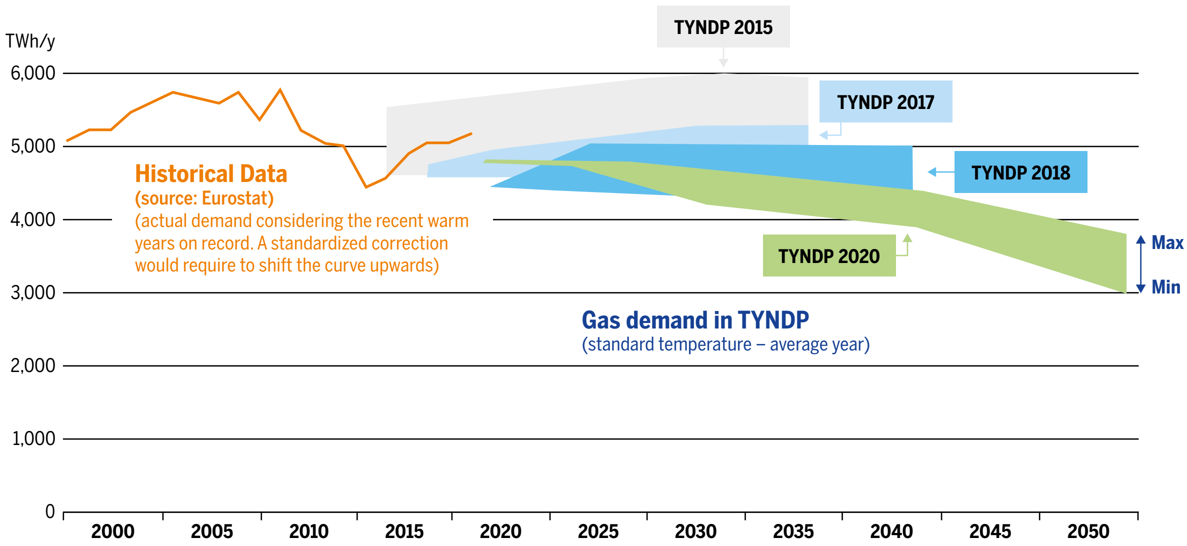


Figure 2.2 Actual EU Gas Demand 2000–2020, TYNDP Demand Scenario data.

It is important to note that the actual demand levels shown reflect the actual weather conditions, whereas data collected for the scenarios represents yearly demand under average climatic conditions.

There was a drop of around 11 % for gas demand between 2013 and 2014, driven by many factors such as low coal and CO_2 prices pushing gas out of the power generation mix, a continuation of the slow economic situation and a significantly warmer than average year, leading to significant reduction in the need for heating.

EU gas demand in 2015 saw a 4 % recovery from the previous year to 4,595 TWh, which can again be linked to a number of factors with sectoral differences at a country level.

During 2016, EU gas demand increased again by 6.7 % to 4,903 TWh. The reduction in gas prices that had started towards the end of 2015 continued into first half of 2016, and although gas prices increased in the final quarter of the year, coal prices increased 68 % compared to same period in 2015 meaning gas competitiveness increased in the power generation market. Power generation analysis has shown a significant coal to gas switch in a number of countries during 2016, linked to the above-mentioned price situation, but this was also influenced by the ongoing Carbon Price Floor[2] policy in the UK.

In 2017 further increase in gas demand was observed, reaching 5,077 TWh (+3,5 %). Coal to gas switch continues moderately. Gas prices were higher comparing previous year - strong demand of gas for power and storage injections have supported gas price in EU hubs during summer and increase in gas demand in winter.

In 2018 stabilisation in the context of gas demand was observed – 5,080 TWh was reached, meaning that value was comparable to 2017. At the beginning of the year, Europe experienced an extreme cold spell. Gas hub tested to limit on cold snap and prices reached multi-year highs. These circumstances led to declaration of early warning in few European countries and as a consequence of the situation, significant gas withdraw from storages was observed. Later the year, during summer, gas consumption was lower and allowed to fill the gas storages to be prepared in case of any events. Last quarter of 2018 showed decrease of gas demand comparing with the 2017.

2019 has confirmed the role of gas before coal in the power generation merit order and it translated into an increase compared to 2018 – 5,171 TWh. The warm weather in first quarter of the year allowed to enter summer with considerably high gas volumes in storages. Comfortable supply, falling gas prices and flexibility during the first quarter of the year allowed for reaching the very high stock level at the beginning of the winter and moderate usage of gas inventories in the last quarter. In 2019, LNG strengthened its role in supplying Europe.

In TYNDP 2018 all scenarios have been built as realistic and technically sound, based on forward looking policies, whilst also being ambitious in nature and aiming at reducing emissions. For the first time, the ENTSOs for gas and electricity have worked together, using their expertise to provide broadly technically feasible a joint set of scenarios. This uniquely common approach has led to resolutely forward-looking scenarios. This is key to test the need and performance of possible future infrastructure in challenging but realistic situations. Future scenario development processes will seek to enhance and improve gas and electricity interactions, looking for synergies, leading to better sharing of data and cooperation.

Following stakeholders' request for some continuity in the scenario storylines, TYNDP 2020 scenarios are built based on the TYNDP 2018 scenarios. However, the energy landscape is continuously evolving, and scenarios must keep up with the main drivers and trends influencing the energy system. All scenarios head towards a decarbonised future and have been designed to reduce GHG emissions in line with EU targets for 2030 or the United Nations Climate Change Conference 2015 (COP21) Paris Agreement objective of keeping temperature rise below 1.5 °C.

2 https://www.gov.uk/government/publications/excise-notice-ccl16-a-guide-to-carbon-price-floor/excise-notice-ccl16-a-guide-to-carbon-price-floor

2.2 ACER OPINION AND RECOMMENDATIONS

The full ACER Opinion on the draft TYNDP 2020 can be found on the ACER website[3], the following section will provide responses in the same order as the Conclusions of the Opinion.

2.2.1 RECOGNITION OF IMPROVEMENTS

The ACER Opinion included the following recognition of improvements achieved in the process, methodology and outcome of the draft TYNDP 2020 in comparison to TYNDP 2018:

- A better presentation of the TYNDP via a dedicated website and visualization tools which allow for interactive access to the main TYNDP features.
- The implementation of a common ENTSO-E and ENTSOG process for the development of scenarios for the TYNDP 2020 and the preparation of a stand- alone "scenario report" following the practice initiated for the TYNDP 2018.
- The provision of a window of opportunity for NRAs to check input data for the submitted TYNDP candidate projects at an early stage, in August 2019.
- The publication of the PS-CBA Project Fiches, and the provision in spreadsheet format of the projects' results and the results related to CO_2 and other externalities' savings.
- The increased focus of the TYNDP on Energy Transition aspects and better alignment with the Green Deal decarbonisation goals
- The ongoing efforts to implement a better approach to measuring the contribution of gas infrastructure projects to sustainability.
- The introduction of the "existing infrastructure level", which reflects today's gas infrastructure, in order to assess possible infrastructure gaps.
- The introduction of a mandatory requirement for promoters to submit information related to projects triggered by the incremental capacity process.

3 https://documents.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2002-2021%20on%20the%20ENTSOG%20draft%20Ten-Year%20Network%20Development%20Plan%202020.pdf

2.2.2 SHORT-TERM RECOMMENDATIONS

ACER Opinion provides for a number of short-term recommendations (Section 4, page 23) listed in the table below, in the order they appear in ACER opinion. The TYNDP topic to which these recommendations refer to are also indicated in the table below.

ACER short-term recommendations	Related TYNDP topic	Paragraph in which the recommendation is handled
The comments and remarks of NRAs on the TYNDP 2020 projects, as contained in Annex I to this Opinion.	Additional section in the final TYNDP	2.2.2.3
The publication of a summary document indicating how feedback from the public consultation and from ACER's Opinion are taken into account for the final TYNDP 2020 and will be considered in future TYNDPs.	Additional section in the final TYNDP	Feedback chapter
Including the Economic Performance Indicators in the Project Specific CBA assessments results.	Project assessment	2.2.2.2
Classifying and labelling the ET projects (In addition to the detailed categories for ET projects available in the draft TYNDP 2020) into two main categories, i. e. project pertaining to the supply/gas production side projects (in principle competitive activities) and network related investments to enable injection of decarbonised and low carbon gases in the network, providing further sub-labels where appropriate.	Project assessment	2.2.2.2
Verifying and publishing all projects included in the draft TYNDP which have been commissioned as of end of 2020.	Infrastructure projects	2.2.2.1 + Annex A

Table 2.1 Short-term ACER recommendations.

Below, handling of ACER recommendations is indicated per related TYNDP topic.

2.2.2.1 INFRASTRUCTURE PROJECTS

Projects commissioned since draft TYNDP

Data collection for projects is a long and very important process for ENTSOG as it is a fundamental prerequisite to the modelling and simulations. The input data are the basis for the network assessment and data are collected early in the process of TYNDP.

For TYNDP 2020, the data collection process ended in Q3 2019.

The existing infrastructure level, representing the minimum infrastructure development used in TYNDP 2020 system needs assessment includes all existing infrastructures as of 1st January 2019 as well as submitted projects having their commissioning date not later than 31 December 2019.

By the date of publication of the TYNDP, a number of projects submitted for the assessment were actually commissioned.

Updated list of all TYNDP 2020 projects commissioned before the publication of the Final TYNDP 2020 has been included in an updated version of TYNDP 2020 Annex A.2 (Project Tables) available **here**.

2.2.2.2 PROJECT ASSESSMENT

CBA indicators

In line with the European Commission Opinion on ENTSOG 2nd CBA Methodology, the assessment carried out by ENTSOG for TYNDP 2020 and previous editions, is a Multi-Criteria Assessment that includes qualitative, quantitative, and monetised benefits.

Despite the supposed simplicity in comparing monetary benefits against costs, monetisation is not a trivial exercise and not all benefits can be monetised. Monetary benefits are uncertain and hard to capture while costs represent more certain information.

Additionally, monetization depends on assumptions and inputs as well as market behaviour.

For those reasons, the publication of the Economic Performance Indicators (EPI) might lead to wrong interpretation of results, encouraging the readers of the Project Fiche to give more emphasis only to monetised benefits while disregarding other benefits (e. g. supply dependence reduction).

However, for projects applying to the PCI selection process through ENTSOG Project Portal, and for which ENTSOG as run PS-CBAs, project promoters, when submitting their projects to the PCI selection process, have to accept that all the PS-CBAs related information (including monetary benefits) can be shared with the European Commission and ACER, upon their request.

Classifying and labelling the ETR projects

ENTSOG TYNDP 2020 ETR projects have been divided in 9 categories (please refer to Annex A column "Project Type"). When these categories were not fully applicable, additional information was provided in the column "Project Description".

The categories displayed in TYNDP 2020 Annex A reflect the information collected during TYNDP 2020 project collection. An ex-post categorisation in the Final TYNDP 2020 version may result in conflict with the currently available information.

ENTSOG has already started working on a more detailed and refined project categorisation to be applied to TYNDP 2022 projects.

Picture courtesy of SGI

2.2.2.3 NRA COMMENTS ON THE TYNDP 2020 PROJECTS

Already during TYNDP 2020 Project Collection process, ACER and NRAs were provided with the project data collected for their review and feedback. Promoters were informed on the informal preliminary comments provided by ACER and NRAs and could amend the information provided during the project data collection if deemed necessary. Therefore, Draft TYNDP 2020 Annex A already includes the NRAs feedback whenever considered by promoters.

Other information, such as the maturity of a project, is derived by ENTSOG based on the information submitted by the project promoters and after having applied specific rules as defined in ENTSOG CBA Methodology and in TYNDP 2020 Annex D.1 (Methodology).

As part of its Opinion, ACER offered national regulatory authorities (NRAs) to provide comments on the projects submitted to TYNDP 2020. These comments are available as an annex to ACER Opinion[4] and provide an additional information on projects, in addition to the promoter information collected as part of TYNDP Annex A.

The comments from the NRAs in particular reflect recent project information and, in many cases, own NRAs views on projects benefits. In some cases, NRAs identified incorrect data.

Some project data have been updated after TYNDP 2020 project collection, and on some occasion reflected in national NDPs. Such updates are not included in the Final TYNDP 2020, to ensure consistency between the project information used to perform the TYNDP assessment, and the project information published. In this context, NRAs input on recent project information represents a valuable additional information for stakeholders not to be lost even if not included in the Final version of TYNDP 2020.

In cases where NRAs refer to the actual merit of the project, it must be noted that TYNDP is based on transparent and consulted rules (including the approved 2nd CBA Methodology) for project inclusion and assessment, ensuring a non-discriminatory process and prevention of conflict of interest.

4 https://documents.acer.europa.eu/Official_documents/Acts_of_the_Agency/Opinions/Opinions/ACER%20Opinion%2002-2021%20on%20the%20ENTSOG%20draft%20Ten-Year%20Network%20Development%20Plan%202020.pdf

2.2.3 MEDIUM-TERM AND LONG-TERM RECOMMENDATIONS

The following table illustrates the medium and long-term ACER Opinion recommendation and the TYNDP (or ENTSOG) processes where are or can be tackled.

ACER long-term recommendations (TYNDP20)	Related TYNDP/ENTSOG process
Implementing ACER's recommendations regarding scenarios, as provided in its Opinion No 6/2020.	TYNDP Scenario Report
Planning of future TYNDP processes	TYNDP process
Increasing stakeholders' engagement in the process	TYNDP process
Improve the CBA Methodology	CBA methodology
CBA project assessment for all projects	TYNDP/Project assessment
Encourage promoters to provide more information on costs	TYNDP process
Consider the level of utilisation, and contractual and physical congestion for assessing the need for additional infrastructure	TYNDP/System assessment
Consistent and interlinked electricity and gas networks and market model	TYNDP Scenario Report/System assessment
Identification of the location for the power-to-gas installations (together with ENTSO-E)	TYNDP Scenario Report
Develop metrics to identify unrealistic projects/projects with low market interest.	TYNDP/Practical Implementation Document
Assessment of necessary adaptations of gas infrastructure to inject RES and decarbonised gases, and related costs	TYNDP/Project assessment
Develop ways for analysing and addressing methane emissions	TYNDP/Project assessment

Table 2.2 Medium and long-term ACER recommendations.

The below section addressed the medium-term and long-term recommendations of ACER Opinion.

2.2.3.1 SCENARIOS, TIMING, AND CONSULTATION OF NEXT TYNDP

TYNDP Scenarios

ENTSOG, together with ENTSO-E, has already implemented a number of recommendations of the opinion 6/2020 in the TYNDP 2020 scenario building process and will consider further recommendations in the Scenario report itself.

Improving the planning of the future TYNDP processes and stakeholders' engagement

ACER recommends to better plan the future TYNDP processes in order to make sure that the official submission of the draft TYNDP for the Agency's opinion contains also the information regarding the consultation process, as required by Articles 9(2) and 10 of Regulation 715/2009.

ENTSOG is constantly working on improving the TYNDP process and its synchronisation with the PCI selection process. At the same time, it is important to underline that the implementation in each new TYNDP of new elements from stakeholders (including ACER's) have an inevitable impact on the timeline extension and its uncertainty. Several interactions with stakeholders and their delays in response have an impact on the timeline but the priority for ENTSOG is to ensure that all stakeholders have an opportunity to contribute and provide their feedback.

For TYNDP 2022, and in line with ACER recommendation, ENTSOG intends to plan for the process in line with Articles 9(2) and 10 of Regulation 715/2009, and to publish the draft TYNDP mid-2022.

2.2.3.2 CBA METHODOLOGY AND SUSTAINABILITY ASSESSMENT

ENTSOG is constantly working in improving indicators in view of each TYNDP application of its CBA Methodology.

Improving the implementation of the CBA 2.0 methodology

Compared to TYNDP 2018, ENTSOG has further worked on the sustainability indicators by including a new allocation method (in line with European Commission study "Measuring the contribution of gas infrastructure projects to sustainability as defined in the TEN-E Regulation[5]" performed by Artelys and Trinomics) as well as by including the consideration of other externalities than CO_2 emissions.

Requiring CBA projects assessments for all the TYNDP projects instead of PCI applicants only

In line with Regulation (EU) 347/2013 ENTSOG runs project-specific cost-benefit analysis (PS-CBA) only for projects having declared their intention to apply during TYNDP project collection. This does not replace the actual PCI application organised by the European Commission and under its responsibility. While Regulation (EU) 347/2013 states that only projects *"having reached a sufficient degree of maturity"* should receive a PS-CBA, ENTSOG, assessing any project indicating its intention to apply for the following PCI selection process independently on their "maturity" level already assesses a broader scope of projects and it ensures a fair treatment to any of the PCI candidate. Such approach is also welcomed by the European Commission in its Opinion on the 2nd CBA Methodology.

Providing project cost information irrespective of their intention to apply for PCI status

ENTSOG support and encourages maximum level of transparency from promoters. At the same time ENTSOG must respect the request for confidentiality for projects not applying for PCI selection process. Additionally, there is no problem of same footing comparability since those projects do not receive a project-specific cost-benefit analysis.

Analysing the level of utilisation and contractual and physical congestion of interconnection points, as an essential parameter to be taken into account when analysing the need for additional gas infrastructure, in order to avoid the risk of stranded or inefficient investments.

From TYNDP 2018, ENTSOG already considers long-term capacity booking contracts. These contracts, if signed before the time-horizon considered for the assessment, basically represent a given for the user, and therefore sunk cost that are not expected to impact on its short-term use of the capacity. Their inclusion, and until their expiration, allows to take into account in the TYNDP and infrastructure gaps identification the expected minimum level of utilisation of existing infrastructures. In the long-term, however, with these contracts expiring, gas could flow through any possible route.

Consideration of the long-term capacity booking contracts and minimum supply potentials was continued for TYNDP 2020, to reproduce the most realistic use of the infrastructure.

With regards to long-term supply contracts, those are already included, at European level, in the "minimum" defined for each supply source potential. The different supply sources minimums are based on public available literature, exchanges between ENTSOG and the main suppliers as well as on the stakeholder's feedback received during dedicated workshops.

Consideration of physical congestion is already embedded in the way the many TYNDP 2020 indicators are calculated: a physical bottleneck will identify an infrastructure need. Flows resulting from ENTSOG simulations are one of the possible solutions that the simulation tool might provide. The level of utilisation of existing infrastructure and submitted projects might differ from one simulation to another, depending on the underlying assumptions. To assess situations where existing infrastructure is prioritised, ENTSOG runs sensitivity on the value of the tariffs assumed for the projects. In the same way, the sustainability indicator computed for TYNDP 2020 considers, in the allocation of benefits to projects, that existing infrastructure are always prioritised.

Please consult Annex D.1 for more information.

5 https://op.europa.eu/s/pcwx

2.2.3.3 INTERLINKED ASSESSMENT WITH ELECTRICITY NETWORK PLANNING

Implementing improvements leading to the development of a consistent and interlinked electricity and gas networks and market model

After the publication of the focus study on the interlinkages between gas and electricity infrastructure and projects, ENTSOG, with ENTSO-E, have further improved their joint scenario building exercise and have worked on a pilot project to test and develop a screening methodology to identify future projects requiring a joint system assessment both on the gas and electricity side. This document is available on ENTSOG and ENTSO-E websites.

Identification, jointly with the electricity TYNDP, of the suitable locations for power-to-gas installations in the system needs analysis.

In the scenario building process, the identification of suitable locations for power-to-gas installations is based on available RES, demand for hydrogen and transport capacity (electricity lines and hydrogen grid). The model will, depending on the beforementioned parameters, then decide where to place the power-to-gas installations in the most cost-efficient way. The optimal distribution of power-to-gas installation depends on the scenarios and aims at limiting the need for additional infrastructure in the subsequent assessment. Indeed, power-to-gas installations are not covered by the current TEN-E regulation and therefore, are not part of the system need analysis but part of the ENTSOG and ENTSO-E scenario building process.

2.2.3.4 ALIGN THE NUMBER OF CONVENTIONAL GAS PROJECTS WITH NEEDS AND MARKET INTEREST

Include in Final TYNDP a section on preliminary information on the status of the incremental capacity process initiated in 2019 (non-binding phase)

As part of each TYNDP edition, ENTSOG includes in the Infrastructure Report a section on the incremental capacity process. ENTSOG is currently preparing the data collection for the 2019 Incremental Capacity process monitoring report which will provide a full overview and the results of the 2019 incremental cycle. After the annual yearly auctions on 5 July 2021 the economic tests can be performed which will determine if any incremental capacity projects will be initiated as a result of the 2019 cycle.

Develop metrics to identify unrealistic projects/ projects with low market interest.

TYNDP 2018 and TYNDP 2020 have collected information on projects triggered by market demand indication as part of the incremental capacity process. TYNDP 2018 and TYNDP 2020 already include a section dedicated to the incremental capacity process. Such section provides information on the projects triggered by this process and on the results of the final binding demand indications. For more details, please consult section 7 of TYNDP 2020 Infrastructure Report). Based on the status of the incremental capacity process at the time of the (draft) TYNDP publication, TYNDPs could include projects triggered by indication of non-binding demand indications.

Projects related to the incremental capacity process represent only a limited number of the overall submitted projects. TYNDP scope is in fact to collect project initiatives that could address not only market needs but also security of supply and sustainability needs. This process has been proven effective in the past, with the current gas infrastructure and the gas projects expected to be commissioned no later than in year 2025 already achieving most of the aims of the European internal energy market. With some exceptions in specific areas (for more details please consult ENTSOG TYNDP 2020 System Assessment Report).

While, for future TYNDP editions, the introduction of additional criteria in the project guidelines can help in further filtering submitted projects, the exclusion by default of projects not supported by market needs could have a negative impact on the development of gas projects still needed to mitigate the remaining European infrastructure gaps.

2.2.3.5 NETWORK ADAPTATIONS FOR DECARBONISED GASES, METHANE EMISSIONS

Considering focusing more on the necessary adaptations of the gas infrastructure to enable the injection of higher shares of renewable and de-carbonised gases

For the first time, ENTSOG introduced the Energy Transition (ETR) project category in TYNDP 2020. This category represented ca. 25 % of the total number of projects and was welcomed by stakeholders confirming the relevance of the choice made by ENTSOG on its own initiative.

In the next TYNDP editions ENTSOG will work to further refine the list and the categories of TYNDP 2020 ETR projects, included for the first time in its TYNDP 2020 edition.

ENTSOG will also adapt the TYNDP assessment approach to new project categories, with particular focus on hydrogen-related projects.

Picture courtesy of SGI

2.3 PUBLIC CONSULTATION AND STAKEHOLDER FEEDBACK

ENTSOG opened the public consultation on draft TYNDP 2020 for 7 weeks from 25 November to 15 January 2021.

2.3.1 ANALYSIS OF THE PUBLIC CONSULTATION FEEDBACK

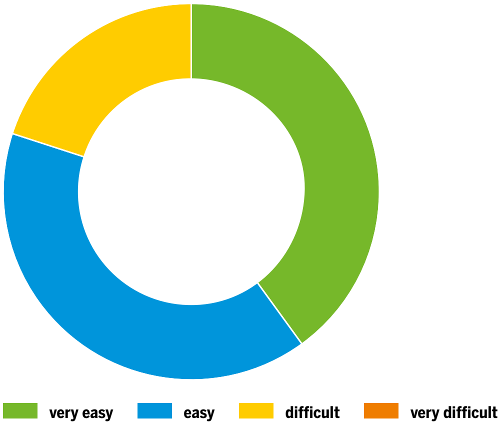


Figure 2.3 Is TYNDP 2020 easy to read and navigate through?

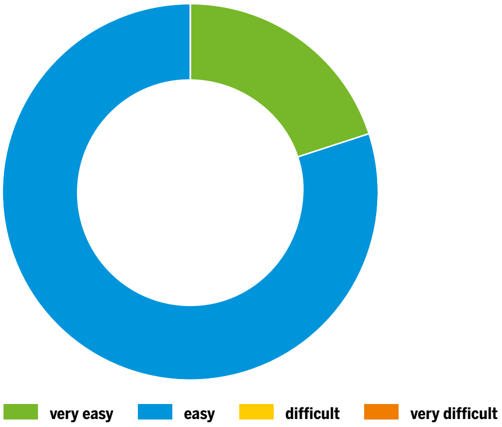


Figure 2.4 Are the maps, graphs and tables easy to understand?

Several improvements aiming on a simple and clear presentation of TYNDP were welcomed by the stakeholders in the 2020 edition and increased readability and navigation. Dedicated website and tailor-made visualization tools allow for interactive access to main TYNDP features. Publication of the dedicated reports to the main sections of TYNDP instead of a single report followed by publication of the TYNDP in form of interactive website allowed to efficiently browse and the same time to focus on the most relevant information while providing the exhaustive information in the annexes. It was noted, that TYNDP process has reached a good level of maturity in particular concerning the data provided and the level of transparency.

Most interesting topics

The overview of the topics identified as most interesting by stakeholders indicates that TYNDP is seen by a large share of stakeholders as a valuable source of European-wide information. It indeed highlights that the expectations of the stakeholders are mainly focused on the joint ENTSOG and ENTSO-E scenarios, assessment of the infrastructure, specific projects, as well as on the TYNDP modelling methodology.

The collection and analysis done by ENTSOG, is a highly valuable source of information, as well as a necessary input to the simulations and the assessment of the infrastructure.

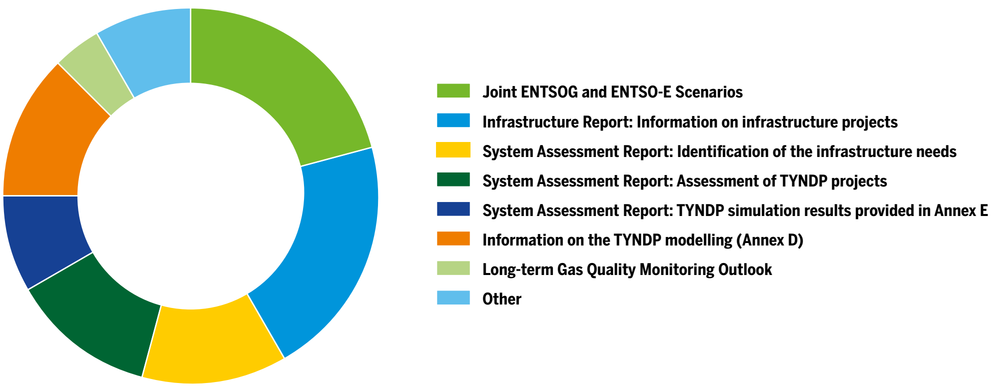


Figure 2.5 Most valuable elements in TYNDP 2020.

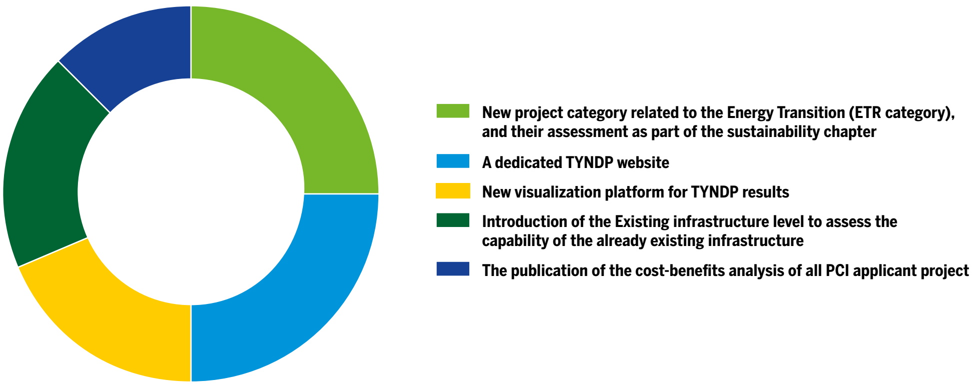


Figure 2.6 Most valuable new elements in TYNDP 2020.

New elements introduced for TYNDP 2020

ENTSOG introduced a number of new elements in TYNDP 2020. Stakeholders were consulted on their views on these new elements. All the elements are considered as valuable by the stakeholders. For the first time, ENTSOG collected projects related to the Energy Transition (ETR project category). This project collection is meant to improve the transparency and provide information on the energy transition from an infrastructure perspective, including the renewable generation and decarbonisation capacities. First step in that direction taken by ENTSOG was well received and appreciated by stakeholders, that in the same time expressed further interest for deeper investigation in the next edition of the TYNDP. This underlines the importance of the energy transition in the perspective of the EU's energy and climate objectives towards 2050.

That observations and requests are proving that TYNDP is coherent with objective of the energy transition and will be the main area of development in the next edition of the report.

The main improvements ENTSOG has brought to the 2020 editions are all considered increasing the usability of the TYNDP. All stakeholders see value in the publication of all simulation results and the description of the modelling as annexes and additionally accessible through interactive website with dedicated visualization platform. Stakeholders support the focus on the relevant scenarios in the reports when assessing the infrastructure needs or the impact of new projects. Further development in this area, planed for the next edition will include access to PS-CBA results in form of the interactive platform.

During the consultation process, stakeholders expressed support and a need for further development in terms of sustainability indicators and energy transition with particular emphasis on hydrogen. Those areas are also addressed in the TEN-E regulation re-opening. ENTSOG has expressed its supports to strengthening the sustainability criteria in the future TEN-E regulation and will work to satisfy the needs expressed by stakeholders in the public consultation procedure.

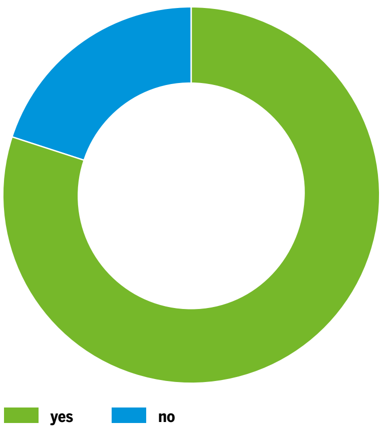


Figure 2.7 For the first time, ENTSOG collected projects related to the Energy Transition. Do you find this approach relevant?

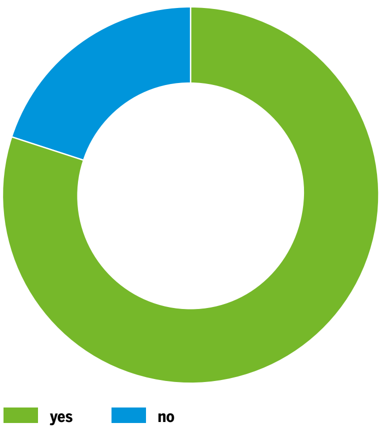


Figure 2.8 TYNDP 2022 will build on ETR projects and TYNDP 2020 R&D to include the assessment of hydrogen infrastructure. Would you find it relevant?

3 SUSTAINABILITY

3.1 A SUSTAINABILITY ORIENTED TYNDP

TYNDP 2020 SCENARIOS SUPPORT THE EUROPEAN CLIMATE AMBITIONS

TYNDP 2020 assesses the European infrastructure gaps against sustainability-oriented scenarios considering either national policies as defined by the Member States' National Energy and Climate Plans (NECPs) or the objectives as defined in the Paris agreement (COP 21). All scenarios therefore comply with European and national ambitions.

Furthermore, building on the ever-improving inter-linked model developed jointly by ENTSO-E and ENTSOG, the COP 21 scenarios – Distributed Energy and Global Ambition – are built on a holistic approach to the European energy system considering the total primary energy mix of Europe to ensure consistency across all sectors, beyond considering the sole interactions between gas and electricity.

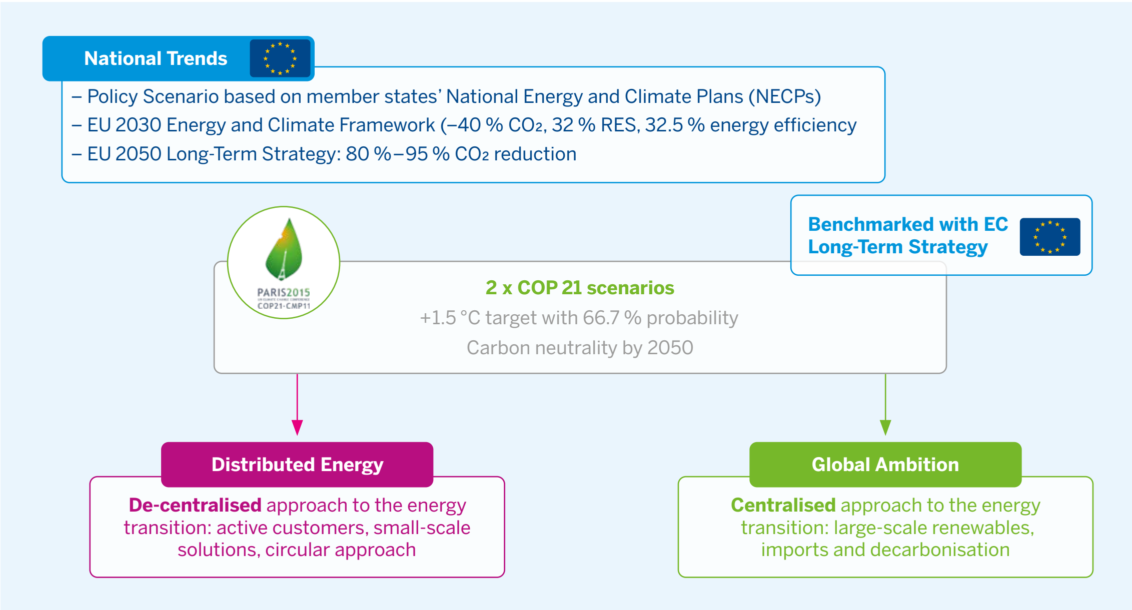
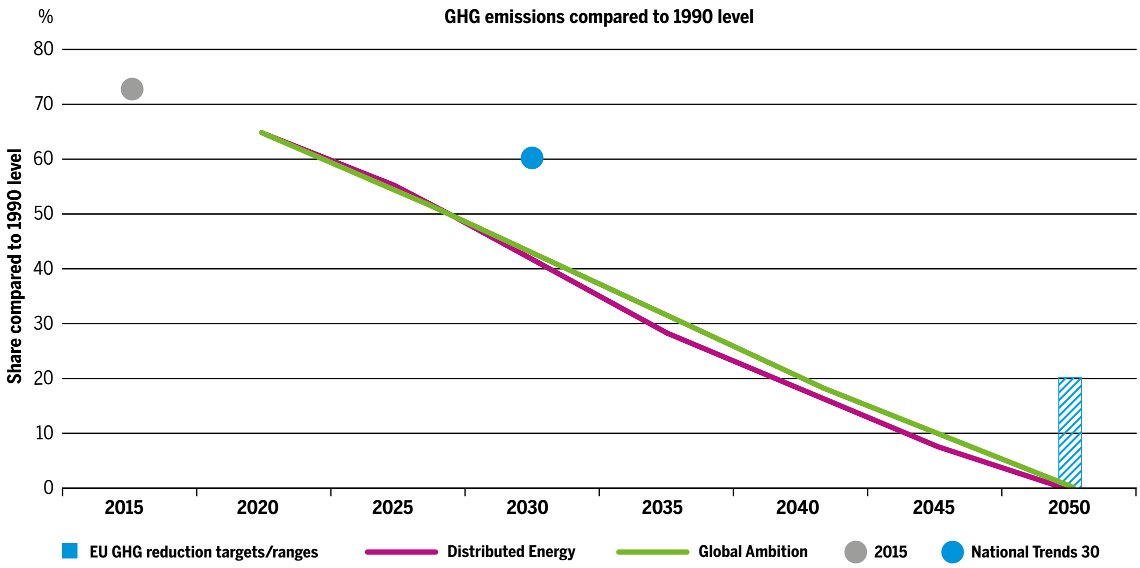


Figure 3.1 TYNDP 2020 scenarios: storylines

3.2 TOWARDS A CARBON NEUTRAL ENERGY SYSTEM BY 2050

TYNDP 2020 assessment reflects the infrastructure needs to reach a net-zero energy system in Europe by 2050. Furthermore, the COP 21 scenarios reach carbon neutrality in 2050 within a carbon budget of 61 to 64 $GtCO_2$, comparable to the EU Long-Term Strategy defined by the 1.5 Life and 1.5 Tech scenarios of the study "A clean Planet for all".[6]



	< 2050	2050	> 2050
Energy and non-energy related CO_2 emissions	57.1 $GtCO_2$	Carbon Neutrality	Additional measures needed, e. g.: LULUCF, BECCS, CCS, DAC
Non-CO_2 GHG emissions (including methane and Fluorinated gases)*	17.7 $GtCO_2$		
Carbon sinks**	−13.4 $GtCO_2$		
Net cumulative emissions	61.4 $GtCO_2$		−13 $GtCO_2$

* Data for methane and fluorinated gases emissions is taken from the European Commission's most ambitious 1.5 Tech and 1.5 Life scenarios (average) as published in the "A Clean Planet for all"-Study (link)

** Data for LULUFC is taken from the European Commission's most ambitious 1.5 Tech and 1.5 Life scenarios (average) as published in the "A Clean Planet for all"-Study (link)

Figure 3.2 TYNDP 2020 scenarios: decarbonisation pathways*

6 https://ec.europa.eu/clima/policies/strategies/2050_en

ONE SOURCE OF CLEAN ENERGY CANNOT DO IT ALL: GAS NEEDS ELECTRICITY AND ELECTRICITY NEEDS GAS

Both gas and electricity systems are interdependent to reach a carbon neutral energy system. Together with biomethane, gas needs renewable electricity to produce the large amount of clean hydrogen anticipated by the European Hydrogen and Energy Sector Integration (ESI) strategies and developed in both TYNDP 2020 COP 21 scenarios. Furthermore, the electricity system increasingly needs clean gas (methane and hydrogen) as a necessary source of energy to produce electricity, especially to support and back-up the necessary development of significant capacities of intermittent renewable power generation[7]. Moreover, scenarios with higher electrification show an increasing demand for clean gases and are also more exposed to Dunkelflaute events[8].

ONE TECHNOLOGY CANNOT DO IT ALL: RENEWABLE AND DECARBONISED GASES ARE BOTH NEEDED

Along with energy efficiency improvements, the development of renewable energy capacities is necessary to reach carbon neutrality by 2050. However, even with more ambitious development trajectories for wind and solar in Distributed Energy, both COP 21 scenarios show a need for decarbonisation technologies (production of hydrogen from natural gas with CO_2 or solid carbon capture) to reach carbon neutrality in 2050, and additional CO_2 capture technologies (e. g. LULUCF, BECCS, CCS, etc) for "hard-to-decarbonise" processes as well as to compensate for the extra amount of CO_2 the EU will emit in the meantime reaching net-zero in 2050. **See Figure 3.4**

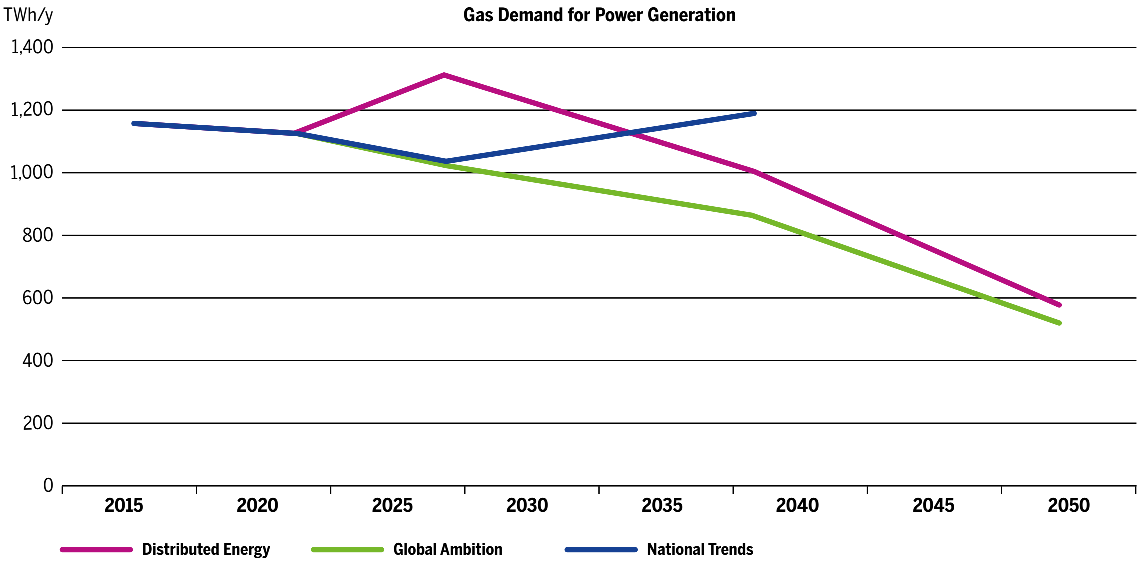


Figure 3.3 Gas demand for power generation

7 For further details on gas demand available see TYNDP 2020 scenario report https://www.entsos-tyndp2020-scenarios.eu/

8 "Kalte Dunkelflaute" or just "Dunkelflaute" (German for "cold dark doldrums") expesses a climate case, where in addition to a 2-week cold spell, variable RES electricity generation is low due to the lack of wind and sunlight.

QUICK WINS ARE ESSENTIALS: FAST IS MORE EFFICIENT

As the amount of CO_2 emitted by the EU will depend on how fast renewable and decarbonisation technologies will develop, quick wins are essentials. The quicker the cut in CO_2 emissions, the lower the need for decarbonisation capacities. The electricity model used by ENTSO-E and ENTSOG to build the scenarios show that an immediate coal-to-gas switch in the sole power sector could already save more than 85 MtCO_2 per year (more than total CO_2 emissions of Austria) without new investments. Additional potential exists in other sectors such as heating, industry and mobility.

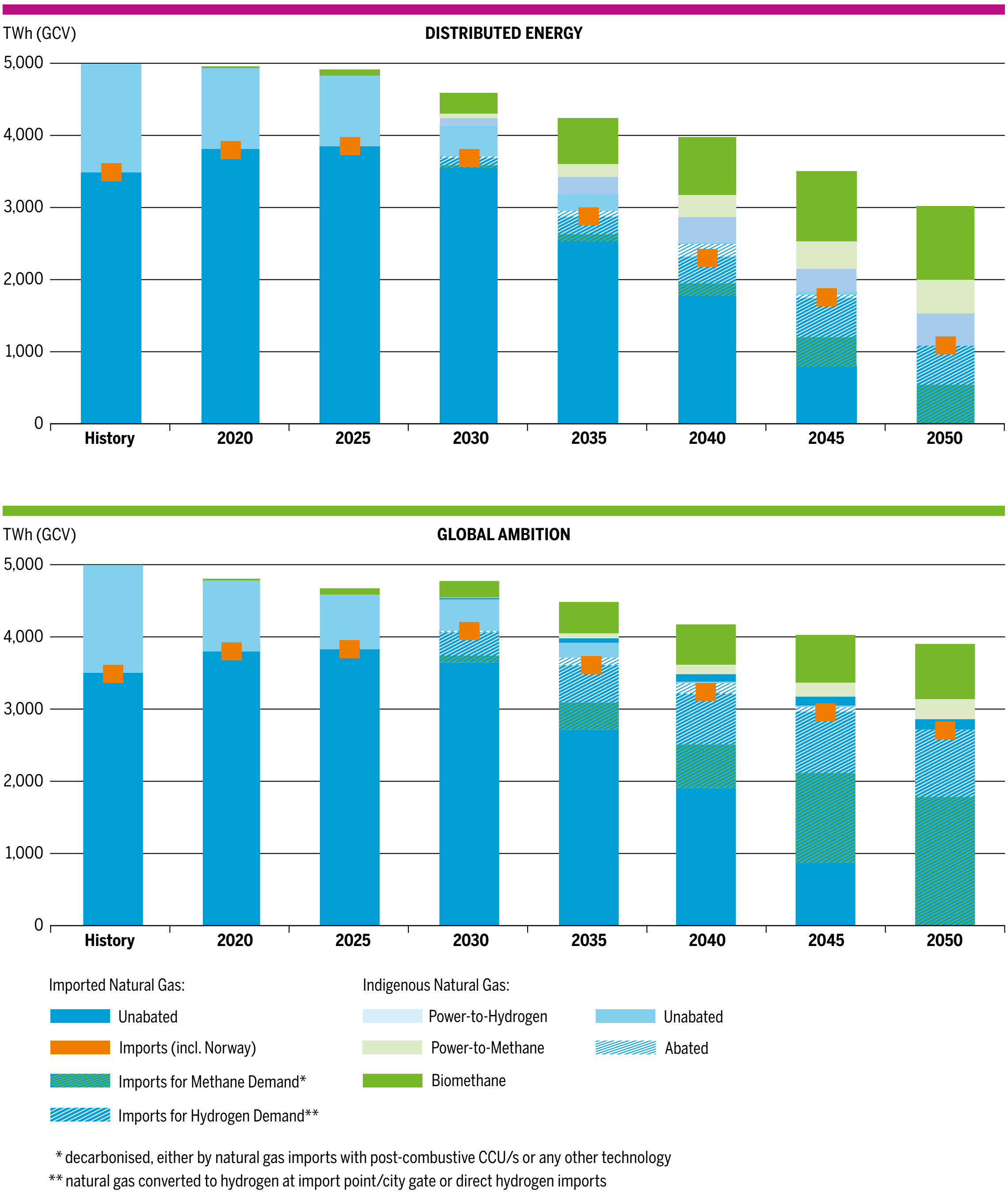


Figure 3.4 Gas source composition in COP 21 scenarios

IMPORT CAPACITIES ARE KEY TO ENSURE THE TRANSITION AND SECURITY OF SUPPLY

COP 21 scenarios show limited energy import needs compared to the EU Long-Term Strategy scenarios. However, the TYNDP 2020 assessment confirms the need for gas import capacities to ensure the transition (production of decarbonised energy besides the development of renewable technologies) and to ensure the security of energy supply (**see Security of supply chapter**).

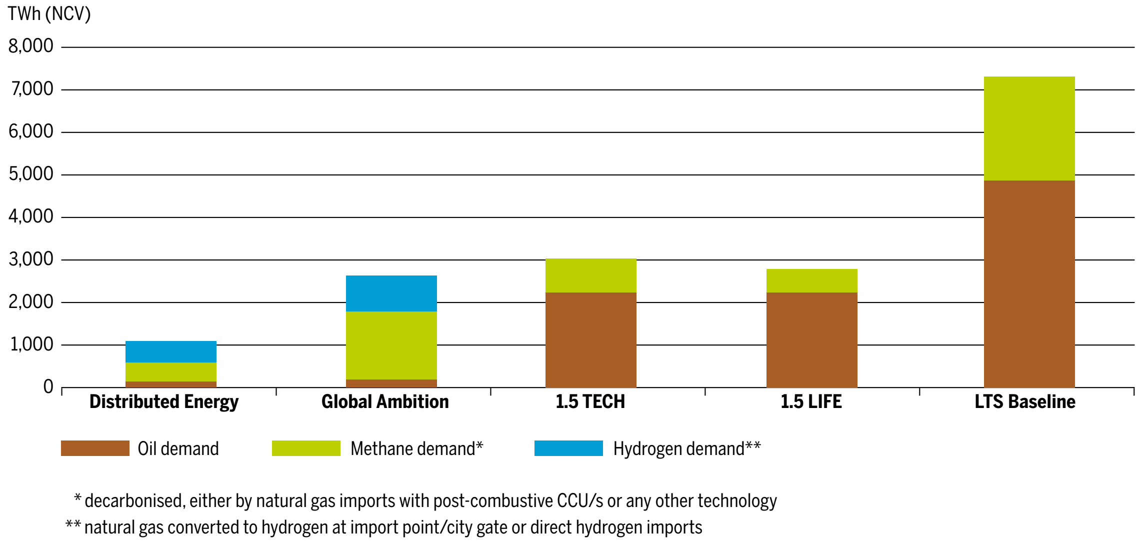


Figure 3.5 Energy imports to the EU in 2050 in TYNDP 2020 scenarios and EU Long-Term Strategy

3.3 TYNDP 2020 IS LOOKING FORWARD

To support Europe in its Climate and Energy ambitions, ENTSOG made the choice to collect and assess projects contributing to the decarbonisation of the gas system on a transparent and non-discriminatory basis.

DEVELOPMENT OF CLEAN GASES IS NECESSARY

TYNDP 2020 scenarios show that reaching a net-zero economy by 2050 must result in energy efficiency improvements and a generally decreasing trend for the overall gas demand. However, as the European energy system goes more and more decarbonised, the gas demand is sustained by energy intensive sectors such as power generation, industry, heating and transport, where the high energy density of gas and its efficient storage and transmission are key assets. Therefore, an adaptation of the energy infrastructure is necessary to develop significant production capacities of renewable and decarbonised gas, and to adapt the demand to new gases, notably hydrogen. Such projects are not covered by the current TEN-E regulation and are introduced for the first time by ENTSOG in TYNDP 2020 in addition to the project categories already covered by the regulation.

TYNDP 2020 ASSESSES GAS PROJECTS PARTICIPATING TO THE DECARBONISATION OF THE EUROPEAN ENERGY SYSTEM

In addition to the usual projects (transmission, storage and LNG) reinforcing the infrastructure backbone of the European gas market and supporting the displacement of more carbon intensive fuels (e. g. coal phase-out in heating, power and industry, or oil phase-out in the transport sector), ENTSOG collected Energy Transition projects (ETR projects) to assess additional gas infrastructure projects meant to decarbonise the European energy system. The ETR projects generally connect to the transmission infrastructure either upstream by producing/enabling renewable or decarbonised gases, or downstream by adapting/enabling the energy demand to new gases or to displace more carbon intensive fuels with decarbonised gases. Furthermore, a number of ETR projects are also related to the repurposing of existing infrastructure to carry hydrogen.

ENERGY TRANSITION PROJECTS CATEGORY ALREADY ACCOUNTS FOR MORE THAN 25 % OF TYNDP 2020 PROJECTS

Although the ETR category has been just created for TYNDP 2020 and project submission was done on a voluntary basis, Energy Transition projects represent 28 % of all projects submitted to TYNDP 2020.

Various types of projects have been submitted and they cover the entire spectrum of the necessary categories identified in the TYNDP scenarios.
See Figure 3.8.

Upstream

The vast majority of ETR relates to renewable gas generation capacities (Power-to-gas and Biomethane) and decarbonisation (methane to H_2 reforming, CCU/S).

Midstream

The significant number of Conversion projects (30 %) for the adaptation of the existing infrastructure to Hydrogen is consistent with the development of Hydrogen production capacities.

Downstream

This category of projects to adapt and develop the demand is the least represented and is expected to increase with the further development of TSO-DSO cooperation.

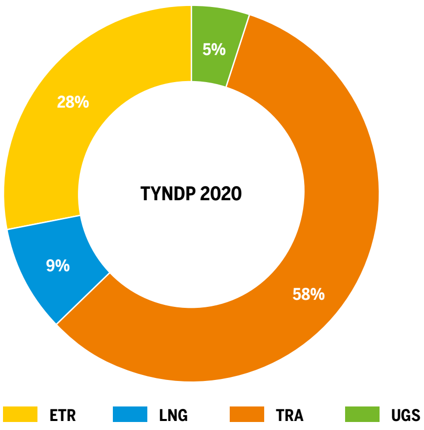


Figure 3.6 Project categories submitted to TYNDP 2020

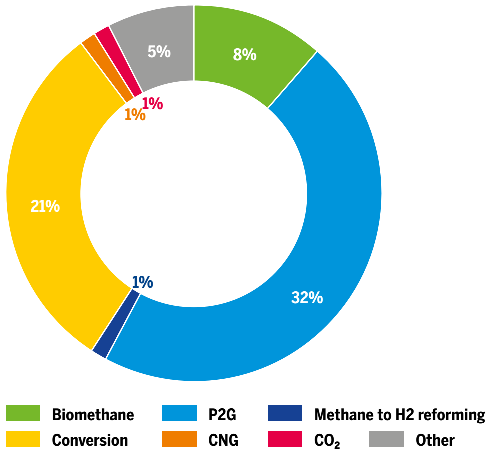


Figure 3.7 Energy Transition projects per category

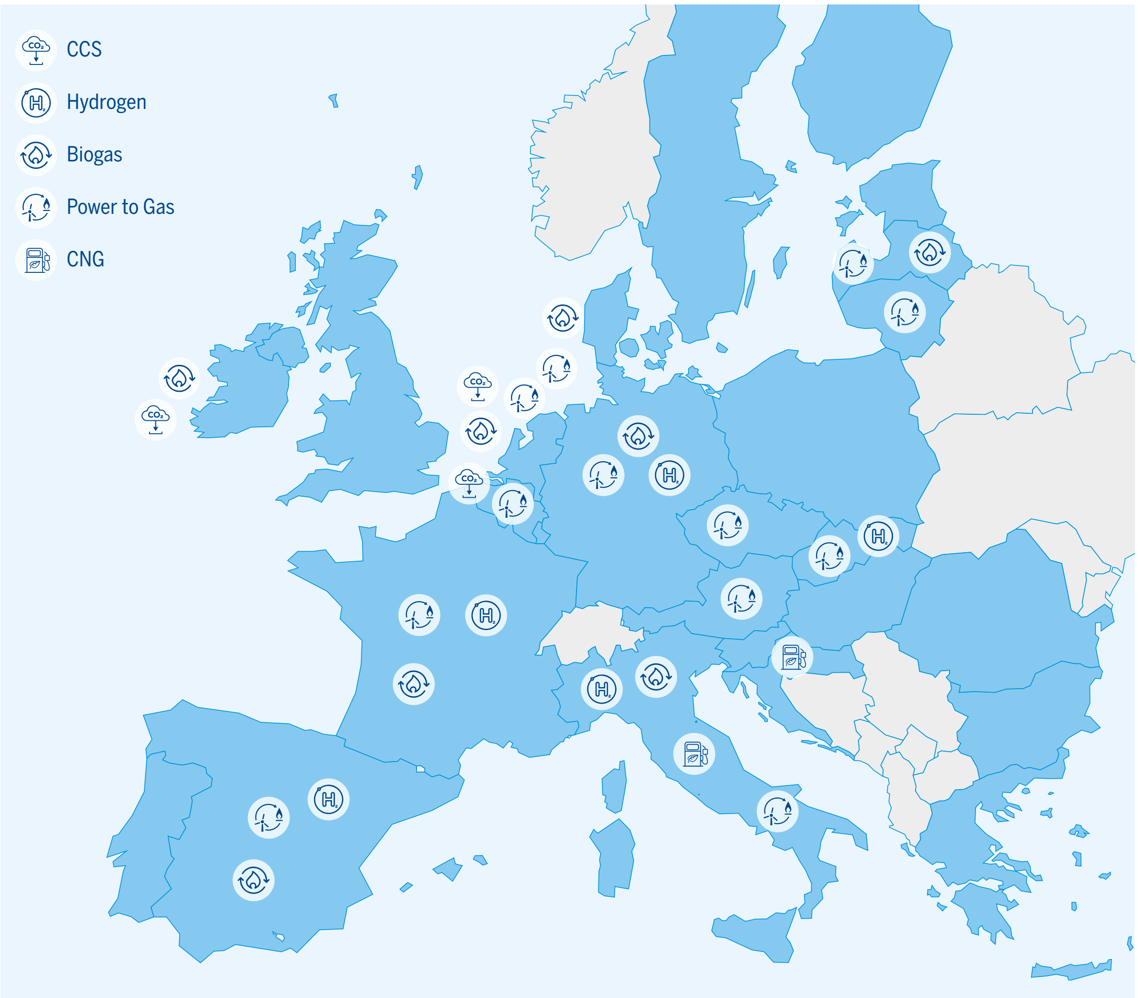


Figure 3.8 Distribution of ETR projects submitted to TYNDP 2020 per type of projects

FIRST ETR PROJECTS SUBMITTED TO TYNDP 2020 CONTRIBUTE SIGNIFICANTLY TO THE DECARBONISATION OF THE ENERGY SYSTEM, BUT MORE PROJECTS ARE NEEDED

All ETR projects participate to reducing the CO_2 emissions of the energy system. However, the first list of projects – submitted by their promoters on a voluntary basis – is far from being comprehensive and many other projects that were not submitted could bring additional support towards reaching the climate and energy targets of the EU.

Many ETR projects show they will take some time to materialise, which confirms the need for quick-to-implement solutions to decrease the carbon intensity of the European energy mix as soon as possible and limit the need for additional CO_2 capture solutions post net-zero in 2050.

Indeed, both COP 21 scenarios reach carbon neutrality in 2050 with a carbon budget of approximately 61 to 64 $GtCO_2$, in line with the European Long-Term Strategy published in the study “A clean planet for all”[9]. However, depending on the total carbon budget defined for the EU until 2100, additional measures are needed after 2050 to go even further to capture additional CO_2 to stay within a COP 21 compliant CO_2 budget to limit the temperature increase to +1.5 °C.

Therefore, quick wins such as coal to gas switch, penetration of gas in carbon intensive sectors and the early implementation of decarbonisation and renewable projects will support both reaching the net-zero target of 2050, but equally limit the need for additional carbon-negative measures post-2050. **See Figures 3.9 and 3.10.**

9 https://ec.europa.eu/clima/policies/strategies/2050_en

Picture courtesy of SNAM

ETR PROJECTS EVALUATED IN TYNDP 2020 COULD SAVE MORE THAN 3,100 MTCO₂ TILL 2050

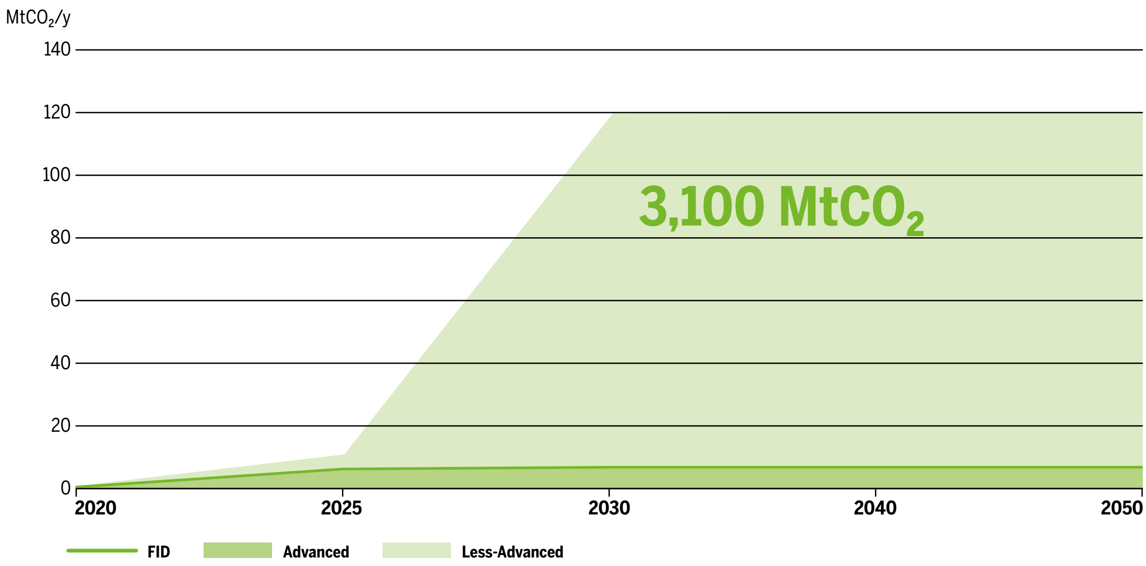


Figure 3.9 CO_2 savings generated by ETR projects in TYNDP 2020

MORE THAN 1,000 KM OF PIPELINE RETROFITTING SUBMITTED TO TYNDP 2020 FOR THE NEXT 10 YEARS

For the first ETR projects collection, around 1,100 km of pipeline retrofitting has been submitted to TYNDP 2020 and they concern only France and Germany. According to some TSOs studies, the potential retrofitting activity could reach 6,800 km by 2030[10].

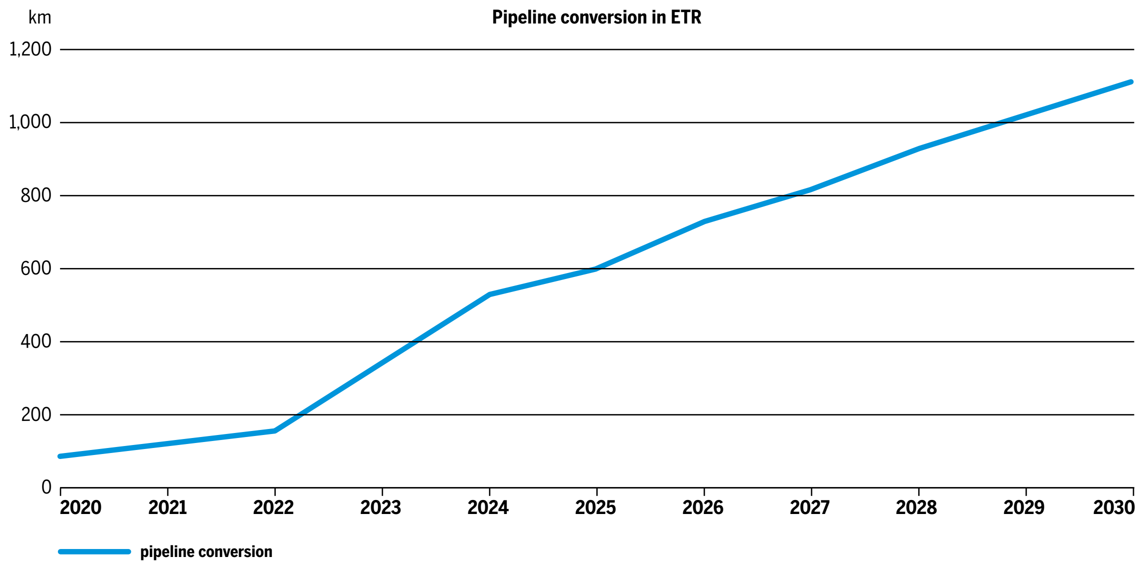


Figure 3.10 Length of pipeline retrofitting in ETR projects in TYNDP 2020

10 https://gasforclimate2050.eu/sdm_downloads/european-hydrogen-backbone/

3.4 CONCLUSION

GAS IS PART OF THE SOLUTION TOWARDS NET-ZERO 2050

TYNDP scenarios confirm the need for various renewable and decarbonisation technologies and the interdependence of the gas and electricity systems in reaching a net-zero European energy system by 2050.

Indeed, as the energy transition will create a change in the use of primary energies depending partly on the level of electrification and on whether it is produced locally or centralised, gas as an energy carrier has a necessary and key role to play and needs to be decarbonised.

ETR PROJECTS WILL DRIVE THE DECARBONISATION

With the creation of the Energy Transition project category, ENTSOG collected a non-comprehensive but still significant list of projects reflecting the wide variety of solutions needed to decarbonise the energy sector, from renewable generation to demand conversion including CO_2 storage and infrastructure conversion. Out of the 70 ETR projects submitted to TYNDP 2020, the 40 projects evaluated can save more than 3,100 MtCO_2 (**see Figure 3.9**). Since the ETR projects collection is not a regulatory requirement, they were submitted to ENTSOG on a voluntary basis. Therefore, the assessment is not comprehensive and the impact of the assessed ETR projects can be considered the very tip of the iceberg.

QUICK WINS ARE NO REGRET OPTIONS

The carbon budget approach considered in the COP 21 scenarios show that the later the transition happens, the more you need to compensate for CO_2 emissions after reaching net-zero. Therefore, quick decisions made today can save a lot compensation measures after 2050.

With no further investments and no matter in which scenario, coal to gas switch can be implemented today and save more than 85 MtCO_2 per year (more than the total CO_2 emissions of Austria), and other solutions already exist to quickly replace relatively higher carbon intensive fuels with gas in carbon intensive sectors such as industry and heating or in sectors where the energy needs to be stored and transported like mobility, including train, shipping and aviation.

THE TRANSMISSION INFRASTRUCTURE AS BACKBONE TO INTEGRATE CLEAN GASES AND SUPPORT AN EFFICIENT ENERGY MARKET

As production capacities of clean gases need to scale up, renewable gases – like offshore power to gas – will be produced further from the consumption areas and will be unevenly distributed throughout Europe, depending where the best potential is located. The most recent ETR projects demonstrate that the existing gas infrastructure can already connect the production or import facilities to the consumption areas, and thus to the storages to cope efficiently and securely with the energy demand seasonality. ETR projects also include conversion projects when the integration of clean hydrogen requires an adaptation of the existing infrastructure.

WHAT'S NEXT?

ENTSOG is adapting its project-specific assessment methodology to include ETR projects and deliver standard assessment for those projects in case they would be eligible for further PCI selection processes.

In the meantime, for the 5th PCI process, ENTSOG has implemented the recommendations of the European Commission to compute the CO_2 savings to be allocated to transmission, underground storage and LNG projects when they support the displacement of more carbon intensive fuels.

4 SECURITY OF SUPPLY NEEDS

Security of supply needs are assessed by measuring the ability of the European gas system to ensure the continuity of gas supply to all countries under various stress conditions.

This section assesses the resilience of the European gas system to cope with various stressful events:

- Climatic stress
- Supply route disruptions
- Infrastructure disruptions

The resilience of the gas system is measured by calculating the Remaining Flexibility (RF indicator) of the system when coping with the various stressful events and, be it the case, the level of demand curtailment (CR indicator: Curtailment rate) to which the EU is exposed. Those indicators are calculated at country/balancing zone level over the whole-time horizon of the TYNDP assessment.

Remaining flexibility measures the resilience of a Zone as the additional share of demand each country can cover before no longer being able to fulfil its demand without creating new demand curtailment in other Zones. The remaining flexibility is expressed as a percentage in the range 0 to 15 % and >15 %.

Demand curtailment is the value of the unsatisfied demand. The curtailment rate is the ratio between demand curtailment and demand. The curtailment rate is expressed as a percentage in the range 5 to 15 %, 15 to 30 %, 30 to 50 % and >50 %. Additionally, curtailment rate in the range 0 to 5 % is interpreted as 0 % remaining flexibility as a result of model allocation.

DEMAND ELASTICITY

When assessing the impact of a climatic stress on the gas infrastructure, the demand is considered static and is not responding to the possibility of gas supply deficit or gas price signals. This assumption is necessary to perform a consistent assessment across the different years and the different scenarios of the TYNDP.

Indeed, as observed in past events, a high demand event, especially if combined with a tight supply or infrastructure situation may trigger a demand reaction to the increase of prices, hence resulting in a reduction of the demand. However, such demand elasticity is subject to various assumptions that differs from one country to the other, and that ENTSOG cannot access.

Additionally, in order to be consistent and transparent, the level of exposure to demand curtailment is always presented in percentage of the demand assuming no demand reaction to the different stressful events.

INFRASTRUCTURE LEVELS

The assessment shows how the EU gas system evolves from an Existing infrastructure level to a Low, Advanced and PCI infrastructure level:

- The Existing infrastructure level is the basis for identification of priority areas facing an investment gap. It includes existing infrastructure as of 1st January 2019 and all projects submitted to TYNDP 2020 having made their Final Investment Decision (FID) and expected to be commissioned not later than 31st December 2019.
- The Low infrastructure level consists of the Existing infrastructure level complemented with all projects having taken the FID during the TYNDP 2020 project collection. Sixty-three FID projects have been submitted for this TYNDP edition.
- The Advanced infrastructure level is assessed to determine the further impact of the projects having an advanced status. The Advanced status is applied to all projects that, based on the information submitted, have commissioning year expected at the latest by 31st December of the year of the TYNDP project data collection (i. e. 2019) + 6 years (i. e. 2025) and: whose permitting phase has started ahead of the TYNDP project data collection, or FEED has started, or the project has been selected for receiving CEF2016–2020 grants for FEED ahead of the TYNDP project data collection. Sixty-six projects with advanced status have been submitted for this TYNDP edition.
- The PCI infrastructure level shows the benefits of the 4th PCI list projects, independently from their advancement status. There are 62 relevant projects for this infrastructure level. Below the updated list of all projects included in the 4th PCI list.

For more details on the different infrastructure levels and the related projects, please refer to the TYNDP 2020 Infrastructure Report.

Picture courtesy of FGSZ

Code	Project name	Promoter	Commis-sioning year
LNG-A-30	Shannon LNG Terminal and Connecting Pipeline	Shannon LNG Ltd	2022
TRA-A-31	Melita TransGas Pipeline	Melita TransGas Co. Ltd.	2024
TRA-A-429	Adaptation L- gas – H-gas	GRTgaz and Storengy	2025
TRA-F-500	L/H Conversion Belgium	Fluxys Belgium	2026
TRA-F-275	Poland – Slovakia Gas Interconnection (PL section)	GAZ-SYSTEM S.A.	2021
TRA-F-190	Poland – Slovakia interconnection	Eustream,a.s. (a joint-stock company)	2021
TRA-N-245	North – South Gas Corridor in Eastern Poland	GAZ-SYSTEM S.A.	2029
TRA-N-636	Development of Transmission Capacity at Slovak-Hungarian interconnector	Magyar Gáz Tranzit Zrt.	2022
TRA-N-524	Enhancement of Transmission Capacity of Slovak-Hungarian interconnector	Magyar Gáz Tranzit Zrt.	2022
TRA-N-1235	Firm transmission capacity increase at the IP Veľké Zlievce	Eustream,a.s.	2022
LNG-F-82	LNG terminal Krk (first phase)	LNG Hrvatska d.o.o.	2020
TRA-F-90	LNG evacuation pipeline Omišalj - Zlobin (Croatia)	Plinacro Ltd	2020
TRA-F-334	Compressor station 1 at the Croatian gas transmission system	Plinacro Ltd	2019
TRA-F-378	Interconnector Greece-Bulgaria (IGB Project)	ICGB a.d.	2020
TRA-N-128	Compressor Station Kipi	DESFA S.A.	2024
TRA-F-298	Balkan Gas Hub – Modernization and rehabilitation of the Bulgarian GTS	Bulgartransgaz EAD	2022
TRA-N-137	Balkan Gas Hub – Interconnection Bulgaria – Serbia	Bulgartransgaz EAD	2022
LNG-A-62	LNG terminal in northern Greece/Alexandroupolis – LNG Section	Gastrade S.A.	2022
TRA-A-63	LNG terminal in northern Greece/Alexandroupolis – Pipeline Section	Gastrade S.A.	2022
TRA-N-137	Balkan Gas Hub – Interconnection Bulgaria – Serbia	DESFA S.A.	2022
UGS-A-138	Balkan Gas Hub – UGS Chiren Expansion	Bulgartransgaz EAD	2025
UGS-N-385	South Kavala Underground Gas Storage facility	Hellenic Republic Asset Development Fund	2023
UGS-A-233	Depomures	Engie Romania SA	2021
UGS-N-371	Sarmasel undeground gas storage in Romania	SNGN ROMGAZ SA – Filiala de Înmagazinare Gaze Naturale DEPOGAZ Ploiești SRL	2024
TRA-N-325	Slovenian-Hungarian interconnector	FGSZ Ltd.	2023
TRA-N-112	R15/1 Pince – Lendava - Kidričevo	Plinovodi d.o.o.	2023
TRA-N-92	CS Ajdovščina, 1st phase of upgrade	Plinovodi d.o.o.	2025
TRA-N-299	M3/1 Šempeter – Vodice	Plinovodi d.o.o.	2026
TRA-N-1227	Gorizia plant upgrade	Snam Rete Gas S.p.A.	2026
TRA-F-358	Development on the Romanian territory of the NTS (BG-RO-HU-AT)-Phase I	SNTGN Transgaz S.A.	2020
TRA-A-123	Városföld CS	FGSZ Ltd.	2022
TRA-A-1322	Development on the Romanian territory of the NTS (BG-RO-HU-AT)-Phase II	SNTGN Transgaz SA	2022
TRA-A-362	Development on the Romanian territory of the Southern Transmission Corridor	SNTGN Transgaz SA	2021
TRA-A-377	Romanian-Hungarian reverse flow Hungarian section 2nd stage	FGSZ Ltd.	2022
TRA-A-86	Interconnection Croatia/Slovenia (Lučko – Zabok – Jezerišće – Sotla)	Plinacro Ltd	2021
TRA-N-94	CS Kidričevo, 2nd phase of upgrade	Plinovodi d.o.o.	2023

Code	Project name	Promoter	Commis-sioning year
TRA-N-1057	Compressor stations 2 and 3 at the Croatian gas tranmission system	Plinacro Ltd	2029
TRA-N-361	GCA 2015/08: Entry/Exit Murfeld	GAS CONNECT AUSTRIA GmbH	2023
TRA-N-389	Upgrade of Murfeld/Ceršak interconnection (M1/3 Interconnection Ceršak)	Plinovodi d.o.o.	2023
TRA-N-390	Upgrade of Rogatec interconnection (M1A/1 Interconnection Rogatec)	Plinovodi d.o.o.	2021
LNG-N-947	FSRU Polish Baltic Sea Coast	GAZ-SYSTEM S.A.	2025
TRA-A-339	Trans-Caspian	W-Stream Caspian Pipeline Company OU	2022
TRA-N-1138	South Caucasus Pipeline Future Expansion (SCPFX)	SOCAR Midstream Operations LLC	2024
TRA-F-51	Trans Adriatic Pipeline	Trans Adriatic Pipeline AG	2020
TRA-F-941	Metering and Regulating station at Nea Messimvria	DESFA S.A.	2020
TRA-N-971	Compressor station at Nea Messimvria	DESFA S.A.	2023
TRA-F-1193	TAP interconnection	Snam Rete Gas S.p.A.	2020
TRA-A-330	EastMed Pipeline	Natural Gas Submarine Interconnector Greece-Italy Poseidon S.A	2025
TRA-N-1091	Metering and Regulating station at Megalopoli	DESFA S.A.	2025
TRA-A-10	Poseidon Pipeline	Natural Gas Submarine Interconnector Greece-Italy Poseidon S.A	2022
TRA-N-7	Development for new import from the South (Adriatica Line)	Snam Rete Gas S.p.A.	2026
TRA-N-1195	Matagiola – Massafra pipeline	Snam Rete Gas S.p.A.	2026
LNG-A-1146	Cyprus Gas2EU	Ministry of Energy, Commerce and Industry (MECI)	2022
TRA-A-342	Enhancement of Latvia-Lithuania interconnection (Lithuania's part)	AB Amber Grid	2023
TRA-A-382	Enhancement of Latvia-Lithuania interconnection (Latvian part)	JSC "Conexus Baltic Grid"	2023
UGS-F-374	Enhancement of Incukalns UGS	JSC "Conexus Baltic Grid"	2019
TRA-F-780	Baltic Pipe project – onshore section in Denmark	Energinet	2022
TRA-A-271	Poland – Denmark interconnection (Baltic Pipe) – offshore section	GAZ-SYSTEM S.A.	2022
TRA-A-1173	Poland – Denmark interconnection (Baltic Pipe) – onshore section in Poland	GAZ-SYSTEM S.A.	2022
TRA-F-212	Gas Interconnection Poland-Lithuania (GIPL) – PL section	GAZ-SYSTEM S.A.	2021
TRA-F-341	Gas Interconnection Poland-Lithuania (GIPL) (Lithuania's section)	AB Amber Grid	2021

Table 4.1 Updated list of all projects included in the 4th PCI list.

4.1 CLIMATIC STRESS

Climatic stress conditions result in high gas demand situations and are therefore challenging for the gas system. The ability of the system may be challenged to cope with:

- a **peak day** demand that can occur once every 20 years also considered as the design case for most of the gas infrastructures,
- a **2-week cold spell** demand that can occur every 20 years when the average demand is relatively lower compared to a peak day but having a longer duration and being still higher than the demand in average climatic conditions,
- a **2-week Dunkelflaute** considers the possible impact of a long period with minimum amount of wind and solar energy and therefore additional gas demand for power generation when minimum variable renewable generation is available for two weeks.


Picture courtesy of DESFA

4.1.1 PEAK DAY

EXISTING INFRASTRUCTURE LEVEL

The existing gas infrastructure shows a high level of resilience to peak day situations and most of European countries show some remaining flexibility in all years and scenarios. However, in some specific scenarios and years, the Balkan region, Poland, Sweden, and Northern Ireland show some exposure to demand curtailment because of infrastructure limitations. **Figure 4.8** shows the evolution of the Existing infrastructure level described below:

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios results show infrastructure limitations towards **Northern Ireland**, being exposed to a 15 % risk of demand curtailment driven by an increase of its power generation demand.

Additionally, results show infrastructure limitation between Serbia-Bosnia and Herzegovina and their neighbouring countries exposing them to a risk of demand curtailment. In **Serbia**, the increasing exposure is driven by an increase of its gas demand, combined with a decreasing trend of its indigenous production along the years and infrastructure limitation, reducing its cooperation with **Bosnia and Herzegovina** which is exposed as well to a similar risk of demand curtailment (ca. 15 %). **See Figures 4.1 and 4.2.**

2030–2040

NATIONAL TRENDS

Northern Ireland fully mitigates its risk of demand curtailment from 2025 to 2030–2040 thanks to a reduction of its demand.

Some infrastructure limitations between **Poland** and its neighbouring countries expose Poland to a risk of demand curtailment in 2040 due to an increase of its demand (mainly driven by displacing coal and oil in heating and power generation sector). **See Figure 4.3.**

Infrastructure limitations also increase the risk of demand curtailment in **Serbia** from 17 % (in 2025) to 34–36 % (in 2030/2040) driven by an increase of its demand combined with a further decreasing trend of its indigenous production along the years. The same limitations expose **Bosnia and Herzegovina** to an increasing risk of demand curtailment from 18 % (in 2025) to 36–41 % (in 2030/2040) driven by an increase of its demand combined with limited cooperation with Serbia to limit the overall impact.

North Macedonia is exposed to an increasing risk of demand curtailment from 2030 to 2040 due to infrastructure limitations with Bulgaria and a demand increase from 2025 to 2030–2040, together with no national production and infrastructure limitations restricting its cooperation with neighbouring countries. **See Figure 4.4.**

Moreover, together with Poland and Finland, Northern Ireland faces remaining flexibility lower than 15 % in 2030.

Simulation Arcs Flexibility > 0.20 – 1.00 > 0.00 – 0.20 0.00

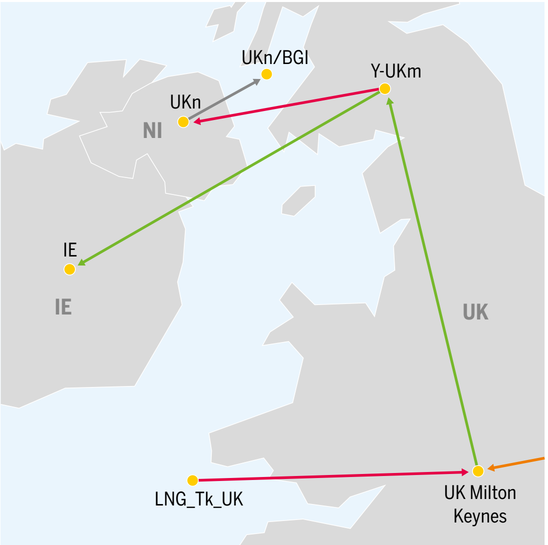


Figure 4.1 Infrastructure limitations towards Northern Ireland, Existing infrastructure, 2025.

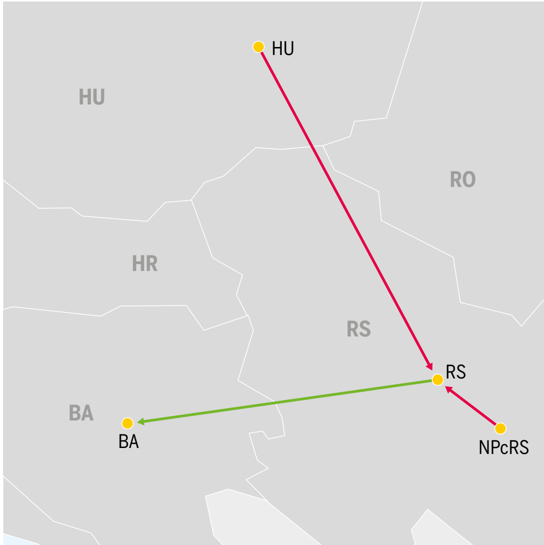


Figure 4.2 Infrastructure limitations towards Serbia and Bosnia and Herzegovina, Existing infrastructure, 2025.

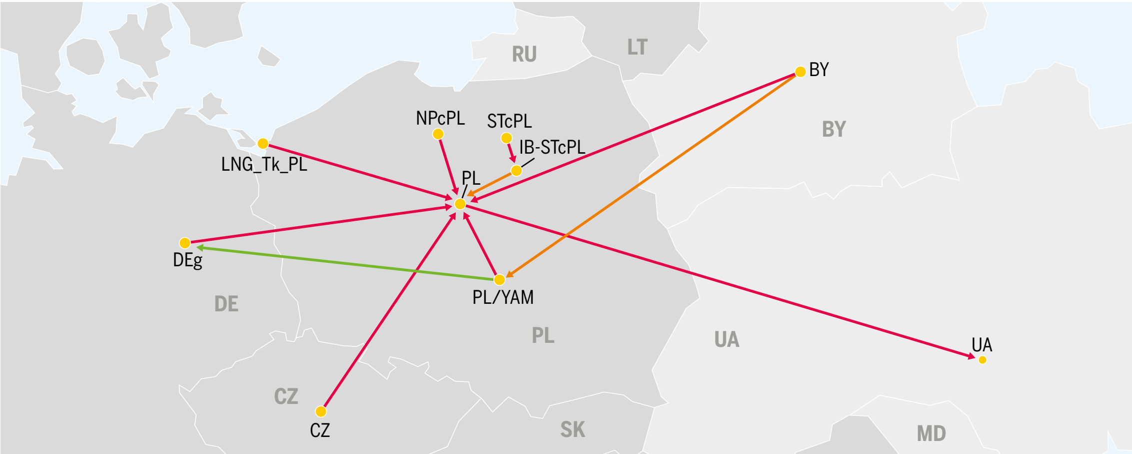


Figure 4.3 Infrastructure limitations towards Poland, Existing infrastructure, National Trends, 2040.

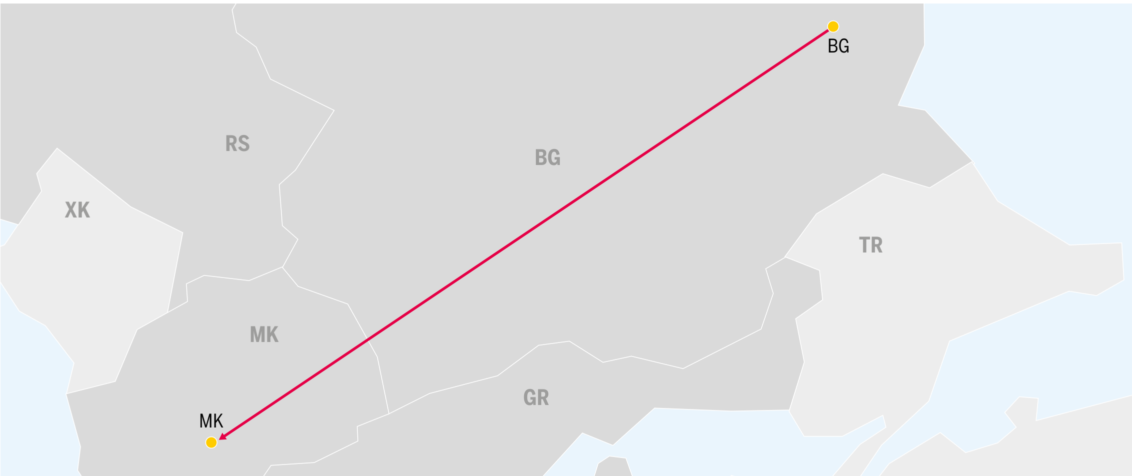


Figure 4.4 Infrastructure limitations towards North Macedonia, Existing infrastructure, National Trends, 2040.

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Global Ambition

Northern Ireland is exposed to a higher risk of demand curtailment in both scenarios in 2030 and 2040 (ca. 20 %), compared to 2025 scenarios, driven by infrastructure limitations with Great Britain and a higher demand compared with 2025 (except for Distributed Energy 2030, ca. 5 %).

Poland faces the same infrastructure limitations as in National Trends and shows an increasing or rather stable risk of demand curtailment driven by an increasing gas demand in both scenarios and years (mainly driven by displacing higher carbon fuels in the heating, power generation and transport sector[11]) combined with an increasing national production from 2030 to 2040 and further penetration of renewables (biomethane and power to gas). **See Figure 4.5.**

Greece faces infrastructure limitations (LNG and imports from Turkey and Bulgaria are 100 % used) and is exposed to a risk of demand curtailment in 2030 Global Ambition, scenario with the highest Greek demand. However, the exposure to a risk of demand curtailment is just mitigated in 2040 thanks to a decrease of the demand combined with an increase of its national production coming from renewables. **See Figure 4.6.**

Moreover, **Sweden** shows a high risk of demand curtailment in Global Ambition 2030 due to limited interconnection capacity with Denmark, which is just mitigated in 2040 thanks to a penetration of renewables increasing its national production and a stable demand. **See Figure 4.7.**

Serbia, **Bosnia and Herzegovina** and **North Macedonia** are facing the same infrastructure limitations as in National Trends scenario.

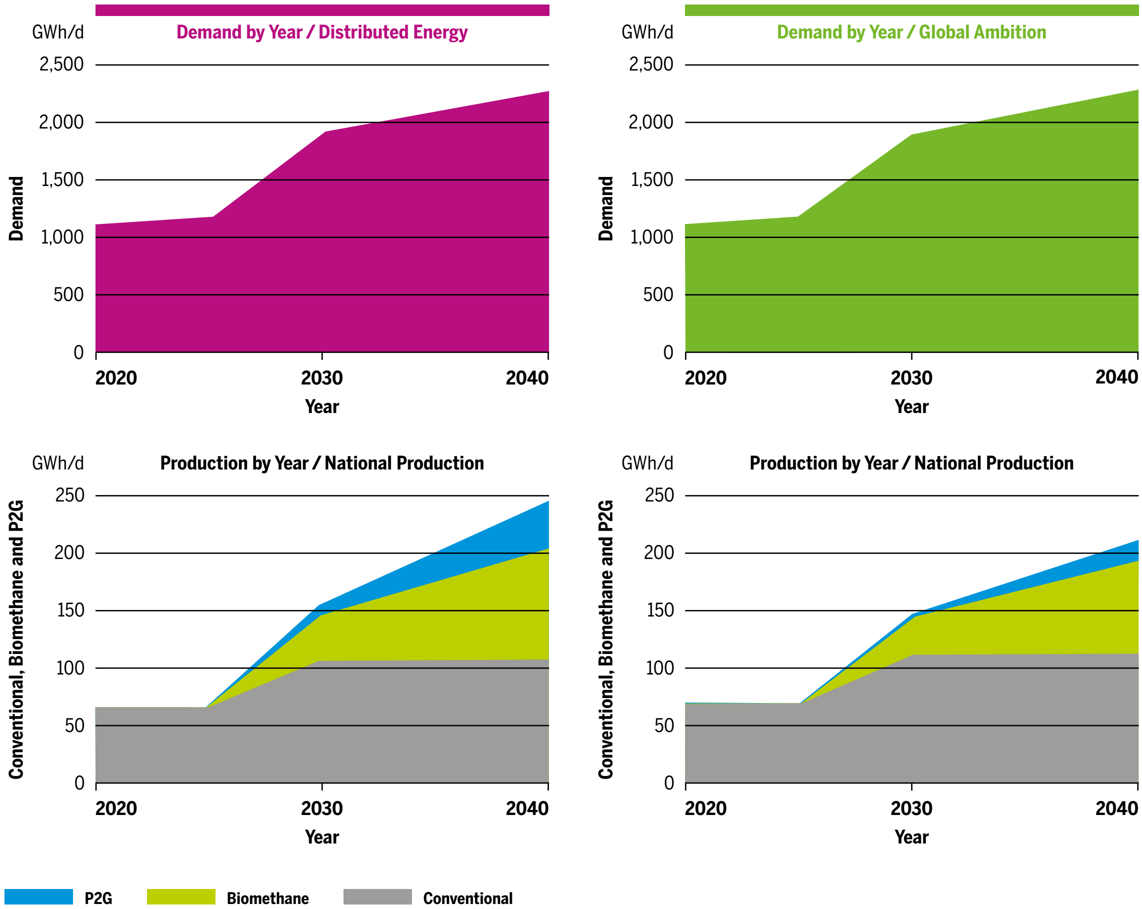

Figure 4.5 Peak demand and production in Poland in COP 21 scenarios in GWh/d.

11 Distributed Energy and Global Ambition scenarios are based on higher ambition level to reach the decarbonisation target, in this regard, it has been taken into account the trend of displacing higher carbon fuels in the power generation sector and transportation sector.

Simulation Arcs Flexibility — > 0.20 – 1.00 — > 0.00 – 0.20 — 0.00

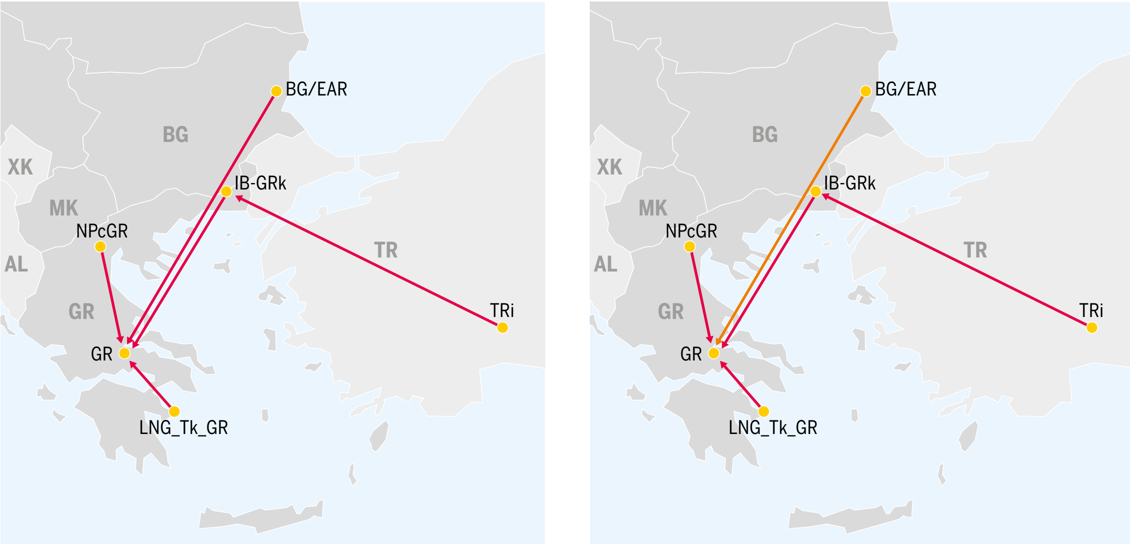

Figure 4.6 Infrastructure limitations towards Greece, Existing infrastructure, Global Ambition, 2030 & 2040.

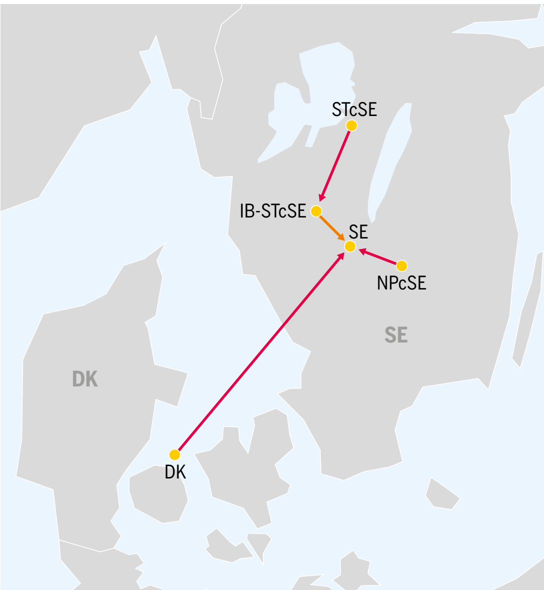

Figure 4.7 Infrastructure limitations towards Sweden, Existing infrastructure, Global Ambition, 2030.

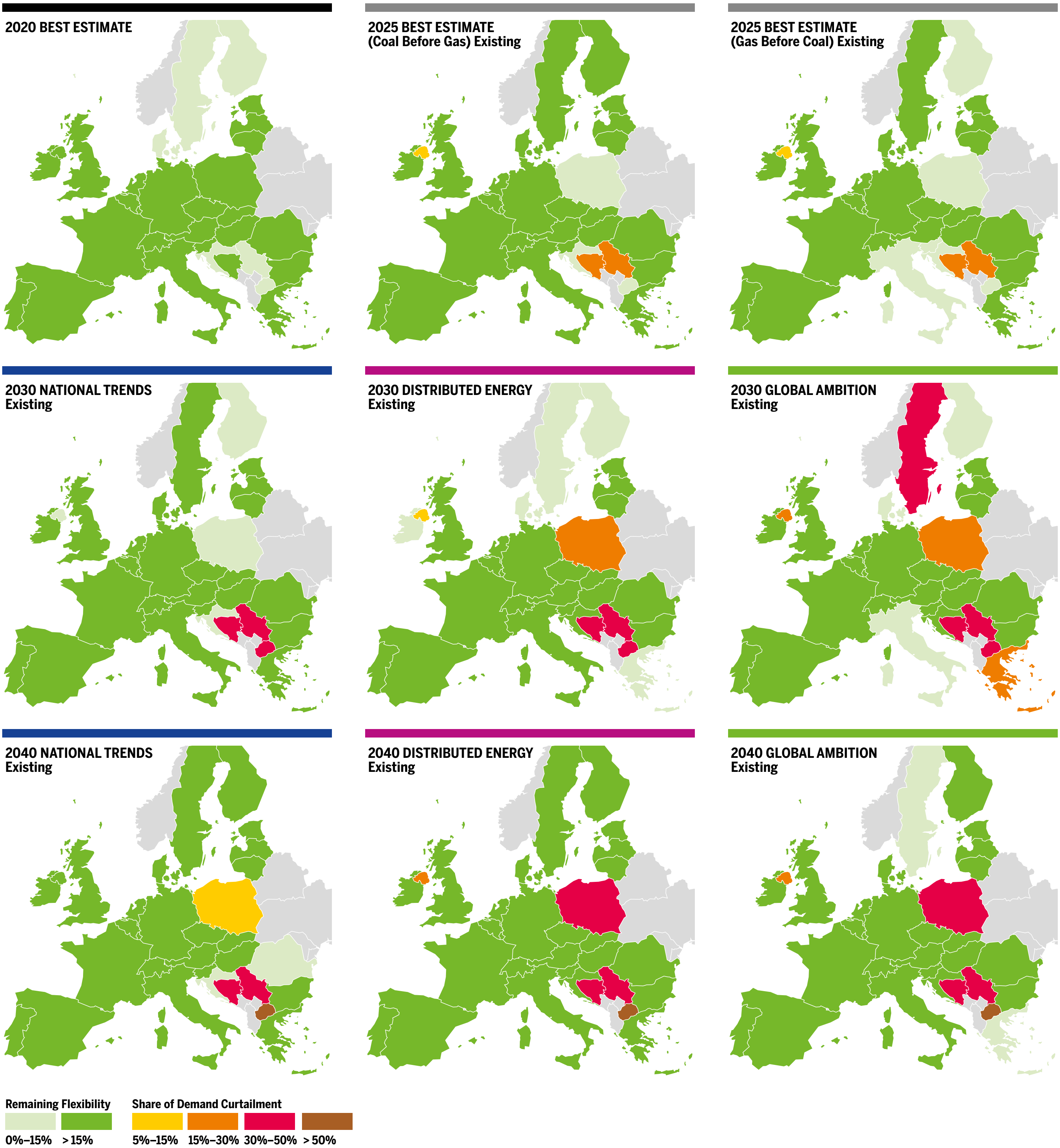

Figure 4.8 Existing infrastructure level: Climatic Stress under a peak day situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that FID projects mitigate, fully or at least partially, most of the infrastructure gaps observed with the existing infrastructure. **Figure 4.12** shows the Low Infrastructure level results described below:

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal, the commissioning of the FID projects fully mitigates the risk of demand curtailment in **Serbia**. Moreover, it increases the cooperation between Serbia and Bosnia and Herzegovina, fully mitigating the risk of demand curtailment in **Bosnia and Herzegovina** as well.

Nevertheless, **Northern Ireland** is still exposed to a 15 % risk of demand curtailment driven by an increase of its power generation demand.

2030–2040

NATIONAL TRENDS

FID projects fully mitigate the risk of demand curtailment in **Poland** in 2040.

Moreover, **Serbia** no longer faces risk of demand curtailment thanks to the commissioning of FID projects that enable the cooperation between neighbouring countries. Nevertheless, **Bosnia and Herzegovina** still faces risk of demand curtailment due to infrastructure limitation and an increase of demand from 2030 to 2040, being the capacity fully used between Serbia and Bosnia and Herzegovina. **See Figure 4.9.**

In **North Macedonia**, FID projects do not mitigate the risk of demand curtailment.

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In **Poland**, FID projects improve the situation:

- In 2030: from 25 % demand curtailment in Poland (existing infrastructure) to ca. 6 % in the Low infrastructure level.
- In 2040: from 35 % (Existing) to 20 % (Low).

However, some infrastructure limitations remain preventing Poland to fully mitigate their exposure to demand curtailment.

In **Greece**, FID projects fully mitigate the risk of demand curtailment in Global Ambition and increase its remaining flexibility in Distributed Energy.

FID projects do not improve the situation in **Northern Ireland** and **North Macedonia**.

Furthermore, in **Denmark** and **Sweden**, the situation deteriorates following the partial decommissioning of a compressor station reducing the capacity between Germany and Denmark. Therefore, in 2030 Denmark and Sweden are exposed to 32 % demand curtailment in Global Ambition.

Despite the development of renewable gases, the additional production in Denmark and Sweden cannot fully compensate for the reduction in capacity at the German – Danish border, even in Distributed Energy scenario. **See Figures 4.10 and 4.11.**

Serbia, **Bosnia and Herzegovina** and **North Macedonia** are facing the same infrastructure limitations as in National Trends scenario.

Figure 4.9 Infrastructure limitations towards Bosnia and Herzegovina, Low infrastructure, National Trends, 2030 & 2040.

Figure 4.11 Infrastructure limitations between Germany and Denmark in Low infrastructure level, Distributed Energy, 2030.

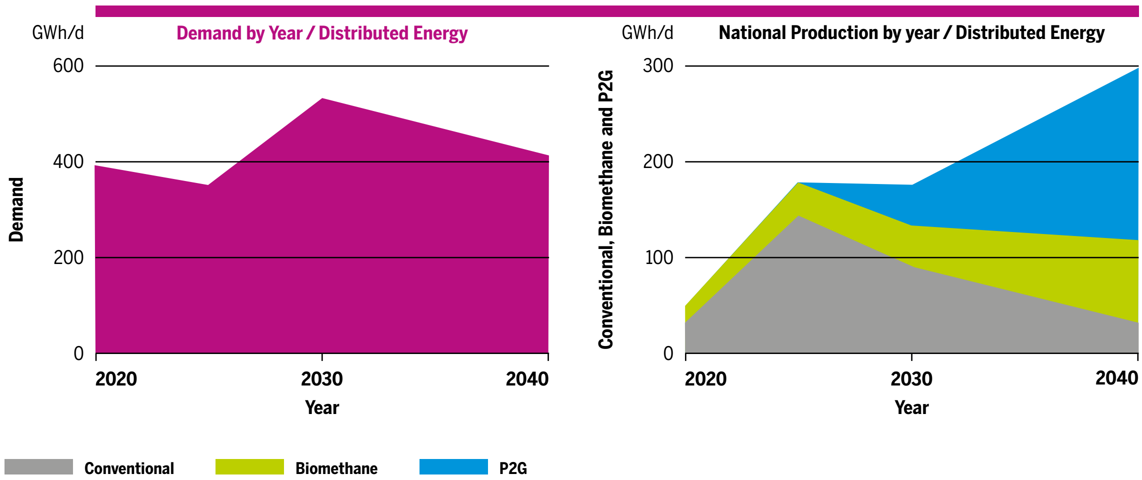

Figure 4.10 Peak demand and production in Denmark and Sweden, Distributed Energy scenario.

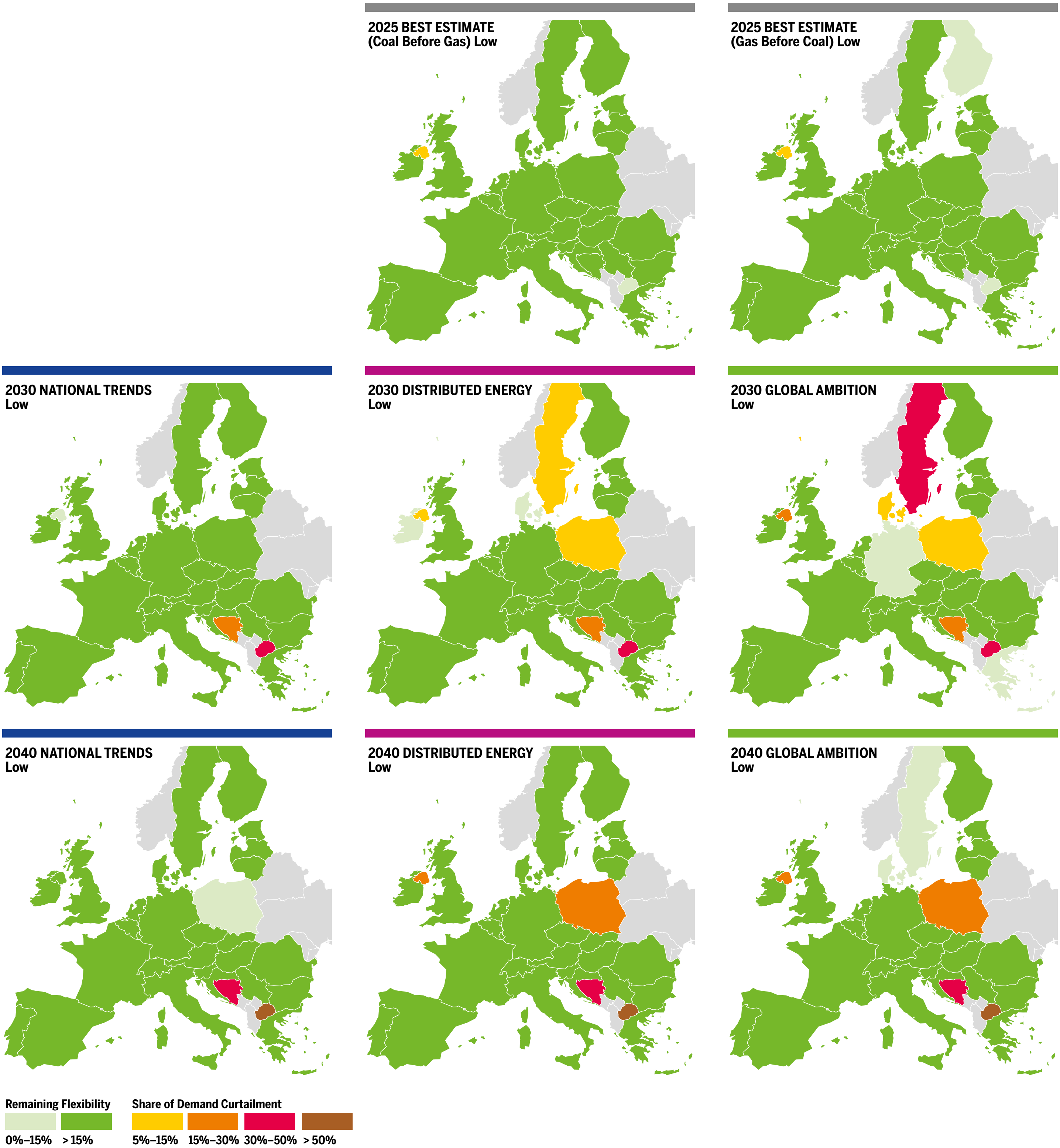

Figure 4.12 Low infrastructure level: Climatic Stress under a peak day situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that advanced-status projects provide an infrastructure reinforcement required to cope with high demand situations. **Figure 4.13** shows the Advanced infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios results show that advanced-status projects fully mitigate the risk of demand curtailment in **Northern Ireland**. Additionally, there is a significant improvement of the remaining flexibility all over Europe.

Picture courtesy of Energinet

2030–2040

NATIONAL TRENDS

Advanced Projects fully alleviates all infrastructure bottlenecks within the EU.

However, **Bosnia and Herzegovina** still faces a risk of demand curtailment, no advanced projects improve the infrastructure limitation with Serbia.

North Macedonia fully mitigates its risk of demand curtailment thanks to the commissioning of Greece/North Macedonia interconnection in the Advanced infrastructure level that allows the two countries to cooperate.

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Advanced projects significantly improve the situation as of 2030.

Distributed Energy

All EU countries are resilient to peak day situations. However, **Bosnia and Herzegovina** is still exposed to demand curtailment due to infrastructure limitations with Serbia.

Global Ambition

Most of Europe is resilient to peak day situations. Advanced projects alleviate the infrastructure limitations for **Northern Ireland**, **Poland** and **Denmark** to be no longer exposed to demand curtailment.

North Macedonia fully mitigates its risk of demand curtailment thanks to the commissioning of the advanced-status project North Macedonia/Greece interconnection allowing an efficient cooperation between Greece and North Macedonia. However, infrastructure limitations with Denmark expose **Sweden** to demand curtailment (32 %) in 2030, but not in 2040.

Regarding **Denmark**, it fully mitigates its risk of demand curtailment in Global Ambition 2030 thanks to the advanced-status project that connects the Norwegian gas system in the North Sea with the Danish onshore transmission system which increases the Danish indigenous production.

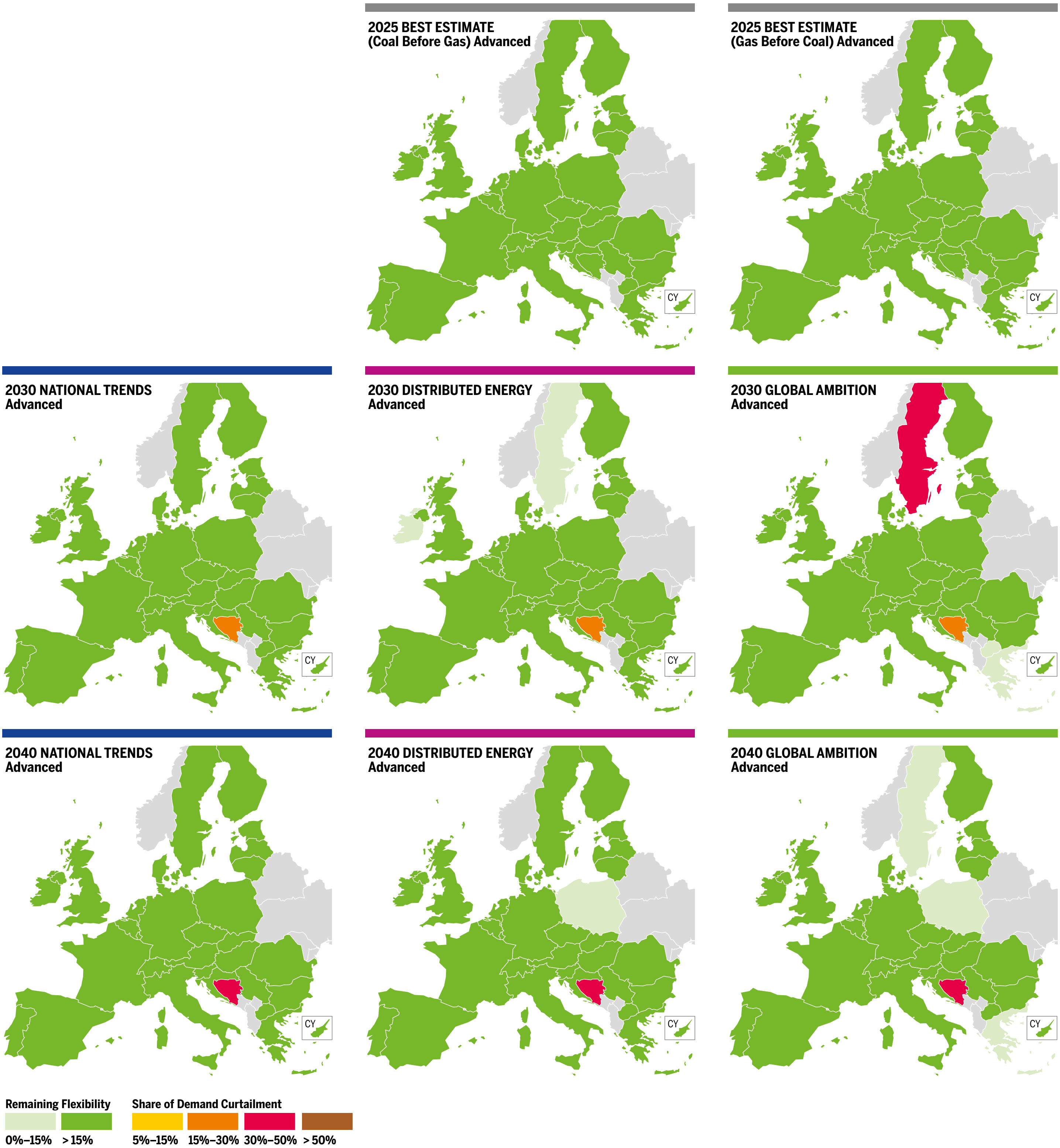

Figure 4.13 Advanced infrastructure level: Climatic Stress under a peak day situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level includes the FID projects and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list during peak demand situation. **Figure 4.14** shows the evolution of the resilience of the PCI infrastructure level to peak demand situations.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios results show that projects included in the 4th PCI list do not help **Northern Ireland** to mitigate the risk of demand curtailment, showing the same risk of demand curtailment (15 %) as for Low infrastructure level.

2030–2040

NATIONAL TRENDS

In terms of mitigating the exposure to demand curtailment, PCI infrastructure projects do not bring additional benefits compared to the FID projects. However, some countries show an improvement in terms of remaining flexibility.

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Distributed Energy

Projects included in the 4th PCI list do not help **Northern Ireland** to mitigate the risk of demand curtailment, showing the same risk of demand curtailment as for Low infrastructure level. (yellow in the map in 2030 and orange in the map 2040)

PCI infrastructure projects alleviates infrastructure bottlenecks for **Poland**, **Sweden** and **Denmark** to be resilient to peak demand situations. However, the PCI projects do not bring additional benefits to **Northern Ireland**, **Bosnia and Herzegovina** and **North Macedonia** compared to FID projects.

Global Ambition

Most of Europe is resilient to peak day situations. Advanced projects alleviate the infrastructure limitations for **Denmark**, **Poland** and **Greece** to be no longer exposed to demand curtailment as of 2030.

PCI projects do not improve the resilience of **Northern Ireland**, **Sweden**, **Bosnia and Herzegovina** and **North Macedonia** compared to the FID projects in 2030. However, PCI projects mitigate the exposure of **Poland** to demand curtailment in 2030 by connecting Denmark, Sweden and Poland allowing those countries to cooperate efficiently and reduce the exposure in 2040 from 20 % in Poland in Low infrastructure level to 8 % in **Poland**, **Sweden** and 6 % in **Denmark** in PCI infrastructure level.

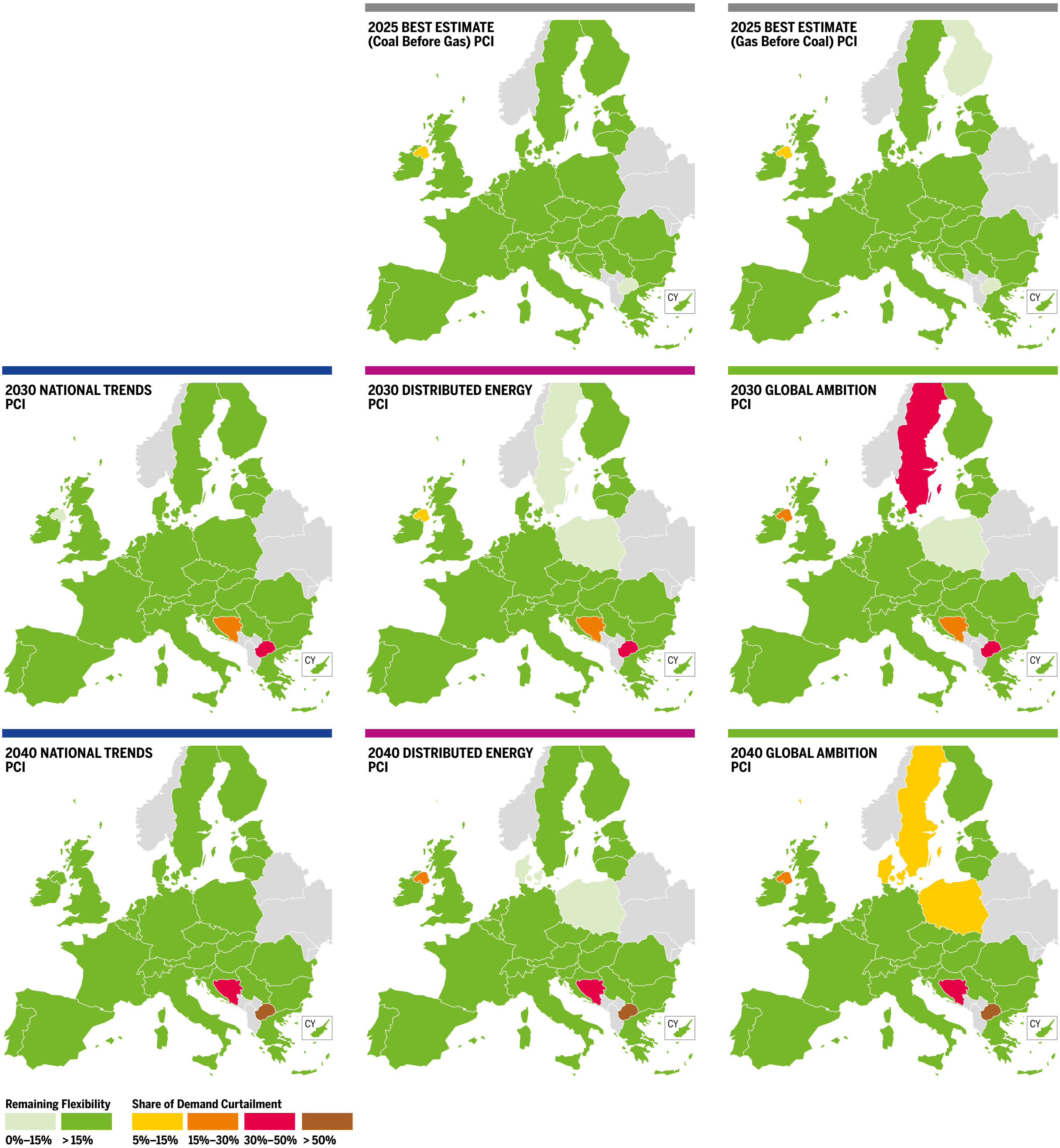

Figure 4.14 PCI infrastructure level: Climatic Stress under a peak day situation.

4.1.2 2-WEEK COLD SPELL

Existing infrastructure level

The existing gas infrastructure shows a high level of resilience to 2-week cold spell situations and most of European countries show some remaining flexibility in all years and scenarios. However, in some specific scenarios and years, the Balkan region, Poland and Sweden face risk of demand curtailment because of infrastructure limitations. **Figure 4.20** shows the evolution of the Existing infrastructure level described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal, scenarios results show infrastructure limitation between Serbia-Bosnia and Herzegovina and their neighbouring countries exposing them to a slightly risk of demand curtailment. In **Serbia**, the risk of demand curtailment is driven by an increase of its gas demand, combined with a decreasing trend of its indigenous production along the years and infrastructure limitation, reducing its cooperation with **Bosnia and Herzegovina** which is exposed as well to a slightly risk of demand curtailment (ca. 8 %).

2030–2040

NATIONAL TRENDS

Scenario results show that infrastructure limitations increase the risk of demand curtailment in **Serbia** from 7 % (in 2025) to 18–14 % (in 2030/2040) driven by an increase of its gas demand from 2025 to 2030, follow by a decreased in 2040, combined with a decreasing trend of its indigenous production along the years. As a result, Serbia reduces its cooperation with **Bosnia and Herzegovina** which is exposed as well to an increasing risk of demand curtailment from 8 % (in 2025) to 18–13 % (in 2030/2040) driven by an increase of its demand combined with limited cooperation with Serbia.

North Macedonia shows infrastructure limitations, fully using its interconnection with Bulgaria, exposing the country to a risk of demand curtailment in 2030–2040. The situation further deteriorates in 2040 due to higher demand together with no indigenous production.

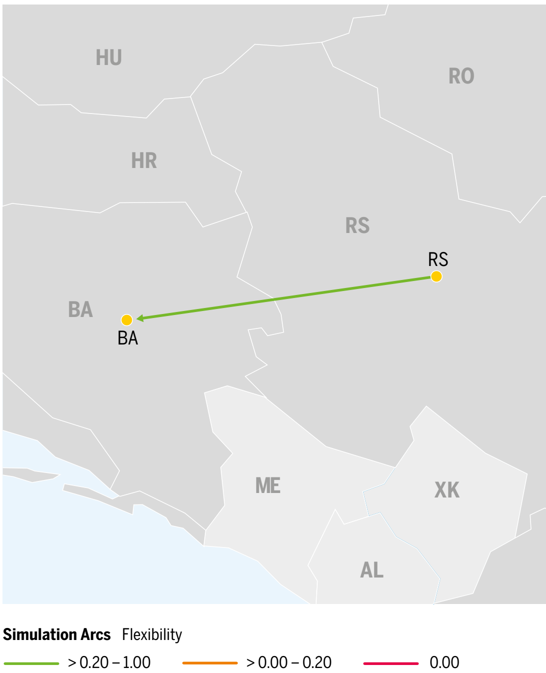

Figure 4.15 Infrastructure limitations towards Serbia and Bosnia and Herzegovina, Existing infrastructure, 2025.

Figure 4.16 Infrastructure limitations towards North Macedonia, Existing infrastructure, 2030.

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Some infrastructure limitations between Poland and its neighbouring countries expose **Poland** to a risk of demand curtailment as result. As for peak demand case, Poland shows an increasing or rather stable risk of demand curtailment due to an increasing gas demand in both scenarios and years (mainly driven by displacing higher carbon fuels in the heating, power generation and transport sector) combined with an increasing national production from 2030 to 2040 coming from renewables (biomethane and power to gas). **See Figures 4.17 and 4.18.**

Moreover, **Sweden** shows a slightly risk of demand curtailment in Global Ambition 2030 (ca. 11 %), due to limited interconnection capacity with Denmark, which is mitigated in 2040 thanks to an increase of its national production coming from renewables and a stable demand. **See Figure 4.19.**

Serbia, **Bosnia and Herzegovina** and **North Macedonia** are facing the same infrastructure limitations as in National Trends scenario. Nevertheless, differing from National Trends scenario, Serbia demand follows an increasing trend of its demand from 2025 to 2030 (remaining quite stable in 2040).

Figure 4.19 Infrastructure limitations towards Sweden, Existing infrastructure, Global Ambition 2030.

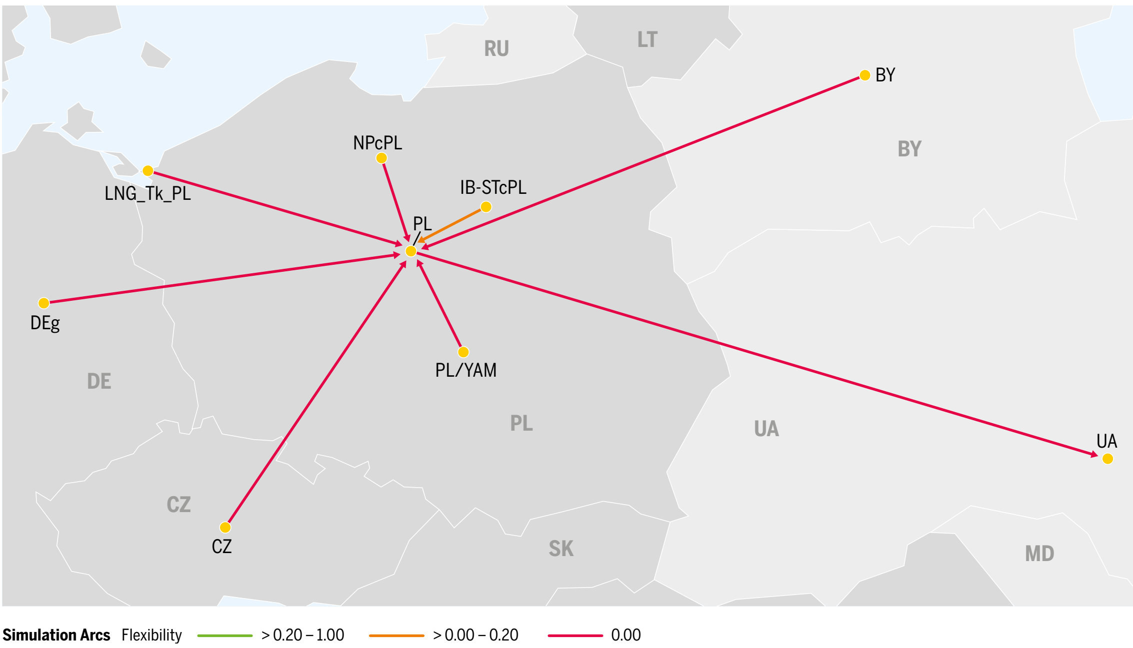

Figure 4.17 Infrastructure limitations towards Poland, Existing infrastructure, Global Ambition-Distributed Energy, 2030.

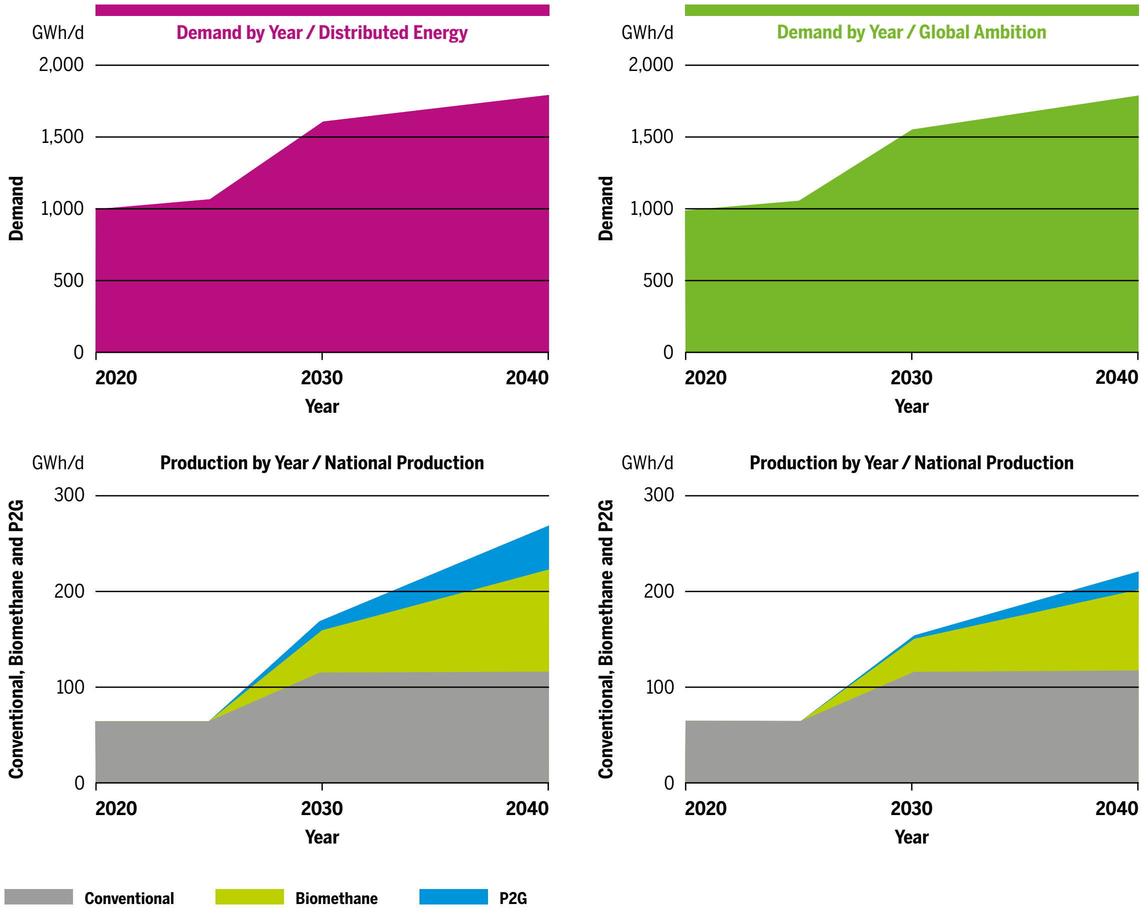

Figure 4.18 2-week cold spell demand and production in Poland in COP 21 scenarios in GWh/d.

Picture courtesy of TAP

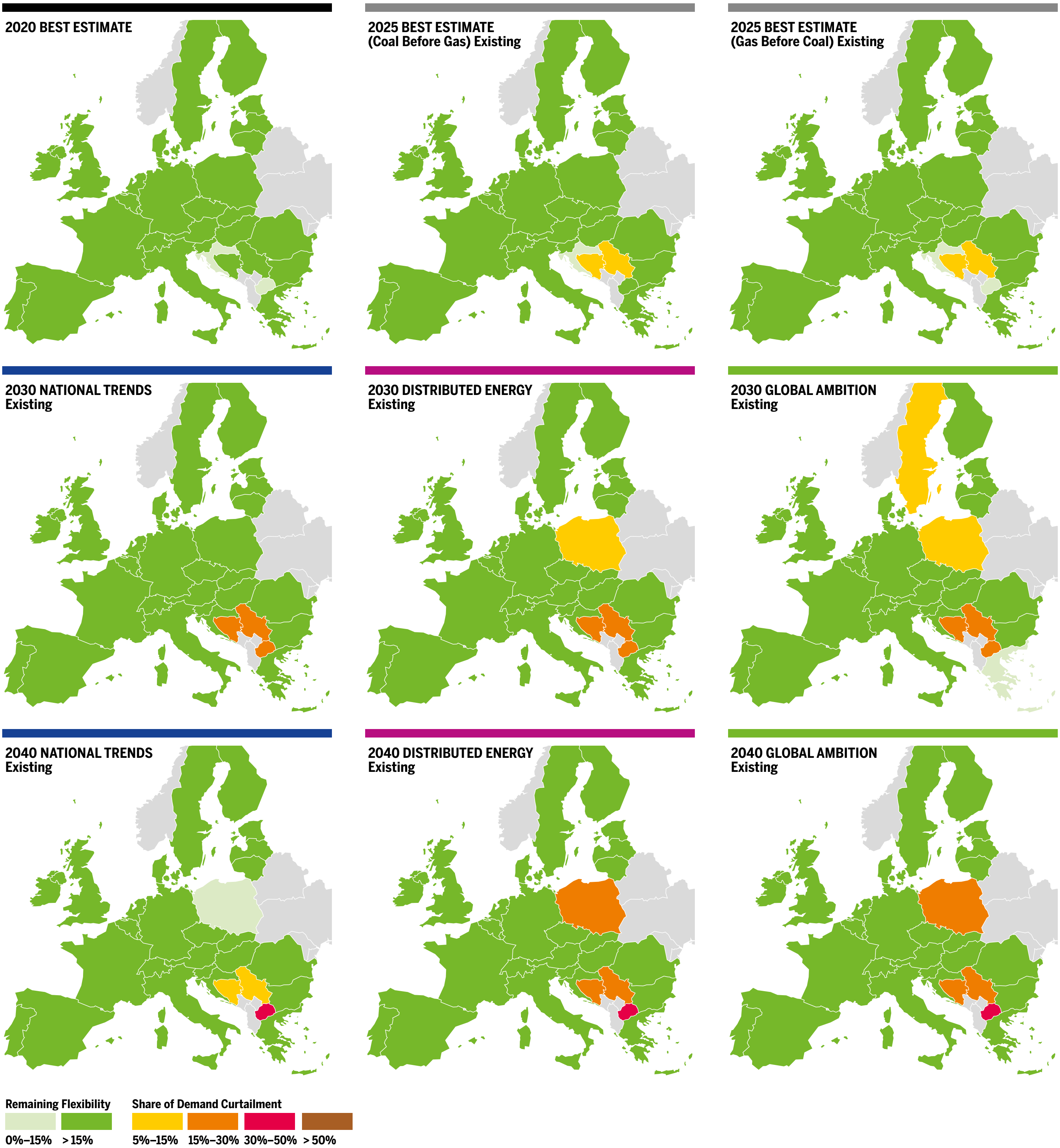

Figure 4.20 Existing infrastructure level: Climatic Stress under 2-week cold spell situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show further improvements in terms of infrastructure gaps with the implementation of FID projects allowing to mitigate, fully or at least partially, the infrastructure gaps observed with the Existing infrastructure level. Nevertheless, there are still some lack of infrastructure. **Figure 4.21** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a 2-week cold spell, with higher remaining flexibility all over Europe.

The commissioning of the FID projects help to fully mitigate the risk of demand curtailment in **Serbia**. Moreover, it increases the cooperation between Serbia and Bosnia and Herzegovina, fully mitigating the risk of demand curtailment in **Bosnia and Herzegovina** as well.

2030–2040

NATIONAL TRENDS

FID projects fully mitigate the risk of demand curtailment in **Serbia** and **Bosnia and Herzegovina** thanks to an efficient cooperation in the area.

Nevertheless, in **North Macedonia** FID projects do not mitigate the risk of demand curtailment, not improving the interconnection between North Macedonia and neighbouring countries with consequent limitations on possible flow from Bulgaria.

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FID projects fully mitigate the risk of demand curtailment in **Poland** allowing an efficient cooperation with its neighbouring countries.

Nevertheless, in **Sweden** FID projects do not mitigate, neither improve, the risk of demand curtailment in Global Ambition 2030.

As in National Trends scenario, **Serbia** and **Bosnia and Herzegovina** fully mitigate their risk of demand curtailment thanks to the commissioning of FID projects. However, **North Macedonia** faces the same infrastructure limitations.

Picture courtesy of TAP

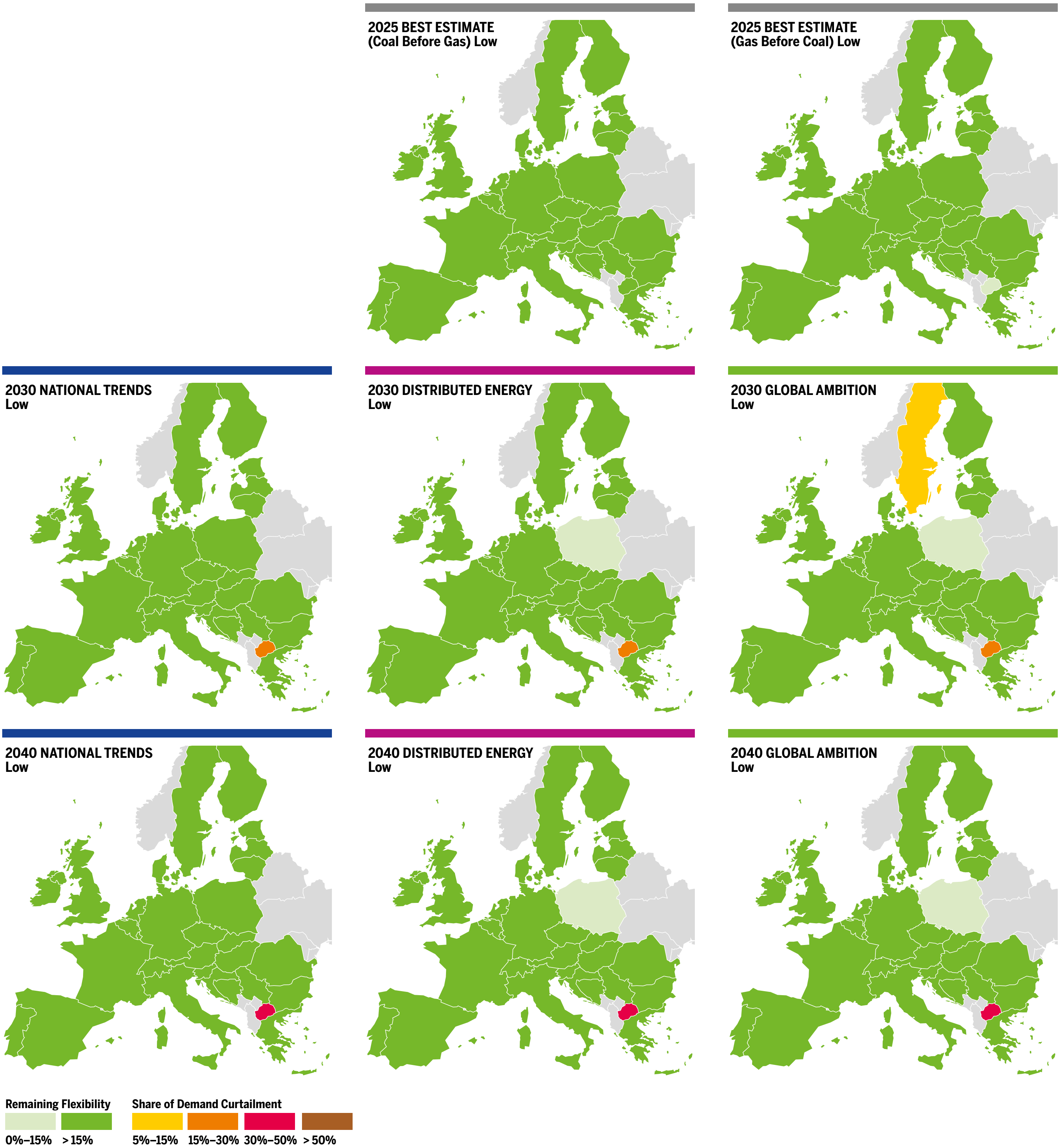

Figure 4.21 Low infrastructure level: Climatic Stress under 2-week cold spell situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that the European gas system is resilient to a 2-week cold spell thanks to the commissioning of advanced-status projects, which provide an infrastructure reinforcement required to cope with high demand situations. Results are shown in **Figure 4.22**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results show that advanced-status projects bring a significant improvement of the remaining flexibility all over Europe.

2030–2040

NATIONAL TRENDS

Advanced-status projects fully alleviate all infrastructure bottlenecks within the EU.

Scenario results show that **North Macedonia** fully mitigates its risk of demand curtailment thanks to the commissioning of the advanced-status project North Macedonia/Greece interconnection allowing an efficient cooperation between Greece and North Macedonia.

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Advanced-status projects significantly improve the situation as of 2030.

Nevertheless, in **Sweden** advanced-status projects do not mitigate, neither improve, the risk of demand curtailment in Global Ambition 2030.

Moreover, as for National Trends scenario, **North Macedonia** fully mitigates its risk of demand curtailment thanks to the commissioning of advanced-status projects.

PCI INFRASTRUCTURE LEVEL

Simulation results show the benefits stemming from the implementation of the latest 4th PCI list during 2-week cold spell demand situation. **Figure 4.23** shows the results of the assessment.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results show that the implementation of the latest 4th PCI projects provide an improvement of the remaining flexibility all over Europe.

2030–2040

NATIONAL TRENDS

Simulation results are in line with Low infrastructure level assessment for 2-week cold spell demand case.

North Macedonia faces the same infrastructure limitations as in Low infrastructure level. PCI projects do not mitigate, neither improve, the risk of demand curtailment in the country.

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Simulation results are in line with Low infrastructure level assessment for 2-week cold spell demand case, as for National Trends scenario.

In **Sweden** and **North Macedonia** PCI projects do not mitigate, neither improve, the risk of demand curtailment.

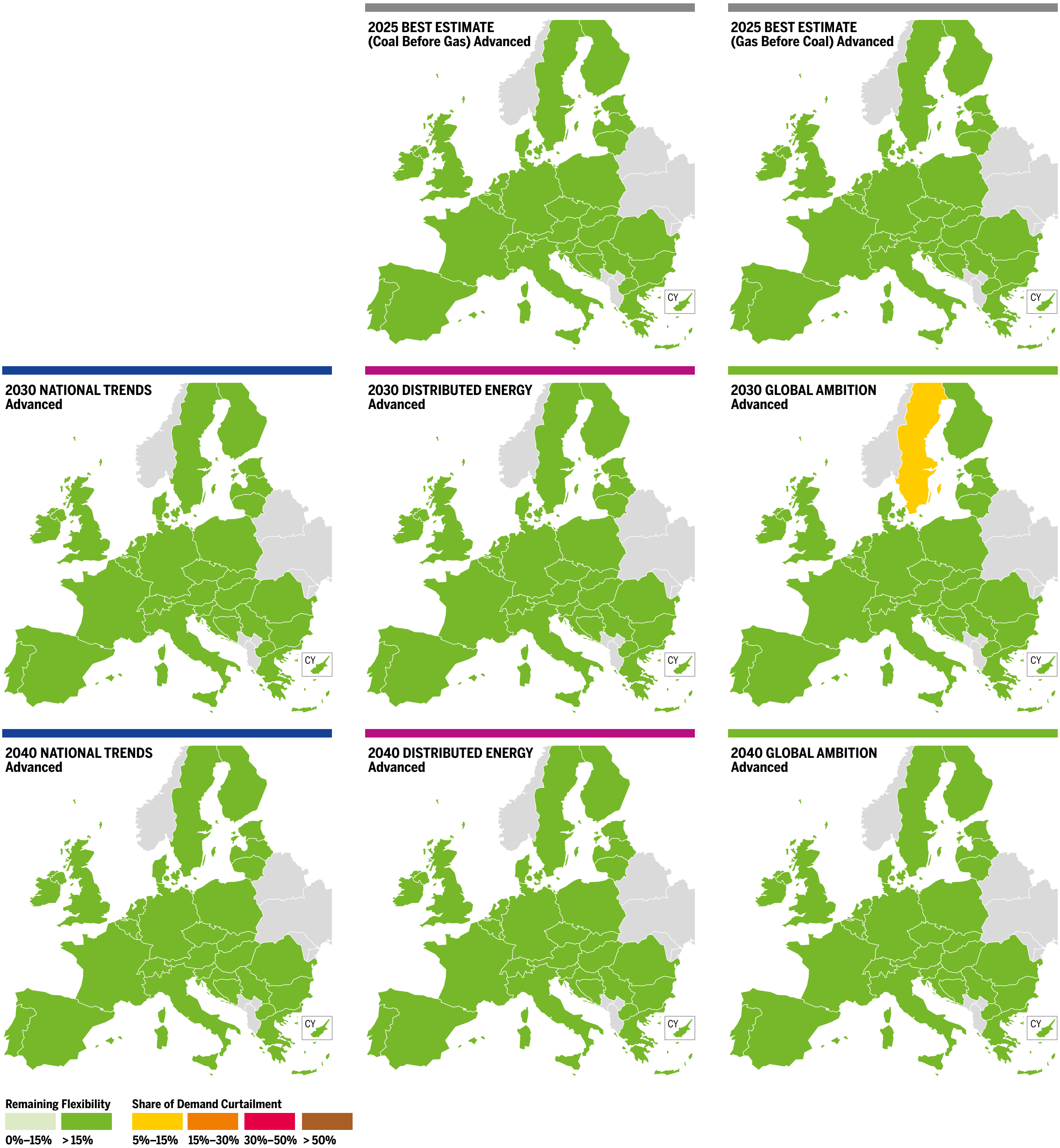

Figure 4.22 Advanced infrastructure level: Climatic Stress under 2-week cold spell situation.

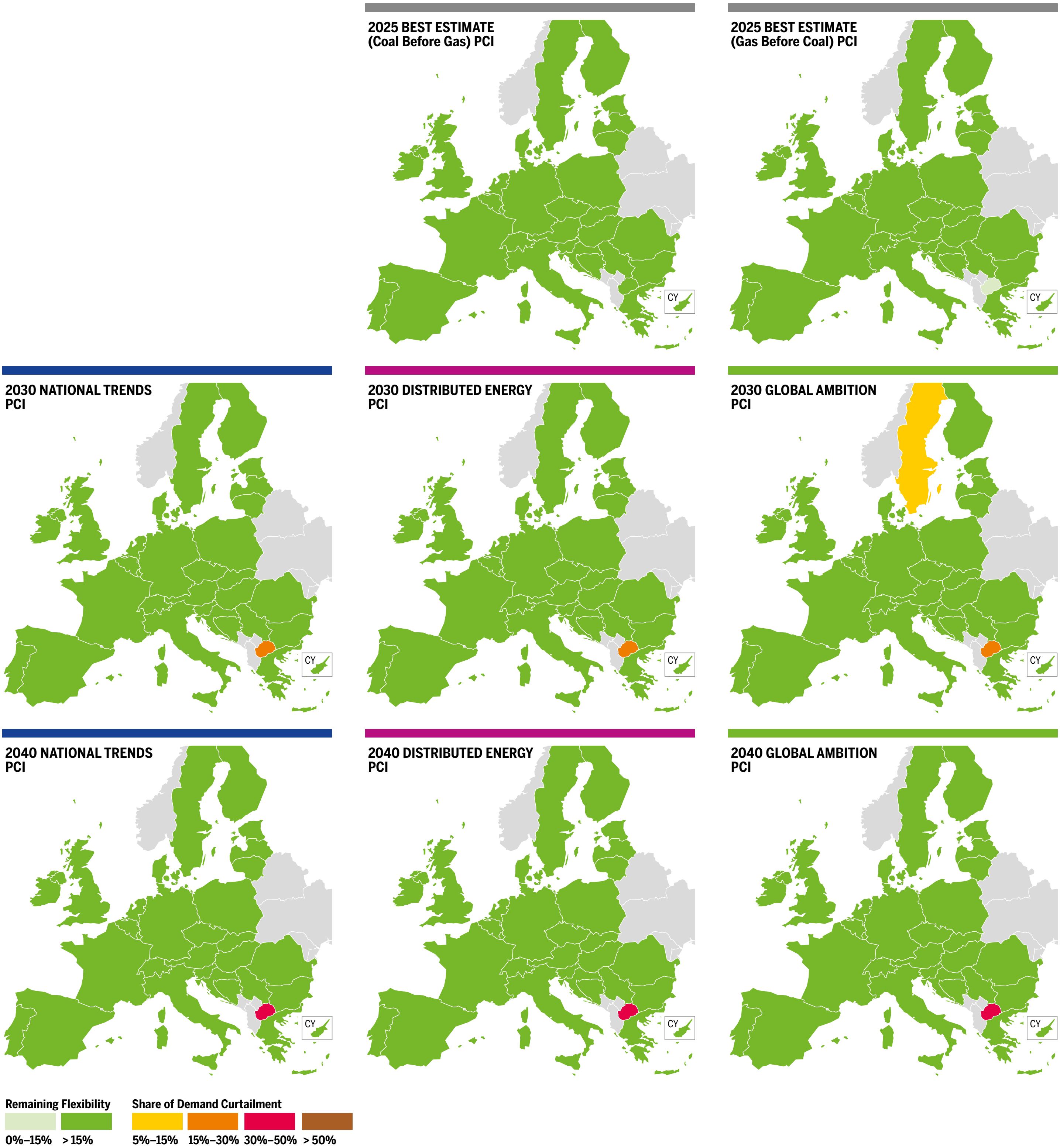

Figure 4.23 PCI infrastructure level: Climatic Stress under 2-week cold spell situation.

4.1.3 2-WEEK DUNKELFLAUTE

EXISTING INFRASTRUCTURE LEVEL

The existing gas infrastructure shows a high level of resilience to 2-week Dunkelflaute situations and most of European countries show some remaining flexibility in all years and scenarios. Nevertheless, the Balkan region, Poland and Sweden face risk of demand curtailment because of infrastructure limitations in some specific scenarios and years. **Figure 4.33** shows the evolution of the Existing infrastructure level described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results show, as for 2-week cold spell, infrastructure limitation between Serbia-Bosnia and Herzegovina and their neighbouring countries exposing them to a limited risk of demand curtailment. In **Serbia**, the risk of demand curtailment is driven by an infrastructure limitation with Hungary following an increase of its gas demand, combined with a decreasing trend of its indigenous production along the years. **Bosnia and Herzegovina** is only connected to Serbia and therefore, is exposed a limited risk of demand curtailment (ca. 8 %).

Figure 4.24 Infrastructure limitations towards Serbia and Bosnia and Herzegovina, Existing infrastructure, 2025.

2030–2040

NATIONAL TRENDS

Some infrastructure limitations between Poland and its neighbouring countries expose **Poland** to a limited risk of demand curtailment (9 %) in 2040 due to an increase of its demand, mainly driven by displacing coal and oil in heating and power generation sector together with additional gas demand for power generation due to no availability of renewable generation coming from wind and solar for two weeks, being the gas system a backup of the intermittent renewable power generation. **See Figures 4.25 and 4.26.**

In the Balkan region, the assessment shows, as of 2025, that infrastructure limitations increase the risk of demand curtailment in **Serbia** and **Bosnia** from 7 % (in 2025) to 18–14 % (in 2030/2040) driven by an increase of its gas demand from 2025 to 2030, then followed by a decrease in 2040, combined with a decreasing trend of its indigenous production along the years.

North Macedonia shows infrastructure limitations, fully using its interconnection with Bulgaria, exposing the country to a risk of demand curtailment in 2030–2040 (ca. 34–48 %). The situation further deteriorates in 2040 due to higher demand together with no indigenous production. **See Figure 4.27.**

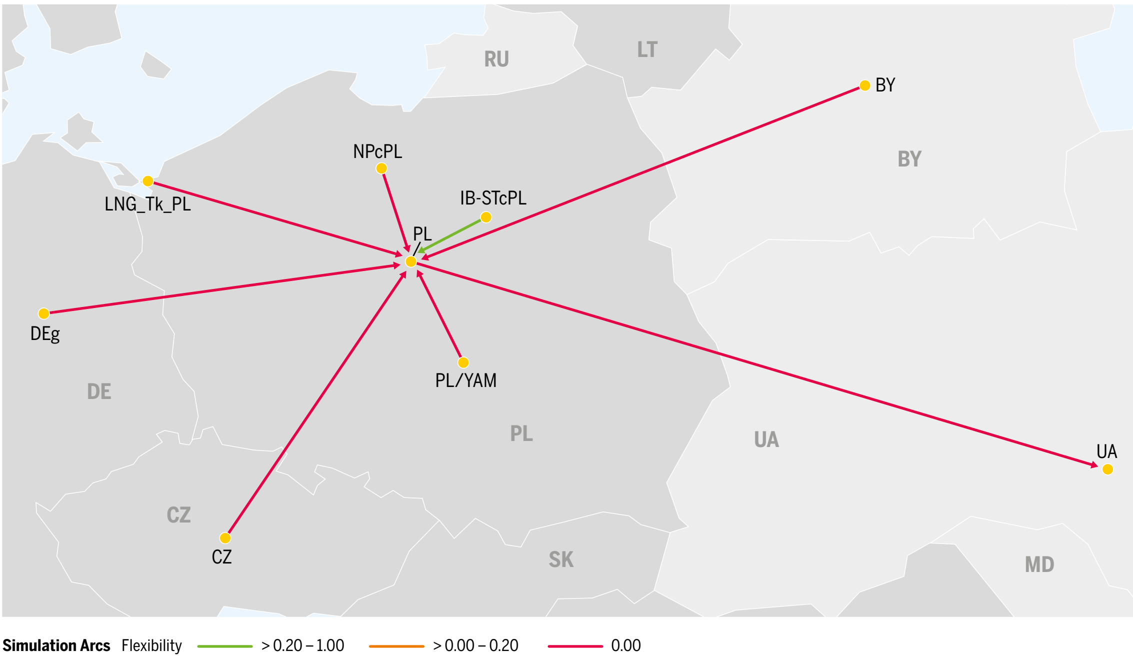

Figure 4.25 Infrastructure limitations towards Poland, Existing infrastructure, National Trends, 2040.

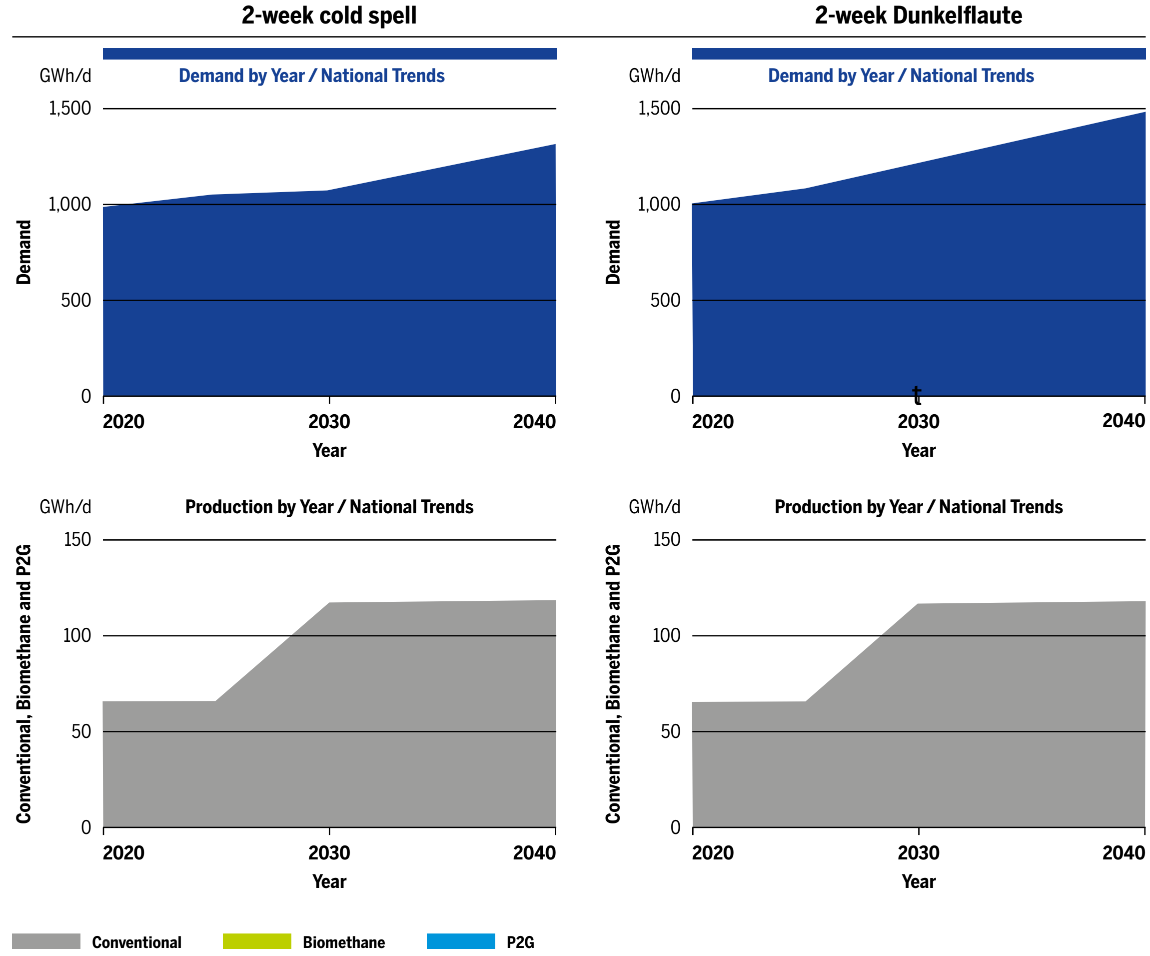

Figure 4.26 2-week cold spell/Dunkelflaute demand and production in Poland in National Trends scenario in GWh/d.

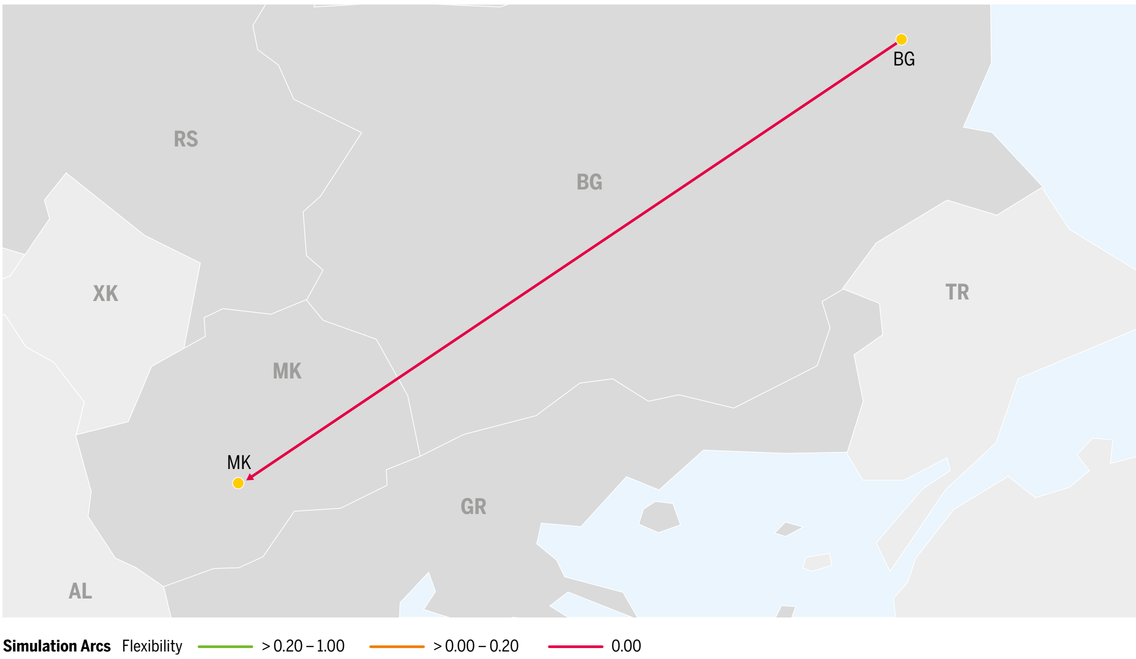

Figure 4.27 Infrastructure limitations towards North Macedonia, Existing infrastructure, 2030.

COP 21 SCENARIOS

Distributed Energy and Global Ambition

Some infrastructure limitations between Poland and its neighbouring countries expose **Poland** to a risk of demand curtailment. As for peak demand case and 2-week cold spell, Poland shows an increasing or rather stable risk of demand curtailment due to an increasing gas demand in both scenarios and years (mainly driven by displacing higher carbon fuels in the heating sector and in the power generation, heating, and transport sector) combined with an increasing national production from 2030 to 2040 coming from renewables (biomethane and power to gas).

A limited increase (between 1–3 %) of risk of demand curtailment compared with 2-week cold spell assessment has been spotted in Poland driven by additional gas demand for power generation together, with no power to gas production, due to no availability of renewable generation (from wind and solar) for two weeks, being the gas system a backup of the intermittent renewable power generation. **See Figure 4.28.**

Greece faces infrastructure limitations (LNG and imports from Turkey and Bulgaria are 100 % used) being exposed to a risk of demand curtailment in 2030 Global Ambition. The exposure to a risk of demand curtailment is mitigated in 2040 thanks to a decrease of the demand combined with an increase of its national production coming from renewables.

Moreover, this penetration of intermittent renewable power generation coming from wind and solar energy in Greece, is also reflected in the decrease of remaining flexibility in Distributed Energy 2030–2040 and Global Ambition 2040, being the gas system a backup of the intermittent renewable power generation. **See Figure 4.30.**

Simulation results show shows a risk of demand curtailment in **Sweden** in Global Ambition 2030 (ca. 19 %), due to limited interconnection capacity with Denmark, which is mitigated in 2040 thanks to an increase of its national production coming from renewables and a stable demand.

Additionally, the slightly increase of the risk of demand curtailment in Global Ambition 2030 and the lower remaining flexibility values in both scenarios and years compared with 2-week cold spell assessment. Swedish gas demand for power generation increases due to no availability of renewable generation (from wind and solar) and there is no power to gas generation in the country for two weeks, being the gas system a backup of the intermittent renewable power generation. **See Figure 4.32.**

Serbia, **Bosnia and Herzegovin**a and **North Macedonia** are facing the same infrastructure limitations as in National Trends scenario. Nevertheless, differing from National Trends scenario, Serbia demand follows an increasing trend of its demand from 2025 to 2030 (remaining quite stable in 2040).

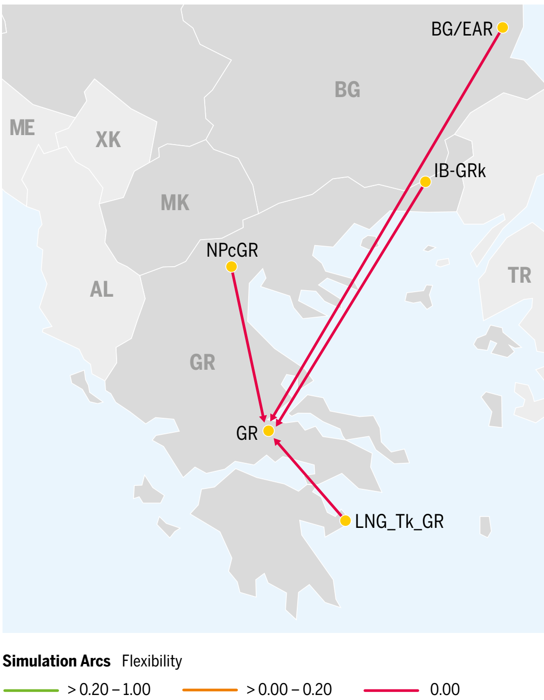

Figure 4.29 Infrastructure limitations towards Greece, Existing infrastructure, Global Ambition 2030.

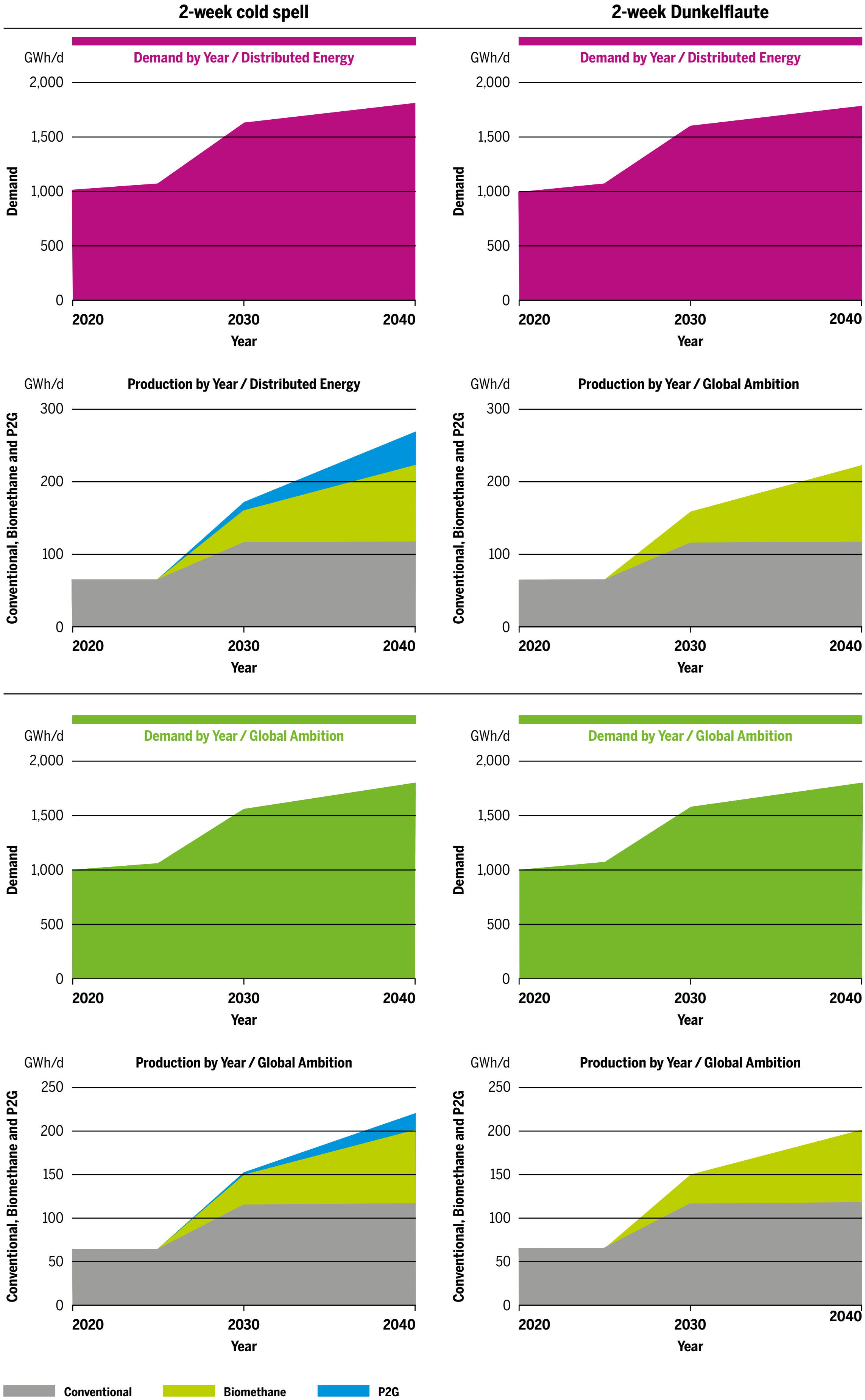

Figure 4.28 2-week cold spell/Dunkelflaute demand and production in Poland in Distributed Energy & Global Ambition scenarios in GWh/d.

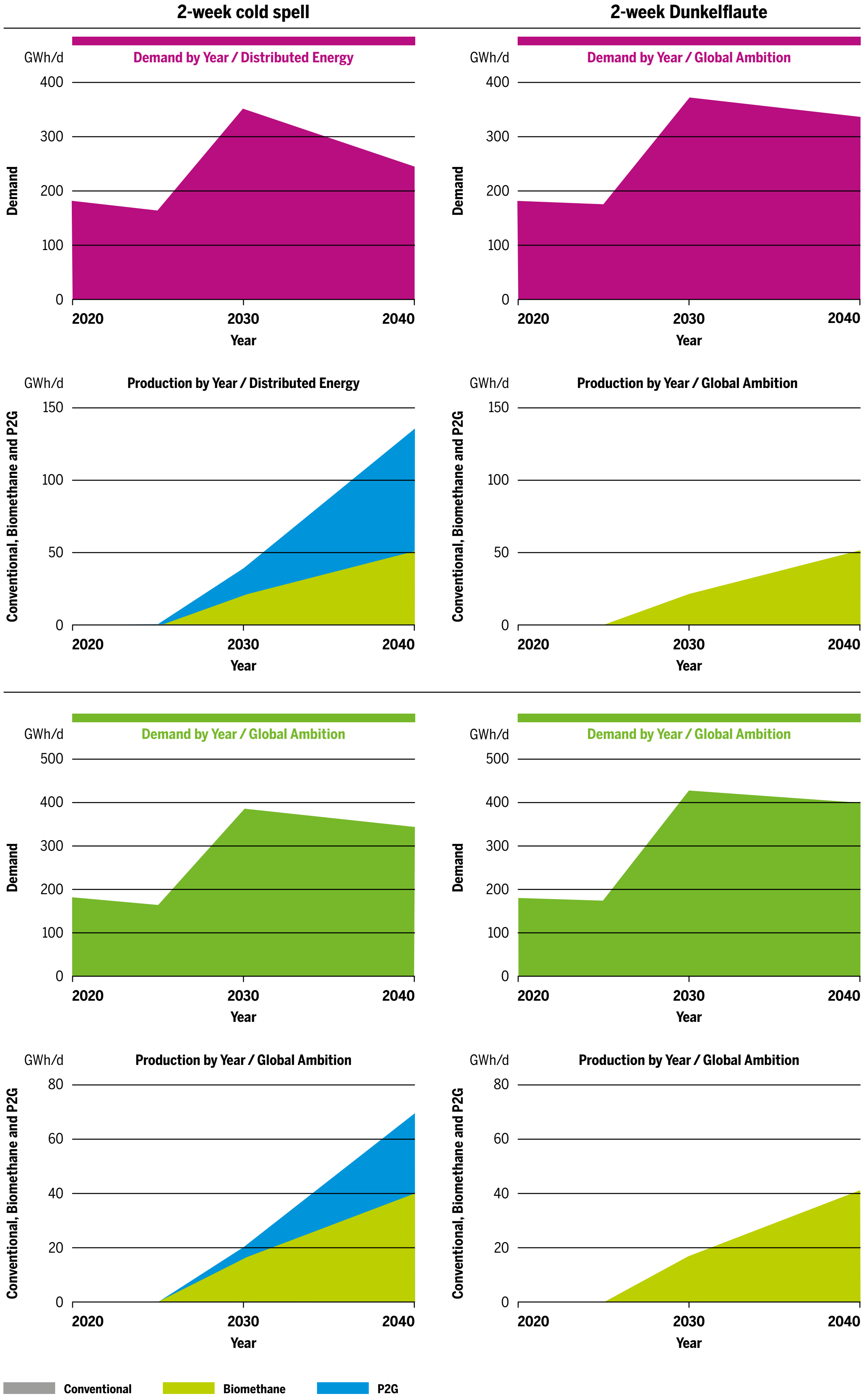

Figure 4.30 2-week cold spell/Dunkelflaute demand and production in Greece in Distributed Energy & Global Ambition scenarios in GWh/d.

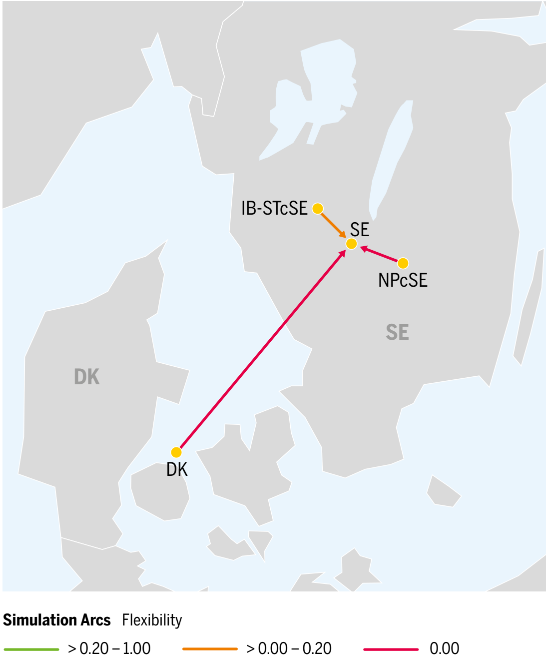

Figure 4.31 Infrastructure limitations towards Sweden, Existing infrastructure, Global Ambition 2030.

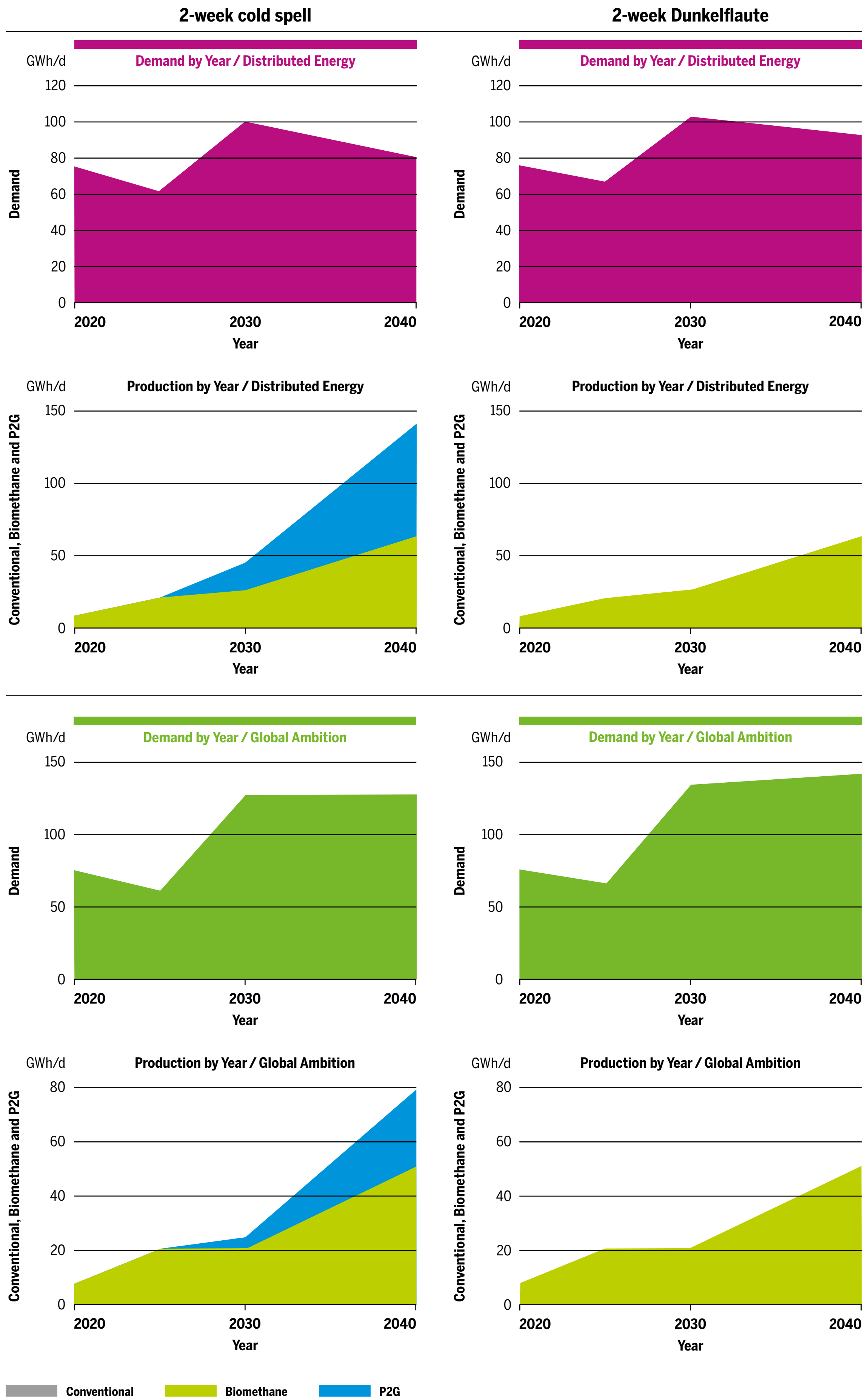

Figure 4.32 2-week cold spell/Dunkelflaute demand and production in Sweden in Distributed Energy & Global Ambition scenarios in GWh/d.

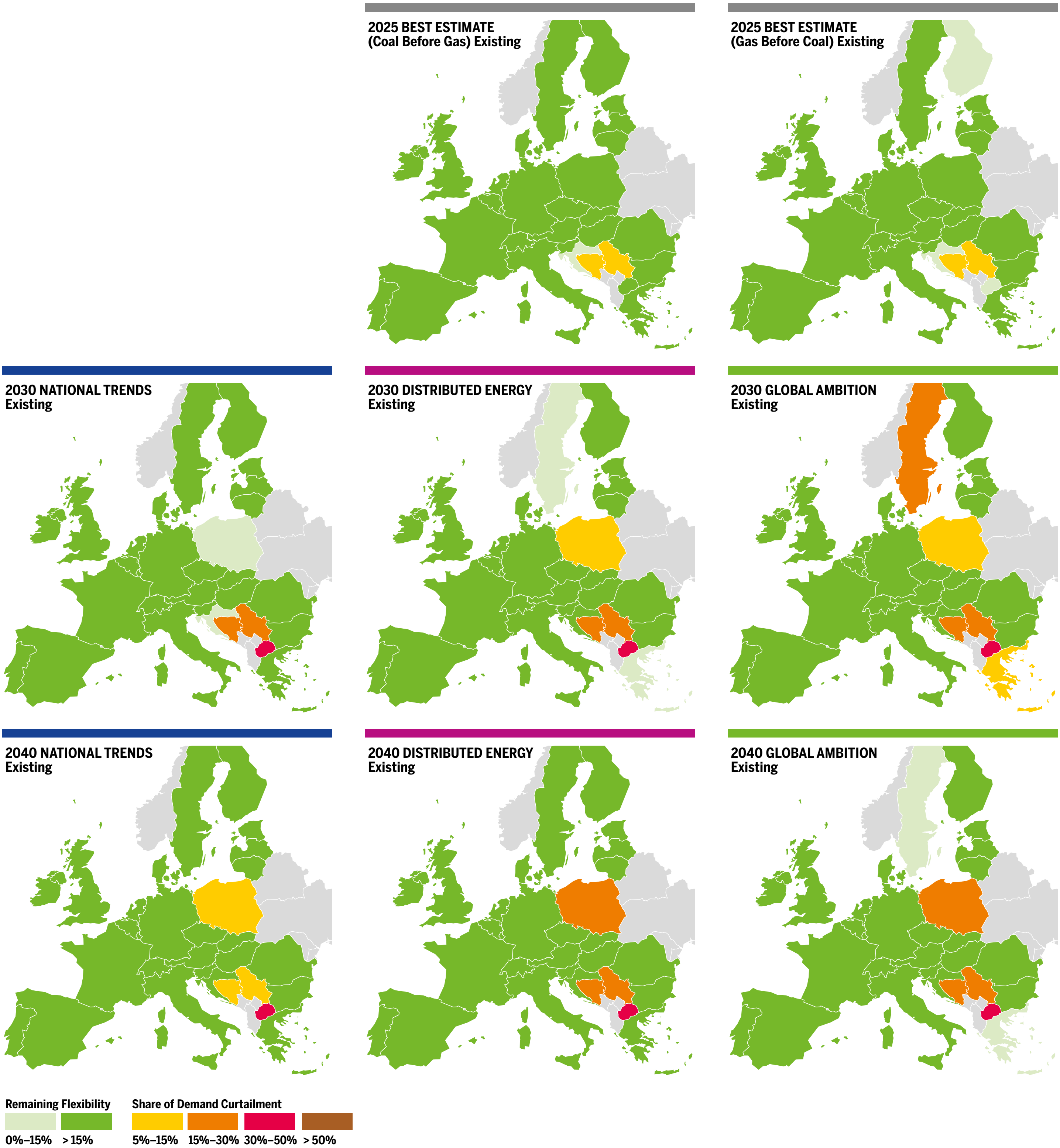

Figure 4.33 Existing infrastructure level: Climatic Stress under 2-wek Dunkelflaute situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that, depending on the considered scenario, FID projects allow some countries to further mitigate, fully or at least partially, the infrastructure gaps identified under Existing infrastructure level. Nevertheless, there are still some lack of infrastructure. **Figure 4.34** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

In line with 2-week cold spell demand case assessment, the European gas system is resilient to a 2-week Dunkelflaute, with higher remaining flexibility all over Europe.

The commissioning of FID projects help to fully mitigate the risk of demand curtailment in **Serbia**. As a result, Serbia increases its cooperation with Bosnia and Herzegovina, fully mitigating the risk of demand curtailment in **Bosnia and Herzegovina** as well.

2030–2040

NATIONAL TRENDS

FID projects fully mitigate the risk of demand curtailment in **Poland** in 2040 allowing an efficient cooperation with its neighbouring countries.

In line with 2-week cold spell demand assessment, FID projects fully mitigate the risk of demand curtailment in **Serbia** and **Bosnia and Herzegovina** thanks to an efficient cooperation in the area.

Nevertheless, in **North Macedonia** FID projects do not mitigate the risk of demand curtailment, not improving the interconnection between North Macedonia and neighbouring countries with consequent limitations on possible flow from Bulgaria.

COP 21 SCENARIOS

Distributed Energy and
Global Ambition

Poland fully mitigates its risk of demand curtailment thanks to the commissioning of FID projects increasing its cooperation with neighbouring countries.

Greece fully mitigates its risk of demand curtailment in Global Ambition 2030, thanks to the commissioning of FID projects.

Nevertheless, in **Sweden** FID projects do not mitigate, neither improve, the risk of demand curtailment in Global Ambition 2030.

As in National Trends scenario, **Serbia** and **Bosnia and Herzegovina** fully mitigate their risk of demand curtailment thanks to the commissioning of FID projects. However, **North Macedonia** faces the same infrastructure limitations.

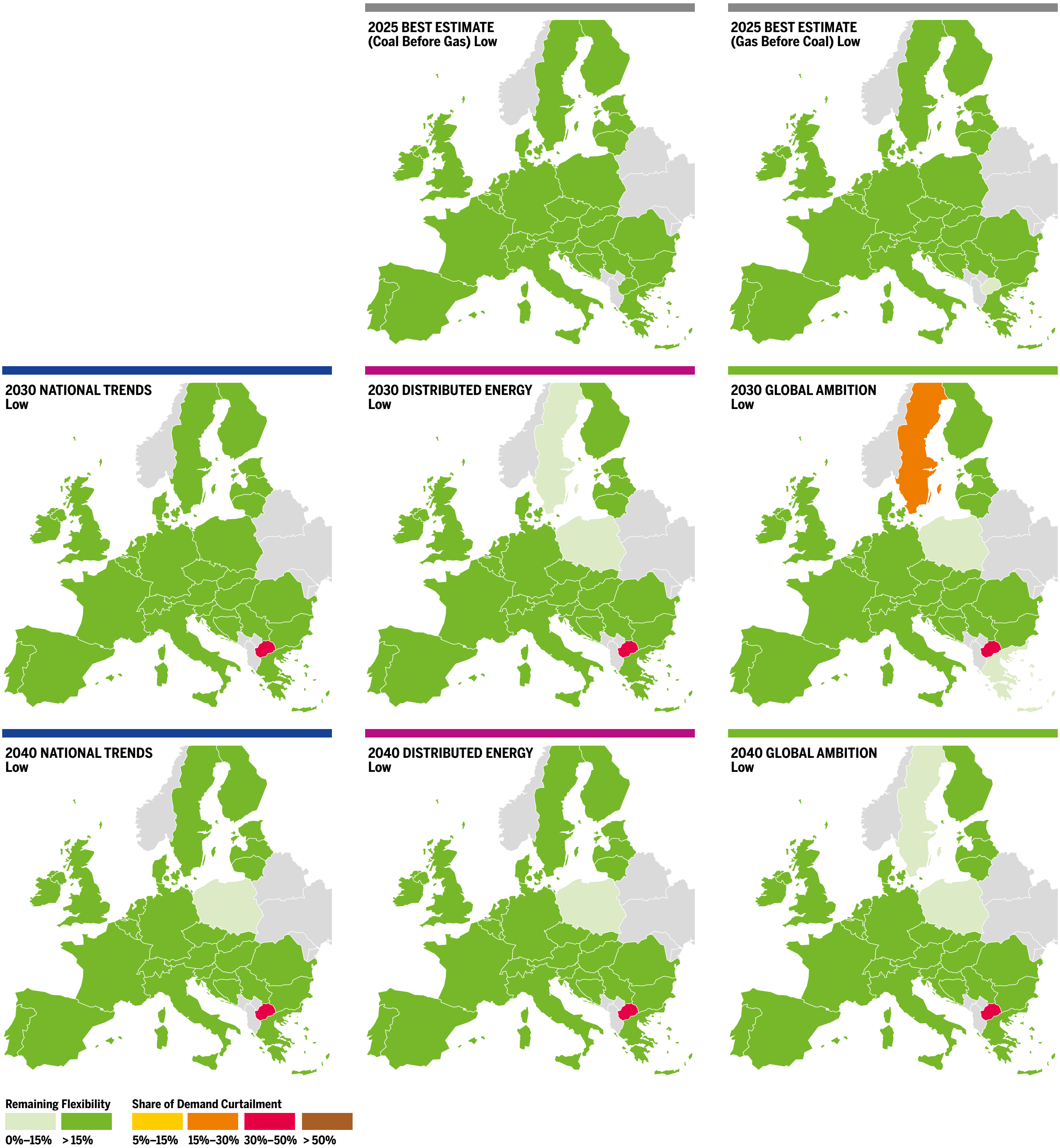

Figure 4.34 Low infrastructure level: Climatic Stress under 2-week Dunkelflaute situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show further improvements in terms of infrastructure gaps. The commissioning of advanced-status projects provide an infrastructure reinforcement required to cope with high demand situations. Results are shown in **Figure 4.35**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and **Gas Before Coal** scenarios, results show that the European gas system is resilient to a 2-week Dunkelflaute. Advanced-status projects bring a significant improvement of the remaining flexibility all over Europe.

2030–2040

NATIONAL TRENDS

Simulation results show the fully mitigation the risk of demand curtailment in **North Macedonia** thanks to the investment of the interconnection between North Macedonia and Greece, allowing Greece to further cooperate with North Macedonia.

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- Distributed Energy and
- Global Ambition

Advanced-status projects significantly improve the situation as of 2030.

Nevertheless, in **Sweden** advanced-status projects do not mitigate, neither improve, the risk of demand curtailment in Global Ambition 2030.

Moreover, as for National Trends scenario, **North Macedonia** fully mitigates its risk of demand curtailment thanks to the commissioning of advanced-status projects.

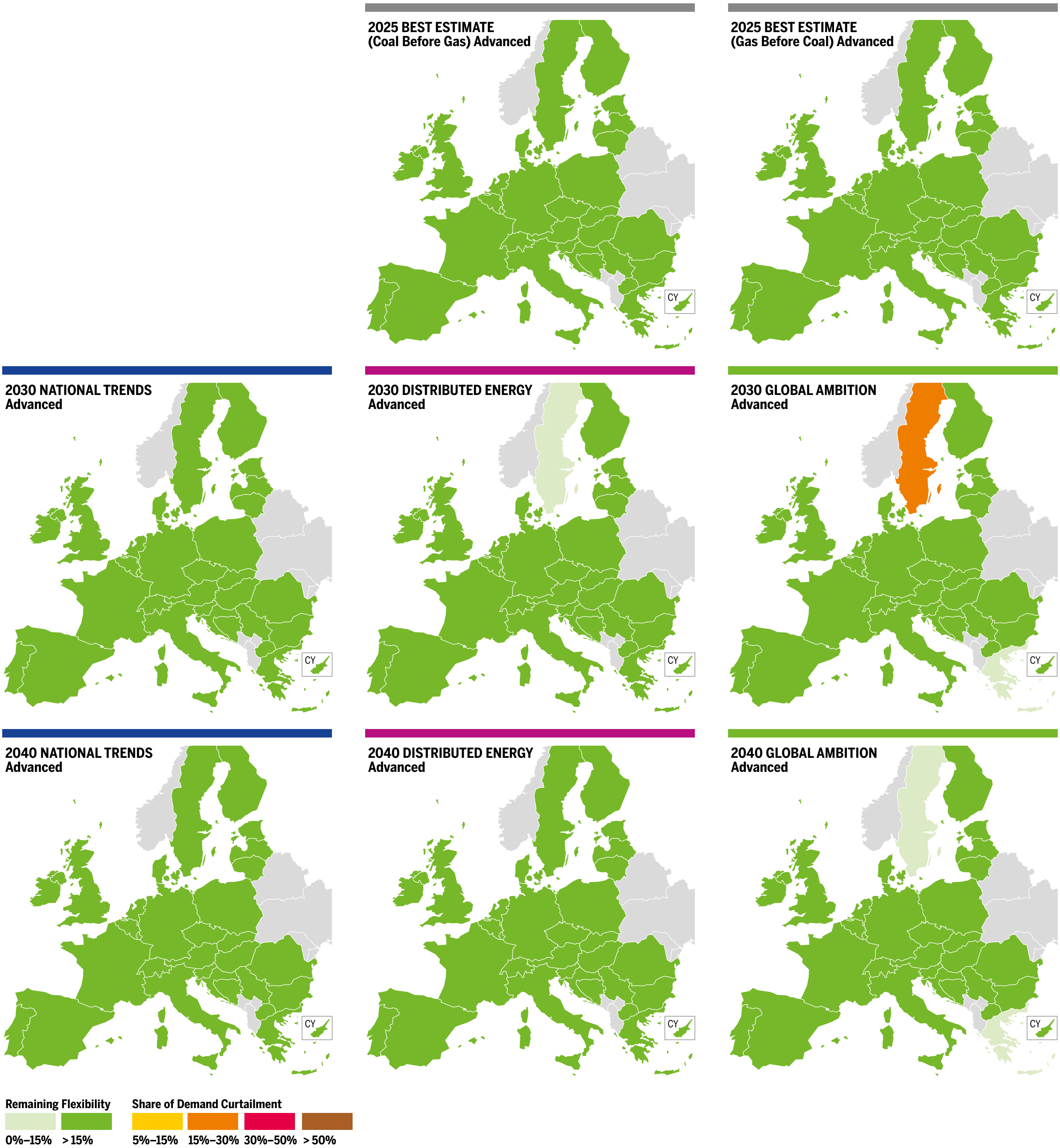

Figure 4.35 Advanced infrastructure level: Climatic Stress under 2-week Dunkelflaute situation.

PCI INFRASTRUCTURE LEVEL

Simulation results show the benefits stemming from the implementation of the 4th PCI list during 2-week Dunkelflaute demand situation. Results are in line with Low infrastructure level assessment. Results are graphically represented in **Figure 4.36**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and **Gas Before Coal** scenarios results show that the implementation of the latest 4th PCI projects provide an improvement of the remaining flexibility all over Europe.

2030–2040

NATIONAL TRENDS

Simulation results are in line with Low infrastructure level assessment for 2-week Dunkelflaute demand case.

North Macedonia faces the same infrastructure limitations as in Low infrastructure level. PCI projects do not mitigate, neither improve, the risk of demand curtailment in the country. The interconnection Greece-North Macedonia is an advanced-status project and it is not part of the PCI list currently in force, therefore, there is no improvement in this infrastructure level.

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Distributed Energy and
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Simulation results are in line with Low infrastructure level assessment for 2-week cold spell demand case, as for National Trends scenario.

In **Sweden** and **North Macedonia** PCI projects do not mitigate, neither improve, the risk of demand curtailment. Both countries expose to the same extent of risk of demand curtailment as for Low infrastructure level.

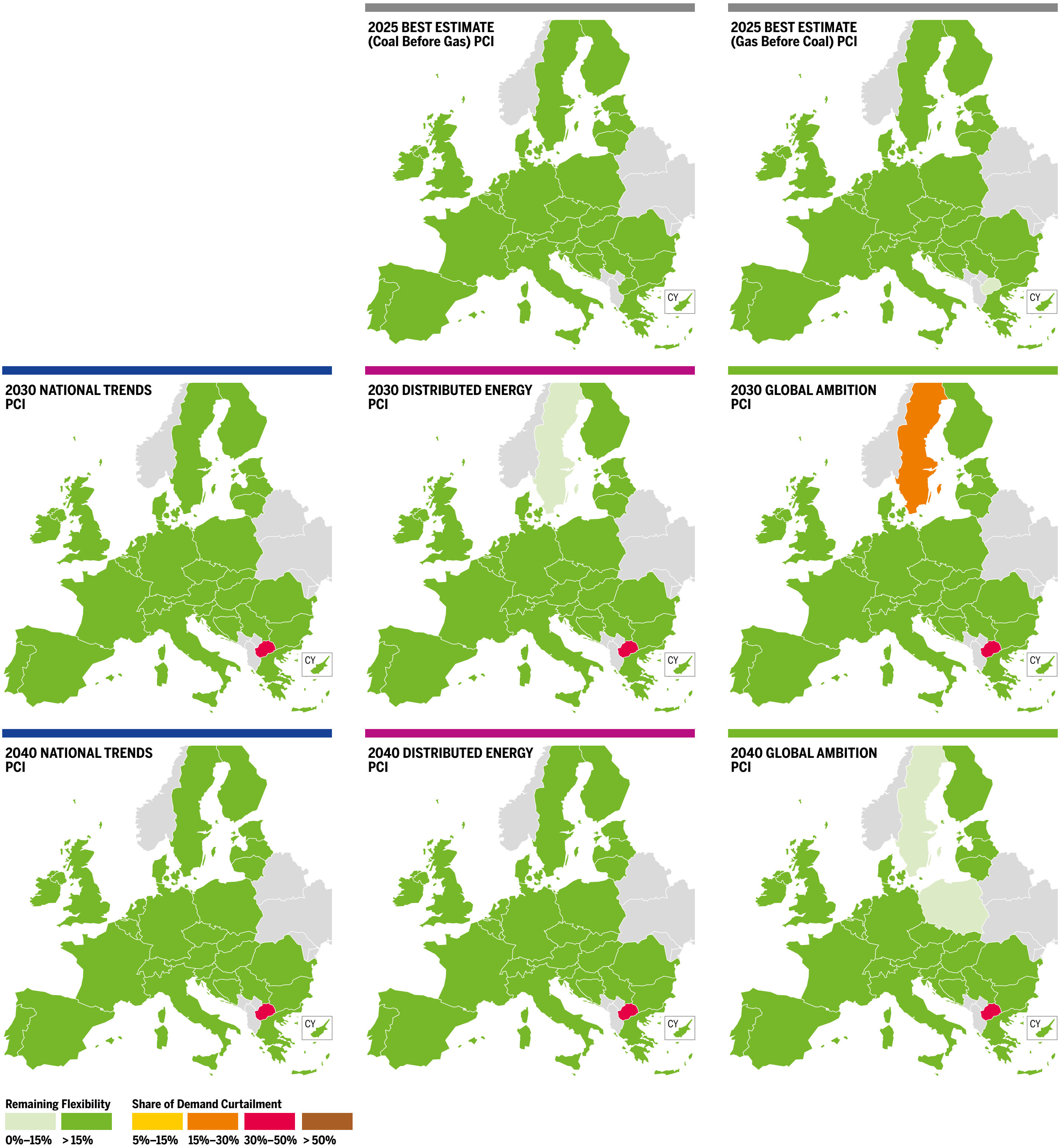

Figure 4.36 PCI infrastructure level: Climatic Stress under 2-week Dunkelflaute situation.

4.1.4 CONCLUSION – CLIMATIC STRESS CONDITIONS

In all scenarios, the assessment shows that the existing European gas system is well developed and, in most European countries, resilient to severe climatic conditions such as a 1-in-20 peak day, a 2-week cold spell or in the future to a 2-week Dunkelflaute event.

However, in some specific areas, further infrastructure is needed to fully mitigate the risk of demand curtailment:

- Northern Ireland and Poland remain exposed to demand curtailment until 2040 in all scenarios, but FID and Advanced projects are efficiently alleviating all the concerned infrastructure limitations as of 2025.
- In the Balkan region, Greece could be exposed to demand curtailment in Global Ambition scenario in 2030, and Serbia, Bosnia and Herzegovina, and North Macedonia are exposed to demand curtailment as of 2025.
- Sweden is exposed to demand curtailment in Global Ambition 2030 and no project can mitigate this risk.

The gas system and renewable gases can support the development of intermittent electricity renewable generation while ensuring a high level of security of energy supply

The assessment confirms that with the development of intermittent renewable power generation, the gas system is generally resilient but is under an increasing stress. However, Biomethane production is beneficial to security of supply on an annual basis and during climatic stress due to its continuous operation. Power-to-gas technologies are beneficial for the security of gas supply on an annual basis too, however, during climatic stress situations, especially during Dunkelflaute events, the role of gas storages associated with power to gas capacities is key to ensure the necessary supply when the demand is high and the production of power to gas is unavailable.

Picture courtesy of Fluxswiss

NATIONAL TRENDS

Under the NECP driven scenario, the assessment demonstrates the resilience of the gas infrastructure in case of severe climatic stress in a context where the development of renewable and decarbonised gases is limited and is far from compensating the decline of the conventional natural gas production.

Therefore, in National Trends, the gas infrastructure can ensure a high level of security of supply by transporting the gases from the gas storages and import capacities throughout Europe.

COP 21 SCENARIOS

Distributed Energy

Under the decentralised COP 21 scenario with the highest level of electrification, gas power generation is a back-up for intermittent power generation and therefore supports the development electricity renewables. In this context, in peak demand situations, the gas demand for power generation increases over time and partly compensate for the decreasing gas demand in other sectors. The gas demand in climatic stress situations decreases overall but to a limited extent compared to the average demand. However, the development of indigenous production of renewable and decarbonised gases is maximum in this scenario and compensate for the decline of conventional natural gas to reach production levels in 2040 similar to 2020.

Therefore, in Distributed Energy, the assessment demonstrates the resilience of the gas infrastructure to cope with severe climatic situations and its ability to supply the European demand relying on interconnections capacities and gas storages, and accommodating with a more decentralised new gas production while importing the necessary complement to ensure the supply and demand adequacy for the next 20 years.

Global Ambition

Under the centralised COP 21 scenario, the development of direct electrification reaches levels similar to the 1.5 LIFE scenario of the Long-Term Strategy of the European Commission in 2050[12] and gas power generation is a back-up for intermittent power generation and therefore supports the development electricity renewables. In this centralised approach, the gas demand for mobility and industry is increasing as those sectors are moving away from carbon intensive fuels to gases that are more and more decarbonised. Furthermore, the global dimension of the energy transition enhances the development of a global market for renewable gases and therefore, production capacities for renewable and decarbonised gases develop in Europe (ca. 750 TWh in 2040), and imports of renewable and decarbonised gases are an option together with large-scale development of decarbonisation facilities.

Therefore, in Global Ambition, the assessment demonstrates the resilience of the gas infrastructure to cope with severe climatic situations and its ability to supply the European demand relying on interconnections capacities and gas storages, and accommodating with significant levels of new gas production while participating to the global decarbonised energy market to ensure the supply and demand adequacy for the next 20 years.

12 https://ec.europa.eu/clima/sites/clima/files/docs/pages/com_2018_733_analysis_in_support_en_0.pdf

4.2 SUPPLY ROUTE DISRUPTIONS

Most of the gas consumed in Europe today is imported through pipelines and LNG cargos. The disruption of a supply route can have a significant impact on the infrastructure and its ability to satisfy the demand.

However, depending on the evolution of the different national policies and on the development of the demand and production technologies to reach the European climate and energy targets, the gas system may rely on the main gas supply corridors in different ways. The TYNDP scenarios are meant to reflect those different possible pathways.

This section investigates the additional impact of a supply route disruption during a high demand situation (climatic stress) for all the different scenarios from 2020 until 2040.

The assessment focuses on the disruptions listed in the Union-wide simulation of gas supply and infrastructure scenarios carried out for the risk assessment defined in Article 7, Regulation (EU) 2017/1938 (hereafter SOS Regulation) concerning security of gas supply. Furthermore, those disruption cases expected to show a risk of demand curtailment in the Union-wide simulation are assessed in this section:

- Ukraine route
- Belarus route
- Imports to Baltic states and Finland
- Algerian import pipelines

The assessment is limited to the impact of a supply disruption occurring during high gas demand situations: peak day, a 2-week cold spell and 2-week Dunkelflaute. The SoS Regulation additionally considers disruptions with longer duration as assessed in the Union-wide SoS simulation report[13].

The assessment of the supply route disruptions is consistent with the Regulation EU 2017/1938. Therefore, Member States belonging to the concerned risk group as defined in Annex I of the regulation[14] are assumed to cooperate to the extent possible to limit the overall impact of the disruption by equally sharing the demand curtailment, if not prevented by infrastructure limitations.

The TYNDP assesses how the EU gas system is resilient to supply route disruptions by investigating whether some infrastructure limitations prevent some countries from being supplied by sufficient quantities of gas. Existing, Low, Advanced and PCI infrastructure levels are assessed.

4.2.1 UKRAINE DISRUPTION

This assessment considers the disruption of all gas imports via Ukraine to Romania, Hungary, Slovakia and Poland during climatic stress situations while maintaining the exports from the EU to Ukraine.

This case considers the disruption of the transit through Ukraine and the risk group is formed by Austria, Bulgaria, Croatia, Czech Republic, Germany, Greece, Hungary, Italy, Luxembourg, Poland, Romania, Slovenia and Slovakia. **See Figure 4.37.**

4.2.1.1 PEAK DAY

Existing infrastructure

The Existing infrastructure is generally resilient to a disruption of gas supply from Ukraine in climatic stress situations. Results are very similar compared to climatic stress assessment without transit disruption assessment; nevertheless, the remaining flexibility decreases not only in southern eastern Europe, but also in most of the western countries. Such improvement compared with TYNDP2018 is driven by the commissioning of Turkstream, which flows gas to Bulgaria, providing Southern Eastern Europe with more flexibility, as well as by the commissioning of Nordstream 2 with enhanced downstream infrastructure, enabling further redirection of flow from West to East via Czech Republic. In this regard, Romania, and Poland to a lesser extent, are exposed to additional demand curtailment under the Ukraine route disruption. **Figure 4.40** shows Existing infrastructure results.

13 https://www.entsog.eu/security-of-supply-simulation

14 https://eur-lex.europa.eu/eli/reg/2017/1938/oj

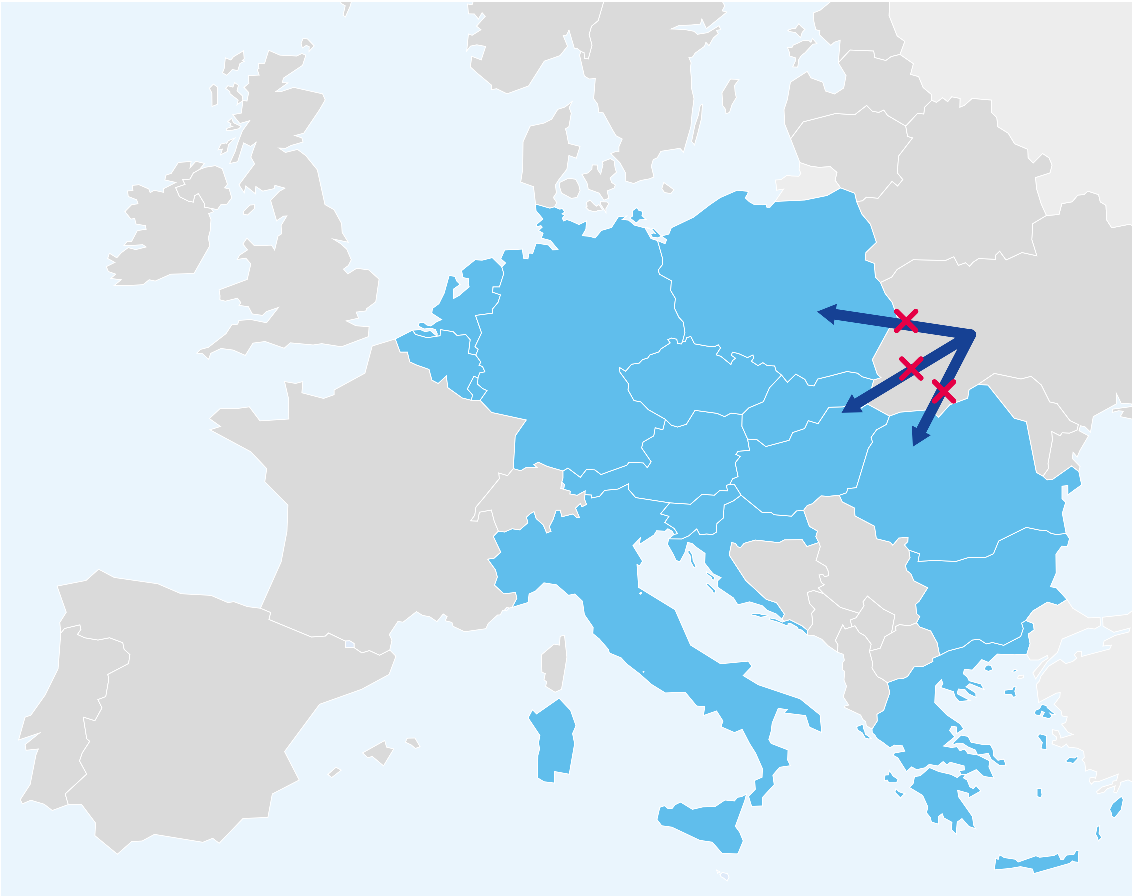

Figure 4.37 Risk group for Ukraine transit disruption.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios results show an additional risk of demand curtailment in **Romania** (ca. 11 %) due to infrastructure limitation from Hungary and Bulgaria towards Romania and from Slovakia and Austria towards Hungary.

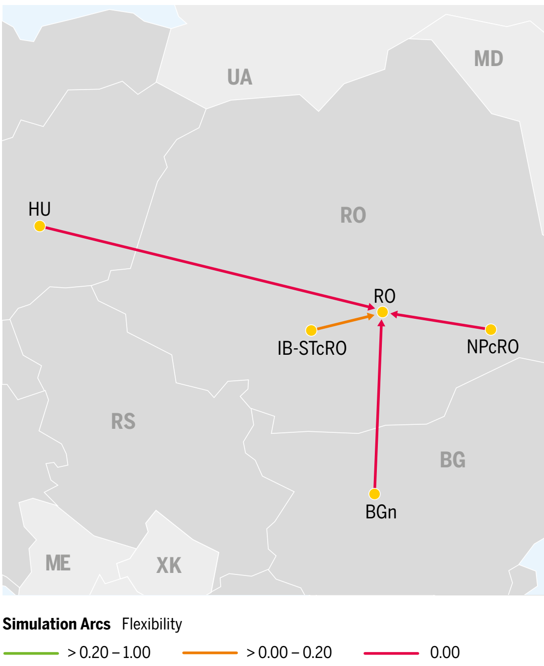

Figure 4.38 Infrastructure limitations towards Romania under Ukraine disruption, Existing infrastructure, 2025.

2030–2040

NATIONAL TRENDS

Romania is exposed to a significant level of demand curtailment in 2030 (ca. 22 %) and it worsens in 2040 (ca. 38 %) due to infrastructure limitations with Bulgaria and Hungary in a context of sharp decline of the indigenous natural gas production not being compensated by any new renewable gas production. **See Figure 4.39.**

Poland is exposed to a higher risk of demand curtailment in 2040 compared to the climatic stress conditions (without transit disruption) assessment from 15 % to 23 %.

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Global Ambition

Romania is not exposed to demand curtailment thanks to lower demand combined with higher indigenous production coming from renewables (biomethane and power to gas) alleviating the congestions in the interconnections with Hungary and Bulgaria. **See Figure 4.40.**

Due to the transition away from coal in power generation and heating generation and the consequent of a significant increase of its peak demand, and despite the development of conventional and renewable gases generation, **Poland** faces an additional risk of demand curtailment under a Ukraine route disruption due to infrastructure limitations with all its neighbouring countries. Throughout 2030 to 2040, the risk of demand curtailment increases from ca. 32 % in 2030 to ca. 40 % in 2040 for both scenarios.

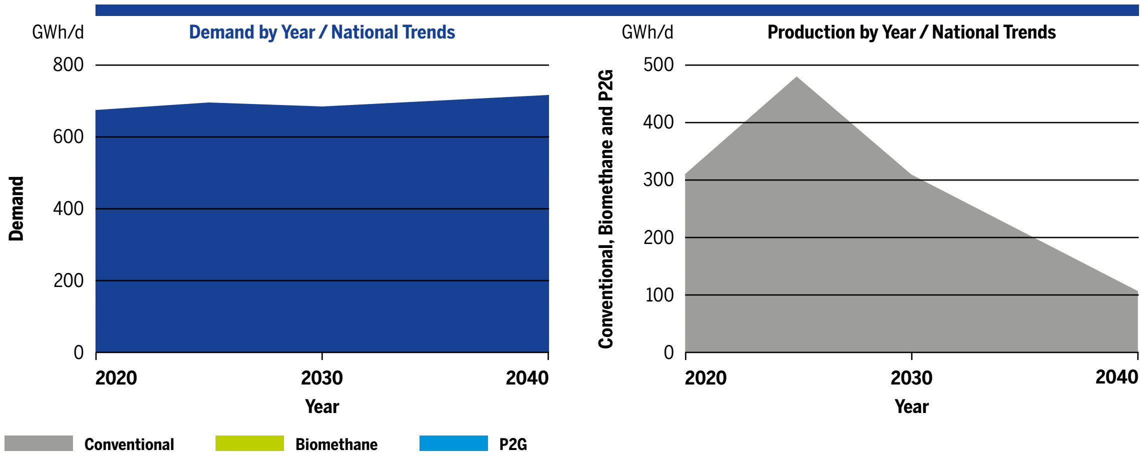

Figure 4.39 Peak demand and production in Romania in National Trends scenario in GWh/d.

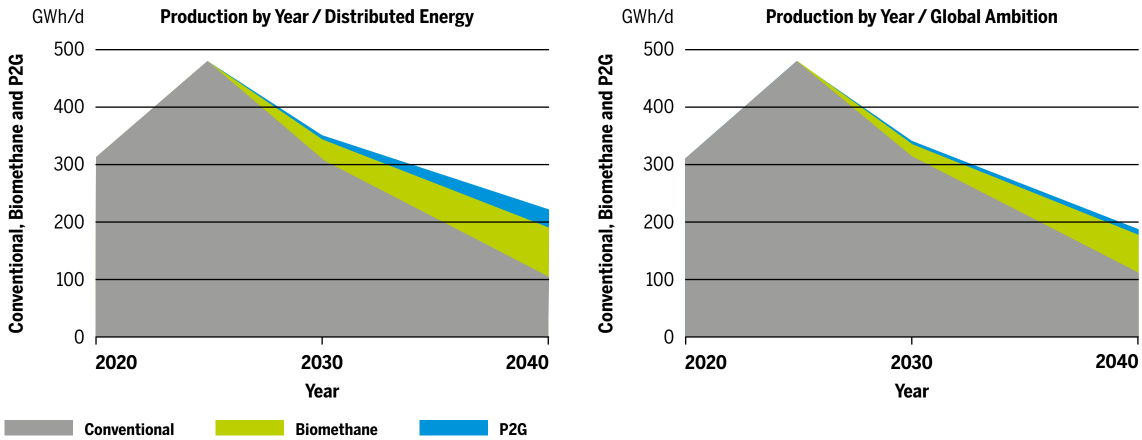

Figure 4.40 Peak production in Romania in COP 21 scenarios (Distributed Energy and Global Ambition respectively) in GWh/d.

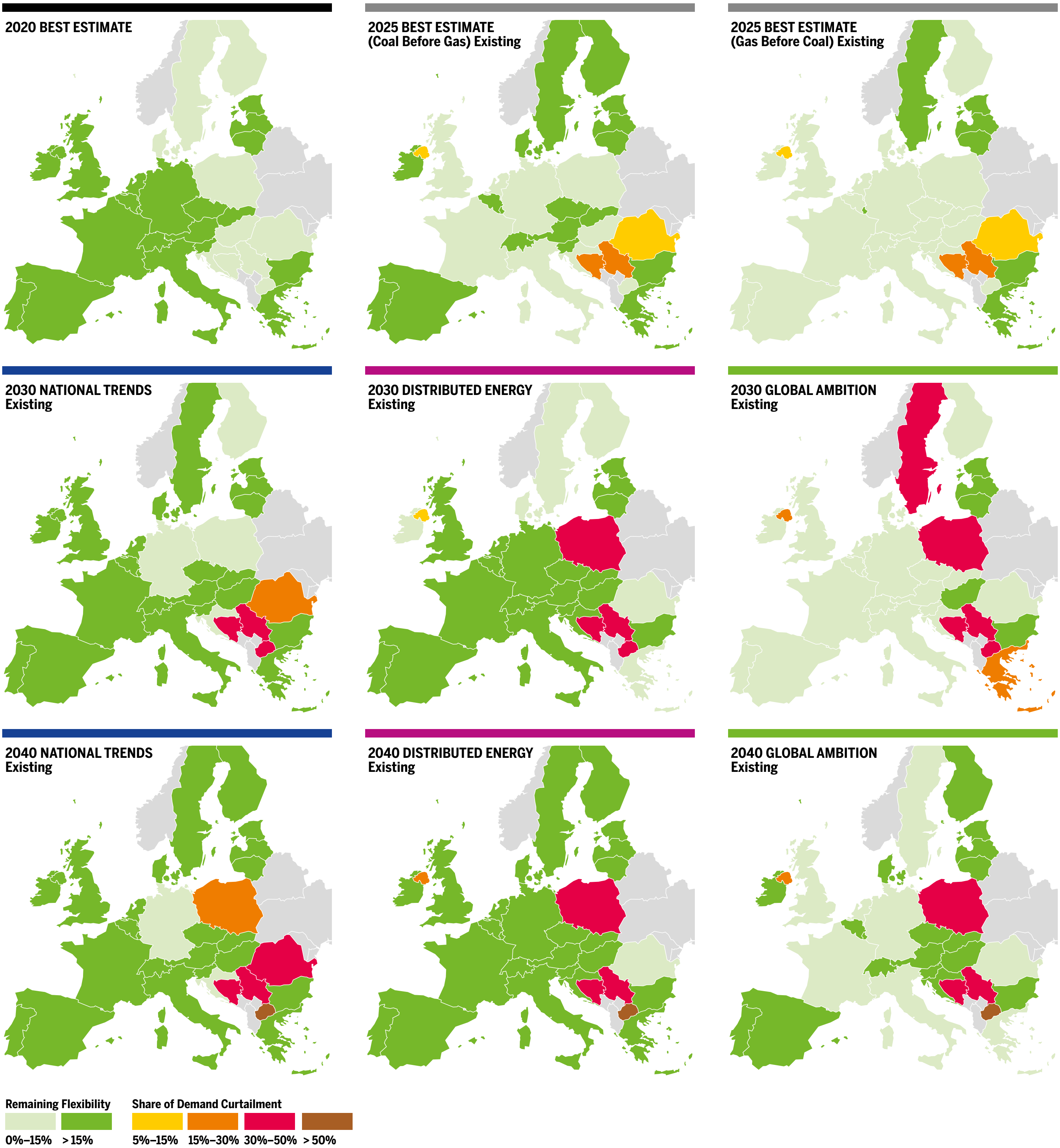

Figure 4.41 Existing infrastructure level: Ukraine transit disruption under peak day situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that FID projects help improving the situation for those countries affected by the Ukraine transit disruption. **Figure 4.42** shows the Low infrastructure level results.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a peak day situation in case of Ukraine transit disruption.

In the Balkan region, FID projects fully mitigate the risk of demand curtailment for Romania.

2030

NATIONAL TRENDS

FID projects bring infrastructure reinforcement in **Romania** and reduce the risk of demand curtailment in 2030 from 22 % in Existing infrastructure level to 7 % in Low infrastructure level.

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Distributed Energy and
Global Ambition

FID projects partially mitigate the exposure of demand curtailment in **Poland** from 32 % (Existing infrastructure level) to 15 %.

2040

NATIONAL TRENDS

FID projects bring infrastructure reinforcement in **Romania** and reduce the risk of demand curtailment from 38 % Existing infrastructure level to 28 %.

Thanks to the commissioning of FID projects, allowing neighbouring countries to cooperate, **Poland** fully mitigates its exposure to demand curtailment.

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Distributed Energy and
Global Ambition

In **Poland** FID projects partially mitigate the exposure of demand curtailment from 40 % (Existing infrastructure level) to 25 %.

In **Romania**, in Global Ambition scenario, FID projects bring additional flexibility and fully mitigate the exposure to demand curtailment.

Picture courtesy of GAZ-System

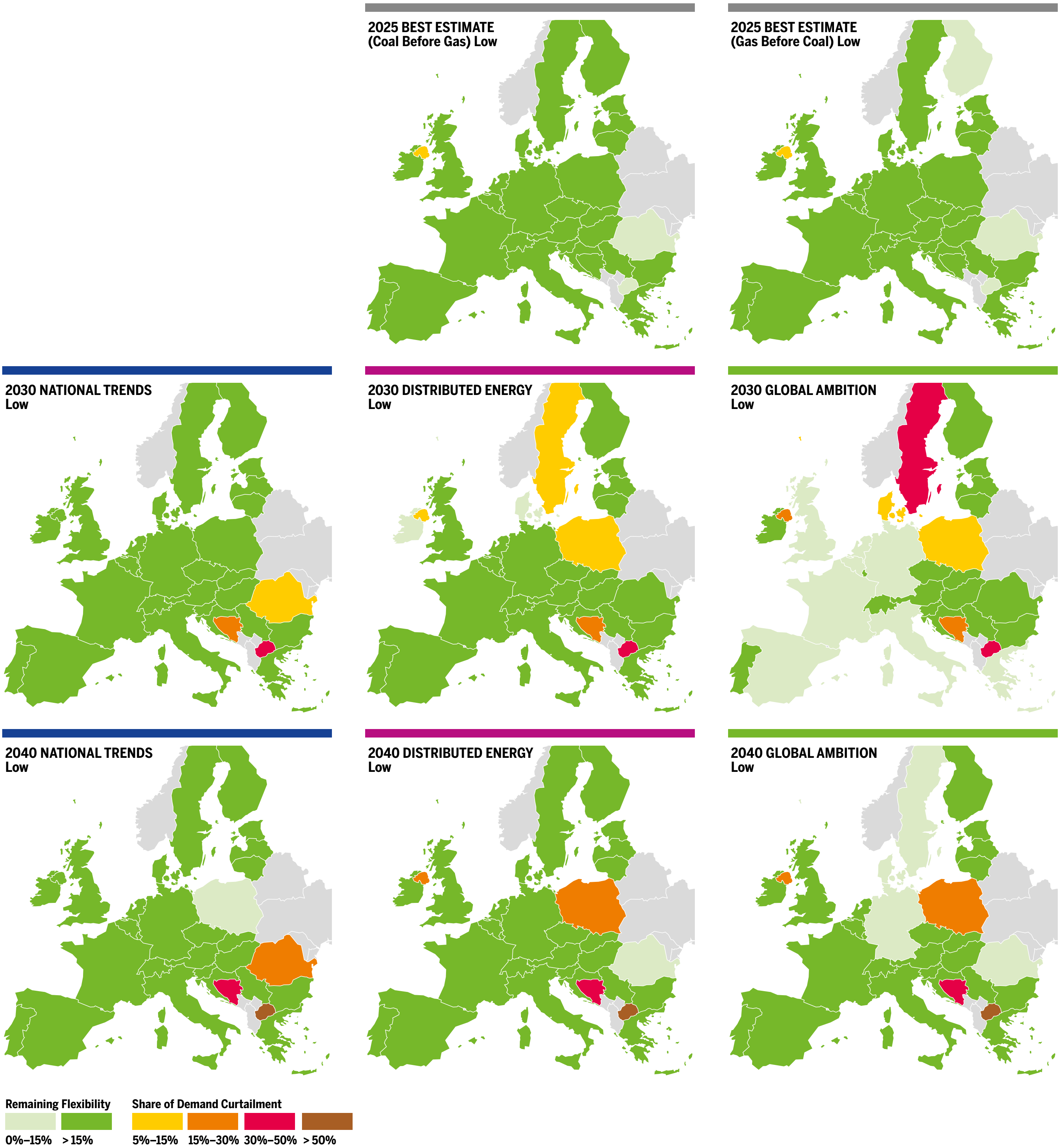

Figure 4.42 Low infrastructure level: Ukraine transit disruption under peak day situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that the European gas system is resilient thanks to the commissioning of Advanced-status projects. **Figure 4.43** shows the results for Advanced infrastructure level.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a Peak day situation in case of Ukraine transit disruption. The commissioning of advanced status projects increases the remaining flexibility all around Europe above 15 %.

2030–2040

NATIONAL TRENDS

Simulation results show that advanced-status projects improve the situation in **Romania** fully mitigating its risk of demand curtailment in 2030 and 2040 and increasing the remaining flexibility in the country.

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Distributed Energy and
Global Ambition

Advanced projects fully mitigate the risk of demand curtailment in **Poland** in both scenarios and years by allowing neighbouring countries to further cooperate. Advanced-status projects help increasing the remaining flexibility in Western European countries in Global Ambition 2030.

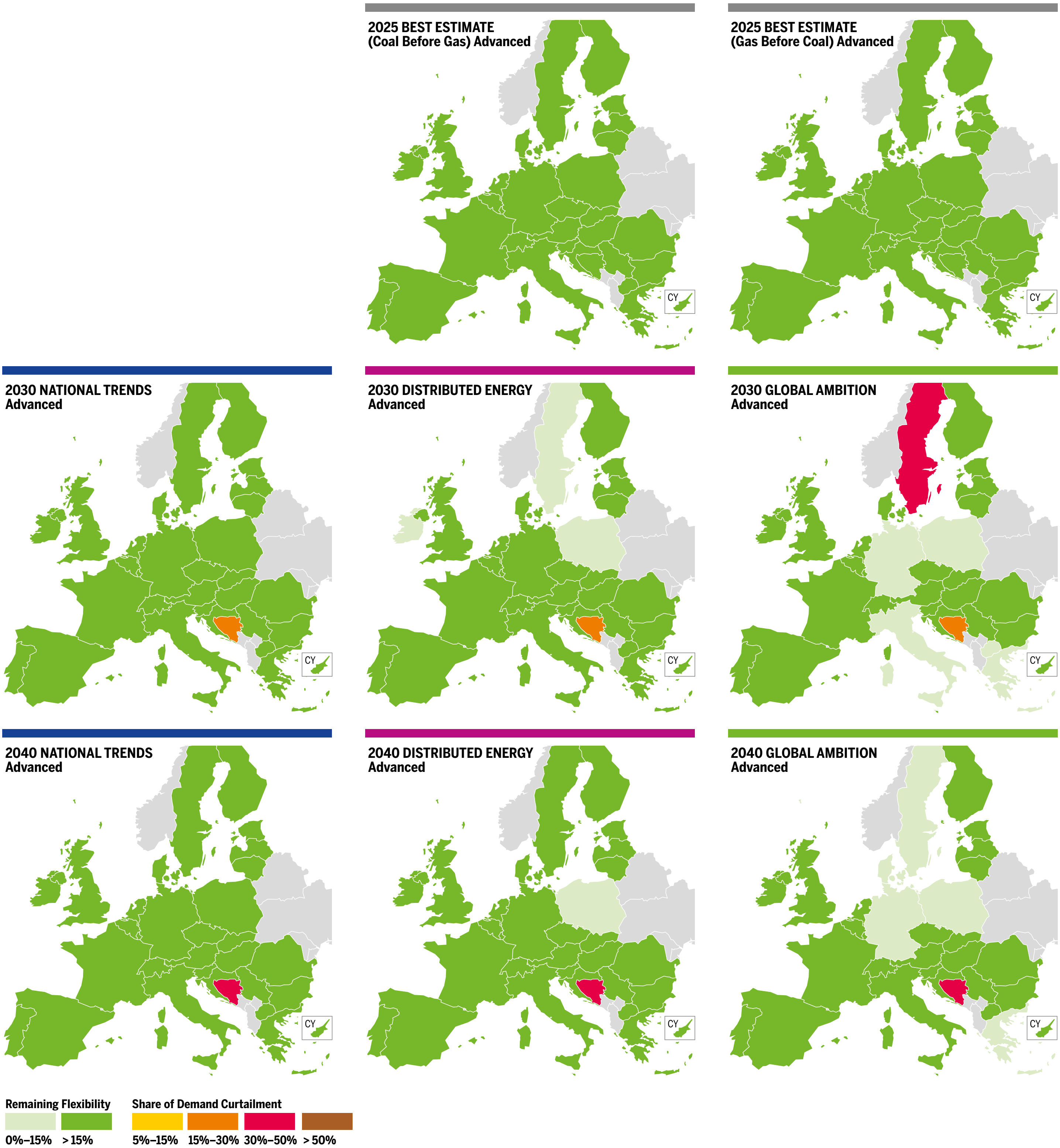

Figure 4.43 Advanced infrastructure level: Ukraine transit disruption under peak day situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under peak day demand and Ukraine transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list. The results show the benefits stemming from the implementation of the latest PCI list. **Figure 4.44** shows the results for this infrastructure level.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

The European gas system, including FID projects is resilient to a peak day situation in case of Ukraine transit disruption. The commissioning of additional projects included in the 4th PCI list improve the remaining flexibility, especially in South-Eastern Europe.

2030–2040

NATIONAL TRENDS

The projects included in the 4th PCI list help **Romania** to fully mitigate its risk of demand curtailment in 2030 and to reduce the risk of demand curtailment in 2040 from 28 % in Low infrastructure level to 7 % in PCI infrastructure level.

Thanks to the commissioning of projects included in the 4th PCI list, **Poland** increases its remaining flexibility above 15 %.

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Global Ambition[15]

Poland fully mitigates its risk of demand curtailment in 2030 and decreases its risk of demand curtailment in 2040 for both scenarios thanks to the commissioning of projects included in the 4th PCI list, allowing neighbouring countries to cooperate. Western European countries increase their remaining flexibility in Global Ambition 2030.

15 Differing from the climatic stress conditions assessment without transit disruption (section 4.1 of this Assessment Report) Denmark and Sweden are not exposed to a risk of demand curtailment in Global Ambition scenario 2040 driven by the lower cooperation between Denmark and Poland which increases the cooperation between Denmark and Sweden. Note that transit disruption cases simulations are based on the regional assessment, in this regard, countries outside the regional zone are not asked to cooperate further.

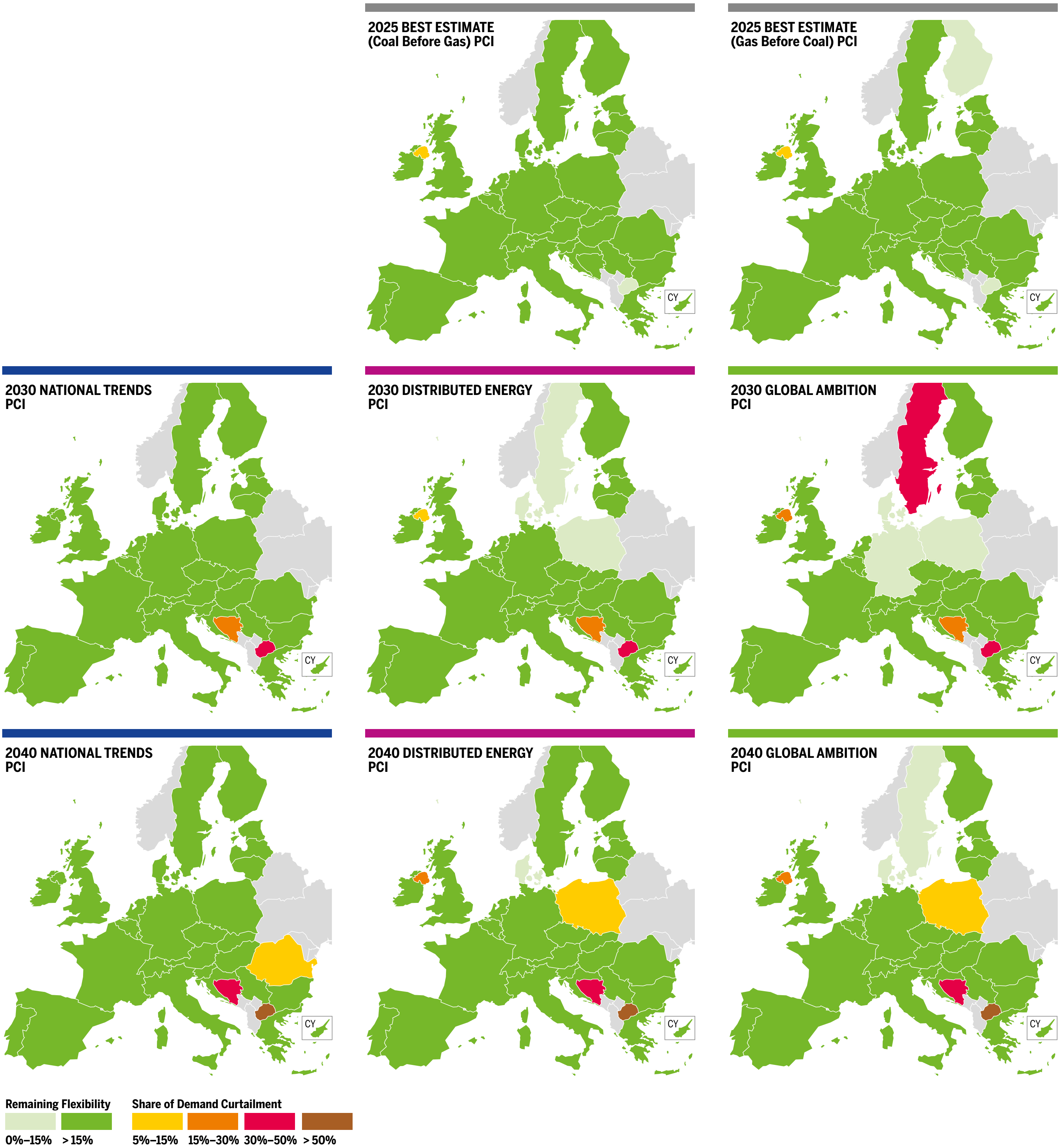

Figure 4.44 PCI infrastructure level: Ukraine transit disruption under peak day situation.

4.2.1.2 2-WEEK COLD SPELL

EXISTING INFRASTRUCTURE LEVEL

As for peak day, the commissioning of Turkstream flowing gas to Bulgaria, and the commissioning of Nordstream 2 with enhanced downstream infrastructure enabling further redirection of flow from West to East, making Southern Eastern Europe more resilient to Ukraine transit disruption. Simulation results show that, apart from the countries already exposed to risk of demand curtailment without any transit disruption, Romania and Poland face risk of additional demand curtailment. **Figure 4.48** shows the results of the assessment.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Simulation results show that apart from the countries already exposed to risk of demand curtailment without any transit disruption, the European gas system is resilient to a Ukraine transit disruption.

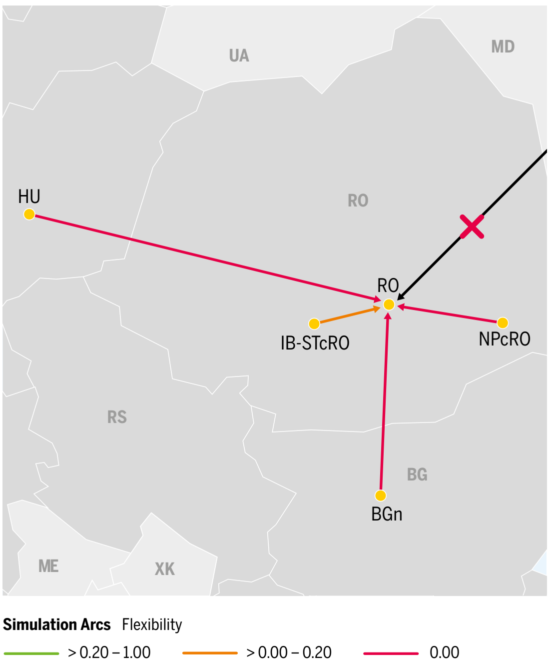

Figure 4.45 Infrastructure limitations towards Romania under Ukraine disruption, Existing infrastructure, 2030.

2030–2040

NATIONAL TRENDS

Simulation results show infrastructure limitations towards **Romania**, limiting the flow from Bulgaria and Hungary, being expose to demand curtailment in 2030 (ca.7 %) further increasing in 2040 (ca.29 %) driven by an increase of the demand combined with a reduction of the indigenous production from 2030 till 2040. **See Figure 4.45 and Figure 4.46.**

Poland is exposed to a limited risk of demand curtailment (9 %) in 2040, being impacted by the Ukraine transit disruption, showing infrastructure limitations towards Poland from its neighbouring countries.

COP 21 SCENARIOS

Distributed Energy and
Global Ambition

In **Romania** the demand curtailment is fully mitigated, thanks to lower demand combined with a higher national production coming from renewables (biomethane and power to gas), in both scenarios compared to National trends. **See Figure 4.47.**

Poland faces an additional risk of demand curtailment under a Ukraine route disruption due to infrastructure limitations with all its neighbouring countries.

The increased of the risk of demand curtailment compared to the assessment of climatic stress conditions without transit disruption shows that Poland is being additionally impacted by the Ukraine transit disruption:

- In 2030: from 13–11 % to 22–19 % for Distributed Energy and Global Ambition respectively
- In 2040: from 17–20 % to 24–28 % for Distributed Energy and Global Ambition, respectively.

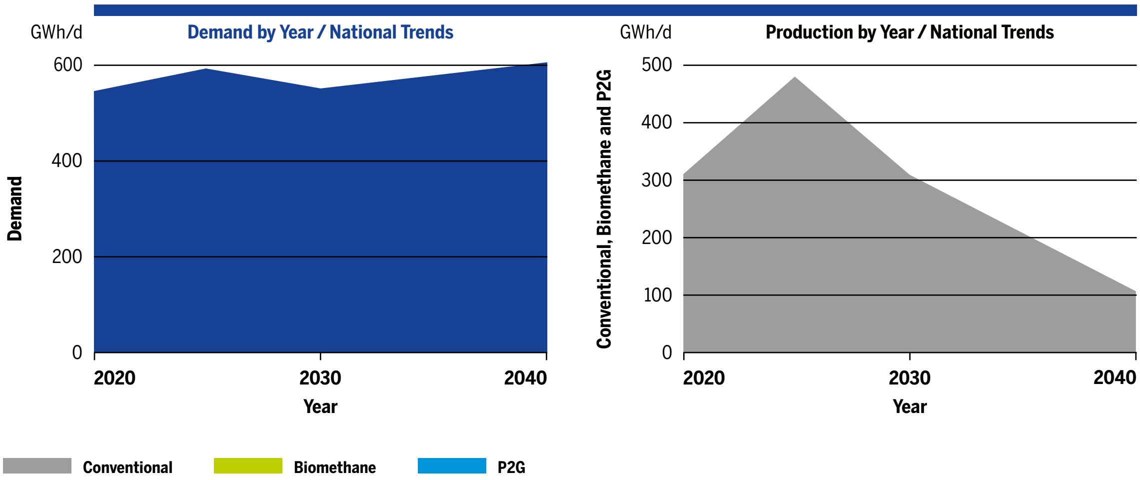

Figure 4.46 2-week cold spell demand and production in Romania in National Trends scenario in GWh/d.

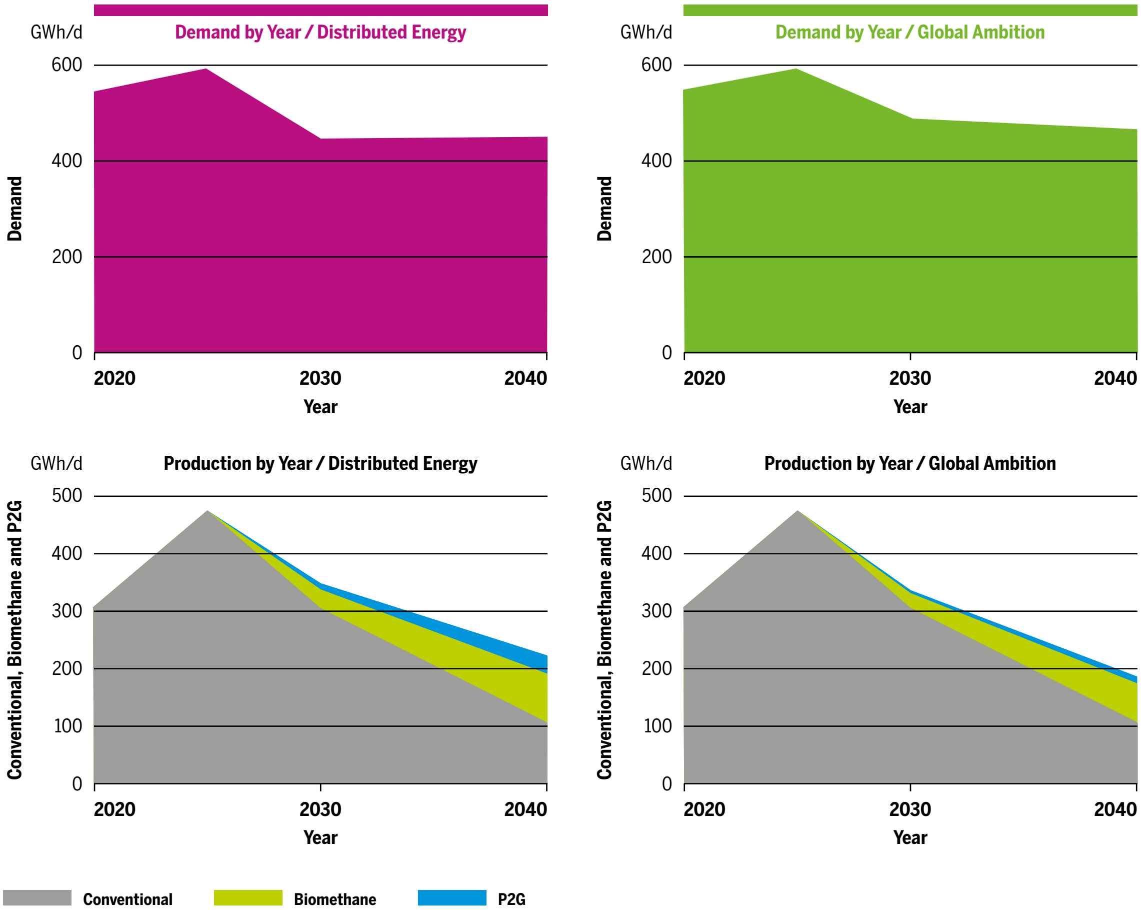

Figure 4.47 2-week cold spell demand and production in Romania in COP 21 scenarios in GWh/d.

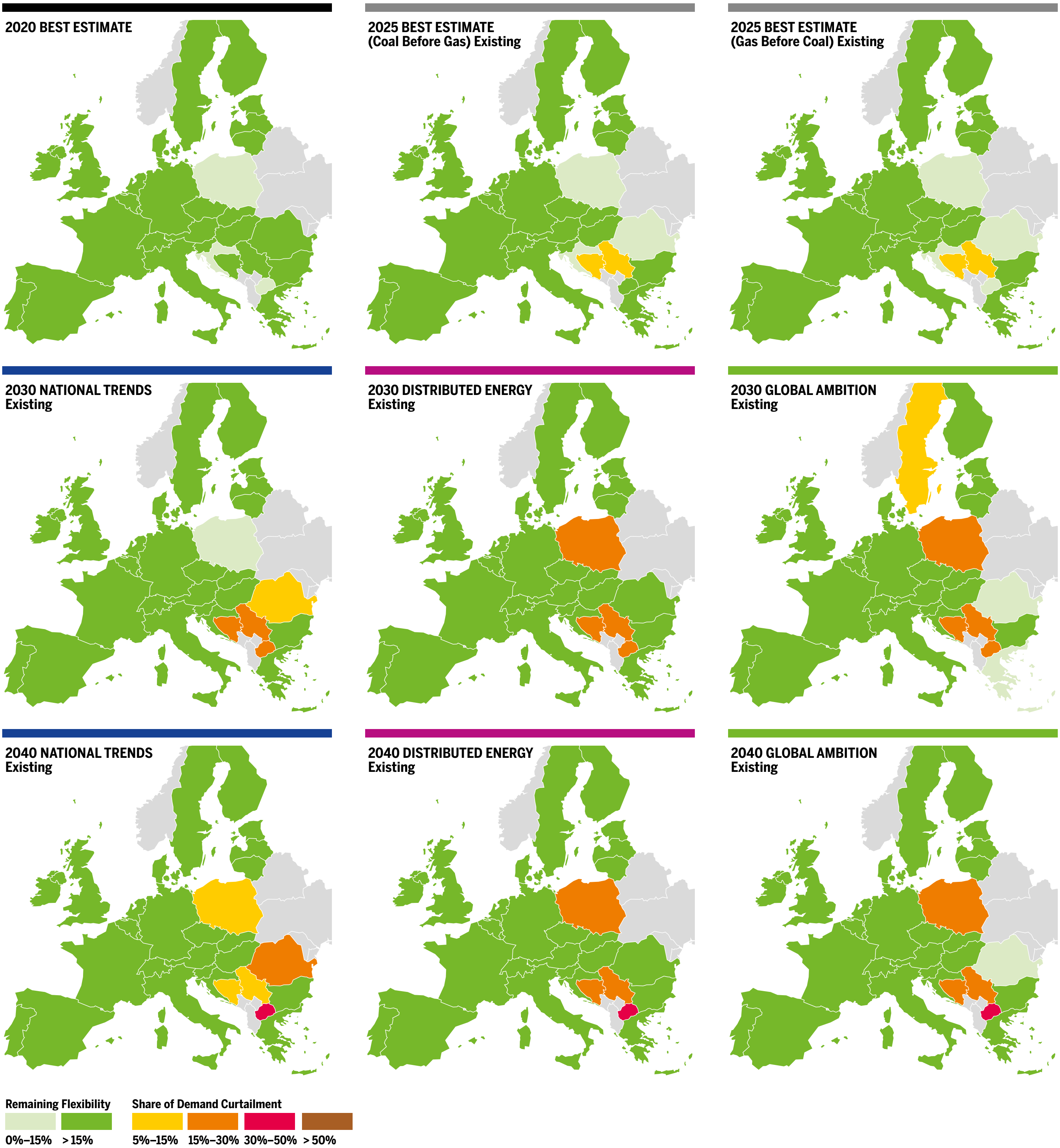

Figure 4.48 Existing infrastructure level: Ukraine transit disruption under 2-week cold spell situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the implementation of FID projects improves the situation of the countries affected by the Ukraine transit route disruption. **Figure 4.49** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Simulation results show that the European gas system is resilient to a Ukraine transit disruption. No country is exposed to demand curtailment and FID projects help to increase the remaining flexibility all around Europe.

2030–2040

NATIONAL TRENDS

Simulation results show that **Romania** fully mitigates its risk of demand curtailment in 2030 and reduces its risk of demand curtailment in 2040 from 29 % in Existing infrastructure level to 19 % in Low infrastructure level, showing that FID projects help to improve the situation within the country.

Poland fully mitigates its risk of demand curtailment in 2040 thanks to the commissioning of FID projects.

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Simulation results show that **Poland** fully mitigates the risk of demand curtailment in 2030 and reduces its risk of demand curtailment in 2040 for both scenarios thanks to the commissioning of FID projects that allow neighbouring countries to cooperate with Poland.

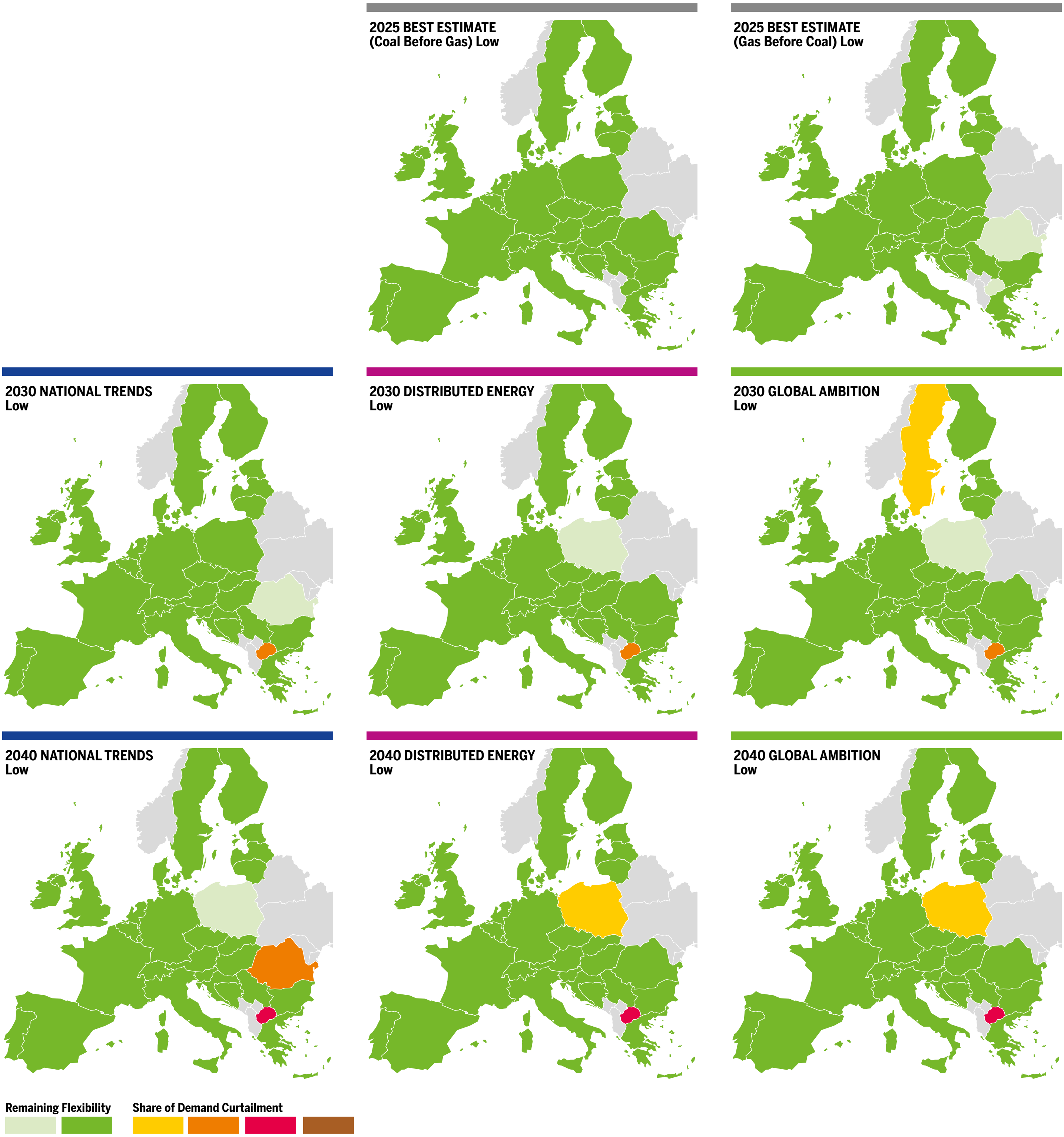

Figure 4.49 Low infrastructure level: Ukraine transit disruption under 2-week cold spell situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that the European gas system is resilient to the Ukraine transit disruption thanks to the commissioning of Advanced-status projects. Results are shown in **Figure 4.50**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

As for Low infrastructure level, the results show that the European gas system is resilient to a Ukraine transit disruption. Advanced-status projects help to increase the remaining flexibility all around Europe.

2030–2040

NATIONAL TRENDS

Simulation results show that **Romania** fully mitigates its risk of demand curtailment in 2040 thanks to the investment of advanced-status projects.

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Simulation results show that **Poland** fully mitigates its risk of demand curtailment in 2040 for both scenarios thanks to the commissioning of advanced-status projects.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week cold spell demand together with Ukraine transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are shown in **Figure 4.51**.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Coal Before Gas and Gas Before Coal, as for Low infrastructure level, the results show that the European gas system is resilient to a Ukraine transit disruption. PCI projects help to increase the remaining flexibility all around Europe.

2030–2040

NATIONAL TRENDS

Thanks to the commissioning of projects included in 4th PCI list **Romania** fully mitigates its risk of demand curtailment (National Trends 2040).

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Thanks to the commissioning of projects included in 4th PCI list **Poland** fully mitigates its risk of demand curtailment in 2040 for both scenarios.

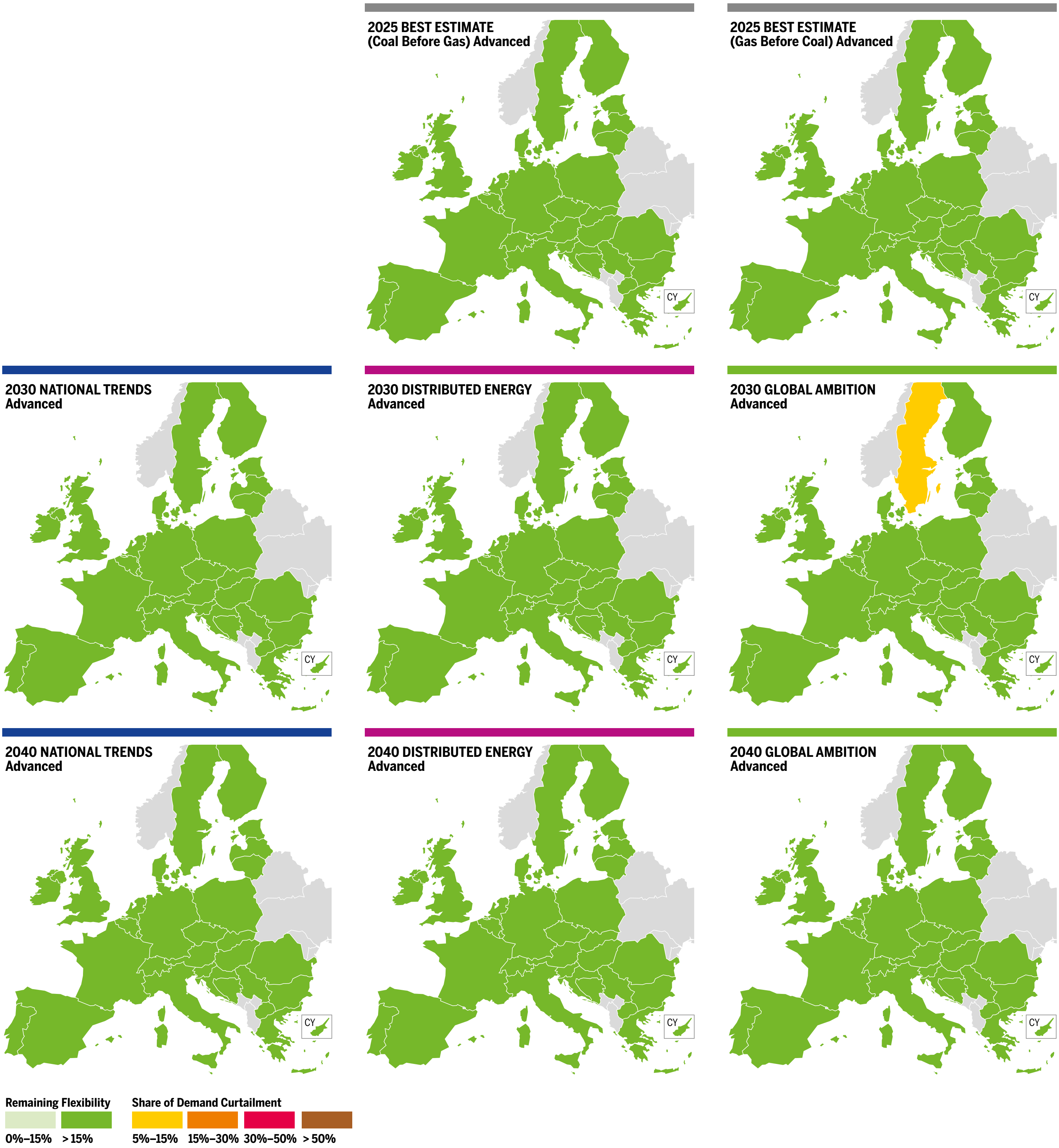

Figure 4.50 Advanced infrastructure level: Ukraine transit disruption under 2-week cold spell situation.

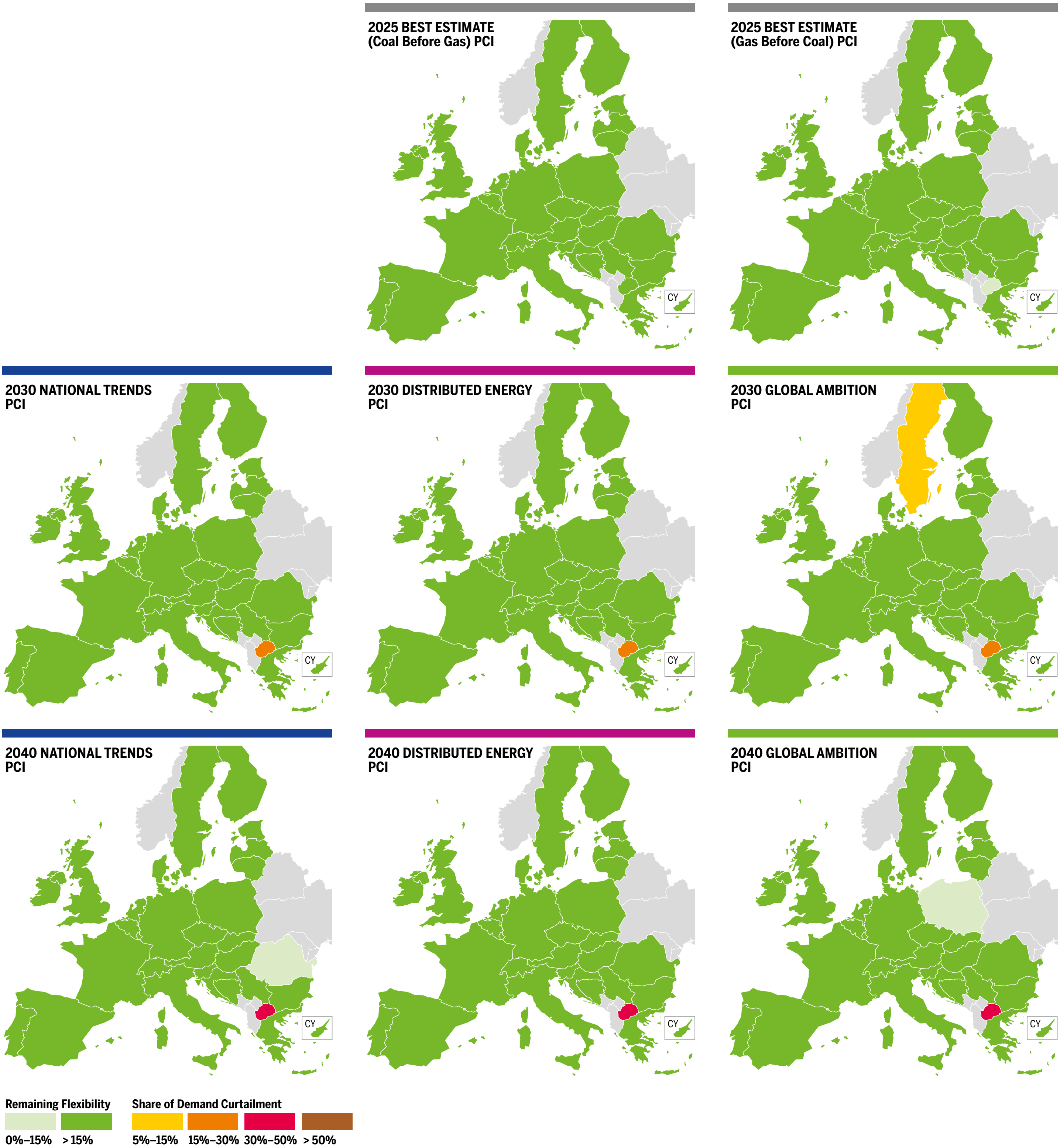

Figure 4.51 PCI infrastructure level: Ukraine transit disruption under 2-week cold spell situation.

4.2.1.3 2-WEEK DUNKELFLAUTE

EXISTING INFRASTRUCTURE LEVEL

As for peak day and 2-week cold spell, assesses the commissioning of Turkstream flowing gas to Bulgaria, makes Southern Eastern Europe more resilient to Ukraine transit disruption. Simulation results show that, apart from the countries already exposed to risk of demand curtailment without any transit disruption, Romania and Poland face risk of additional demand curtailment. **Figure 4.55** shows the results of the assessment.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Coal Before Gas and Gas Before Coal, simulation results show that apart from the countries already exposed to risk of demand curtailment without any transit disruption, the European gas system is resilient to a Ukraine transit disruption.

2030–2040

NATIONAL TRENDS

Simulation results show infrastructure limitations towards **Romania**, limiting the flow from Bulgaria and Hungary, being exposed to demand curtailment in 2030 (ca.11 %) further increasing in 2040 (ca.30 %) driven by an increase of the demand combined with a reduction of the indigenous production from 2030 till 2040. **See Figures 4.52 and 4.53.**

Poland is exposed to a limited risk of demand curtailment (19 %) in 2040, being impacted by the Ukraine transit disruption, showing infrastructure limitations towards Poland from its neighbouring countries.

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Romania thanks to lower demand combined with a higher national production coming from renewables (biomethane), in both scenarios compared to National trends, the demand curtailment is fully mitigated in the country. **See Figure 4.54.**

Some infrastructure limitations between Poland and its neighbouring countries expose **Poland** to a risk of demand curtailment in both scenarios and years.

The increased of the risk of demand curtailment compared to the assessment of climatic stress conditions without transit disruption shows that Poland is being additionally impacted by the Ukraine transit disruption:

- In 2030: from 14–12 % to 23–20 % for Distributed Energy and Global Ambition respectively
- In 2040: from 20–21 % to 27–29 % for Distributed Energy and Global Ambition respectively.

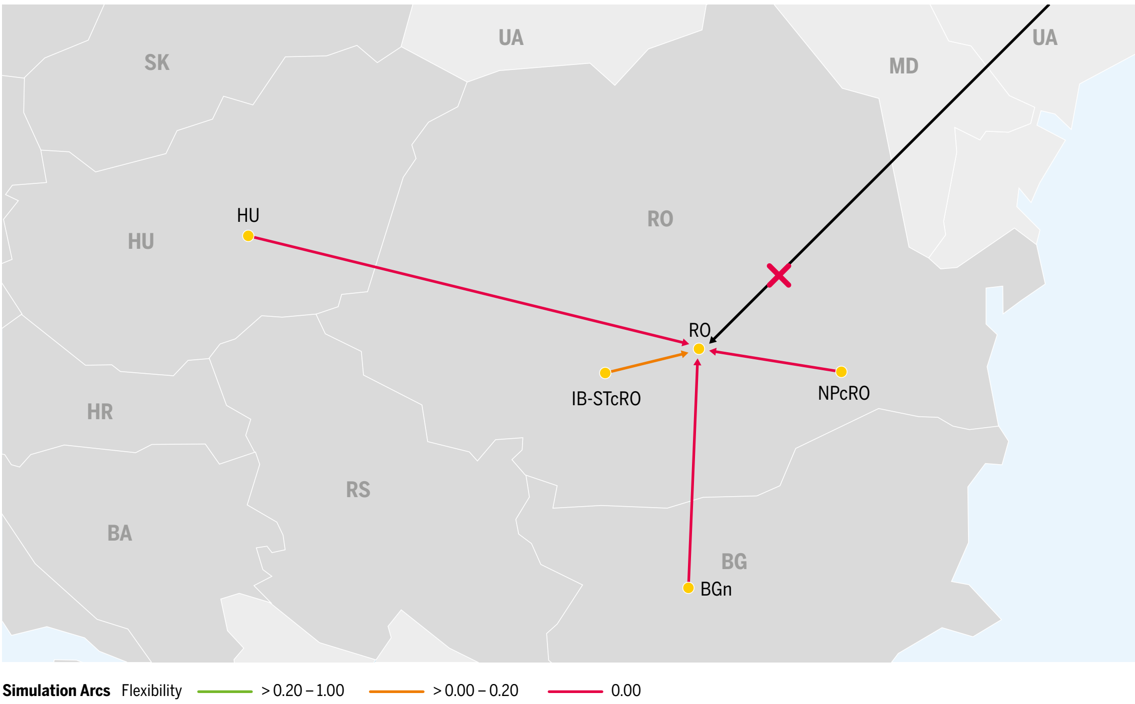

Figure 4.52 Infrastructure limitations towards Romania under Ukraine transit disruption, Existing infrastructure, National Trends ,2030.

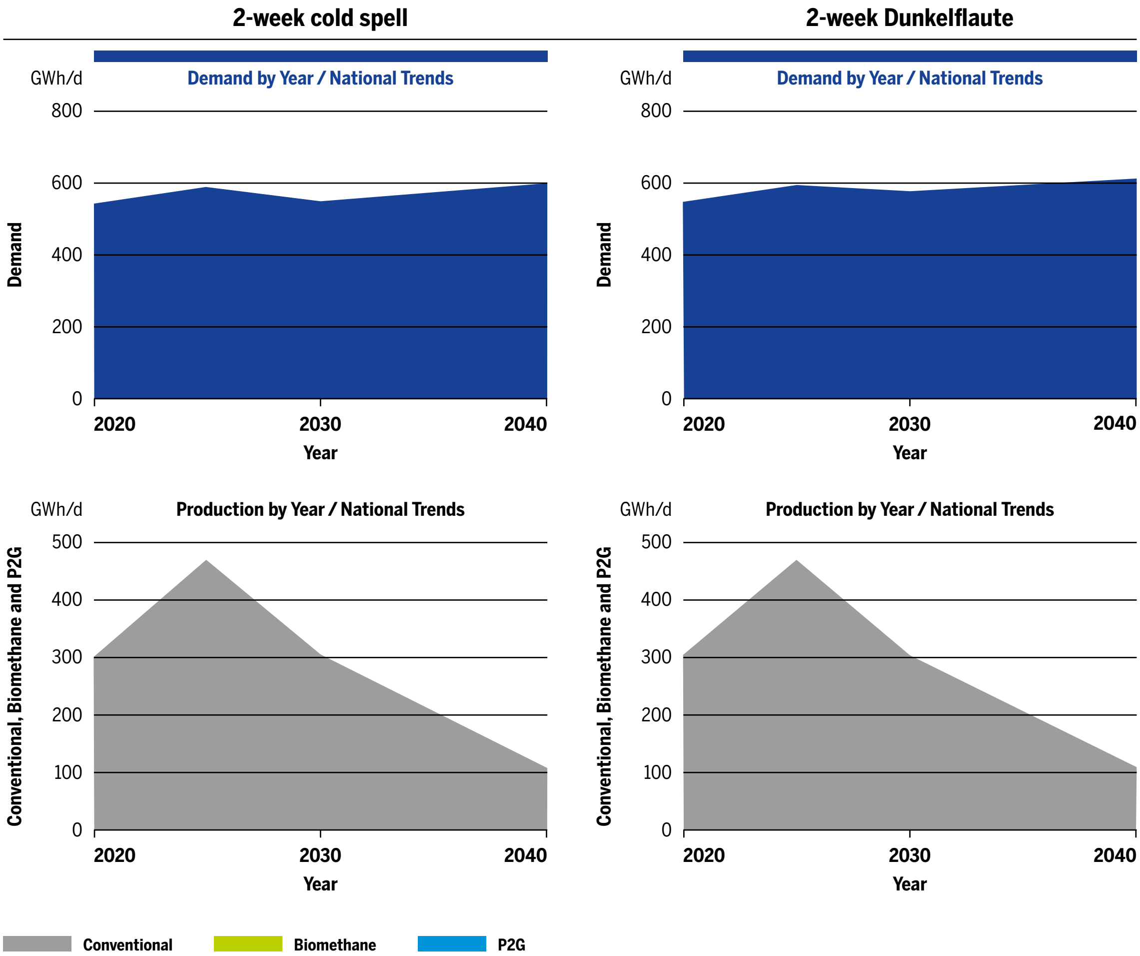

Figure 4.53 2-week cold spell/Dunkelflaute demand and production in Romania in National Trends scenario in GWh/d.

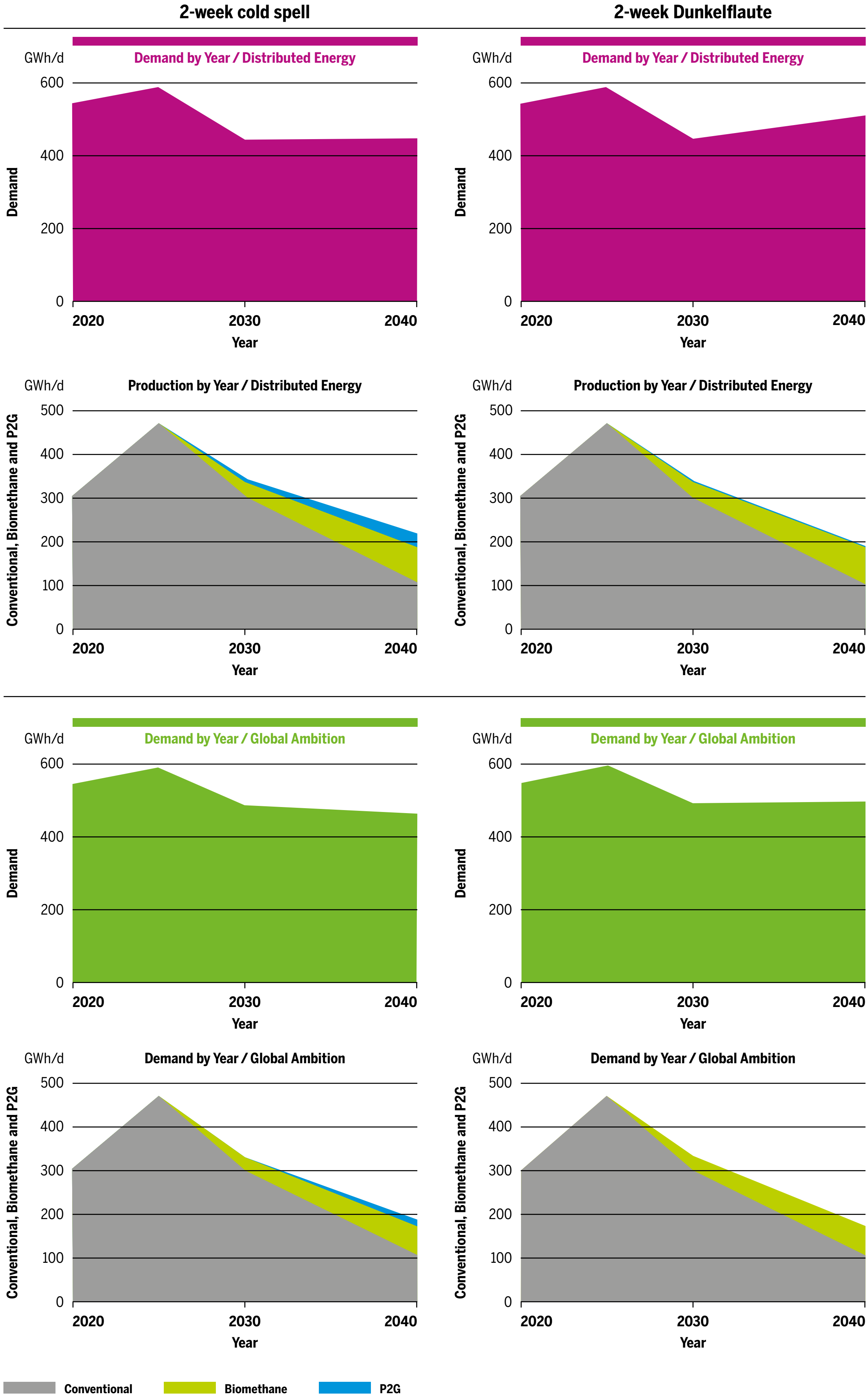

Figure 4.54 2-week cold spell/Dunkelflaute demand and production in Romania in Distributed Energy & Global Ambition scenarios in GWh/d.

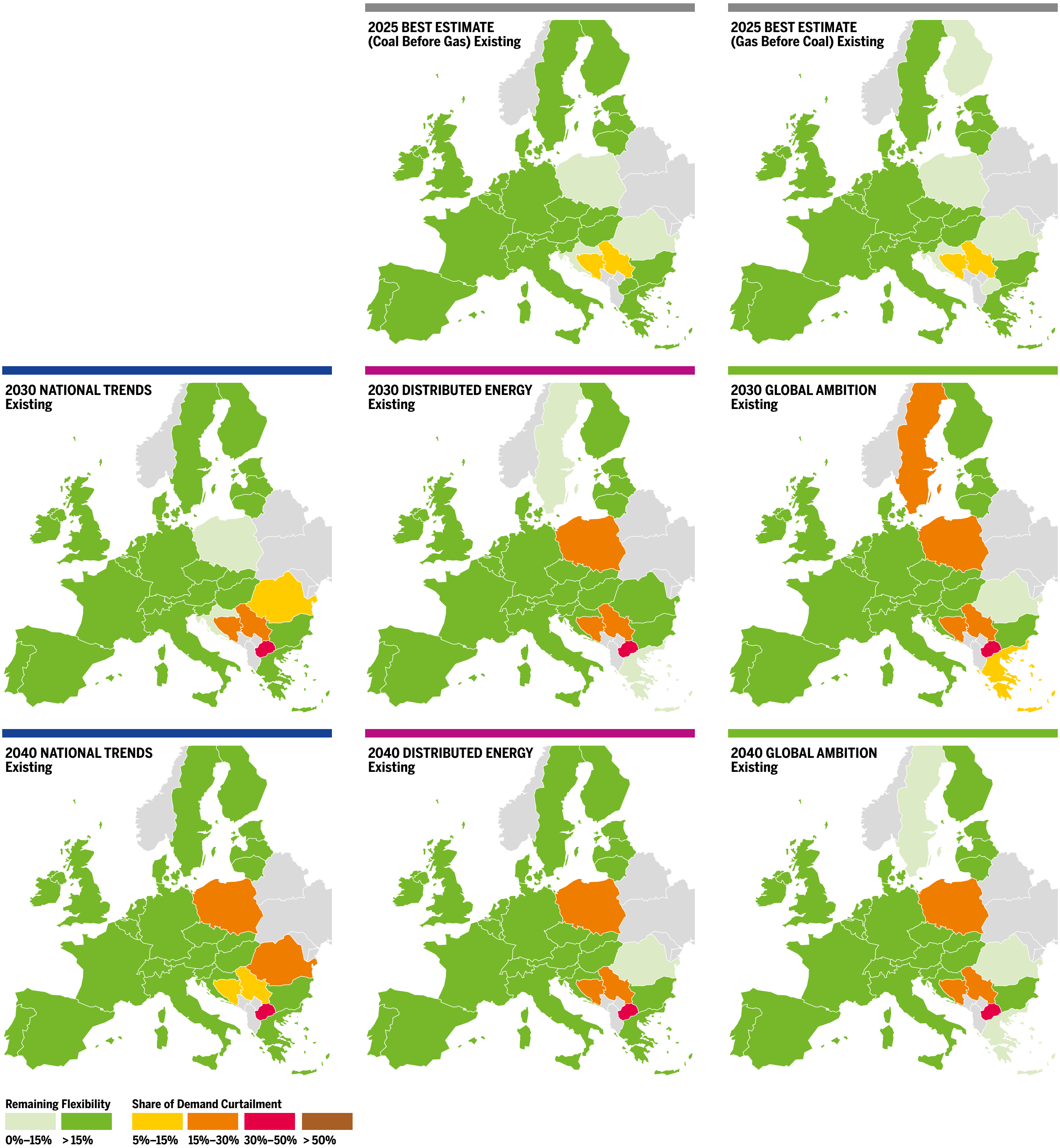

Figure 4.55 Existing infrastructure level: Ukraine transit disruption under 2-week Dunkelflaute situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the implementation of FID projects improve the situation of the countries affected by the Ukraine transit route disruption. **Figure 4.56** shows the results described below:

2025

COAL BEFORE GAS/GAS BEFORE COAL

Simulation results show that the European gas system is resilient to a 2-week Dunkelflaute demand case showing higher remaining flexibility all over Europe thanks to the commissioning of FID projects. Additionally, the remaining flexibility in Romania increases from 1 % in Existing infrastructure level to 15 % in Low infrastructure level (in both scenarios).

2030–2040

NATIONAL TRENDS

Simulation results show that **Romania** fully mitigates its risk of demand curtailment in 2030 and decreases its risk of demand curtailment in 2040 from 30 % in Existing infrastructure level to 20 % in Low infrastructure level, showing that FID projects help to improve the situation within the country.

Poland fully mitigates its risk of demand curtailment in 2040 thanks to the commissioning of FID projects.

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Simulation results show that **Poland** fully mitigates its risk of demand curtailment in 2030 and reduces its risk of demand curtailment in 2040 compared to Existing infrastructure level (from 27–29 % to 9–11 % for Distributed Energy and Global Ambition respectively) scenarios thanks to the commissioning of FID projects that allow neighbouring countries to cooperate with Poland.

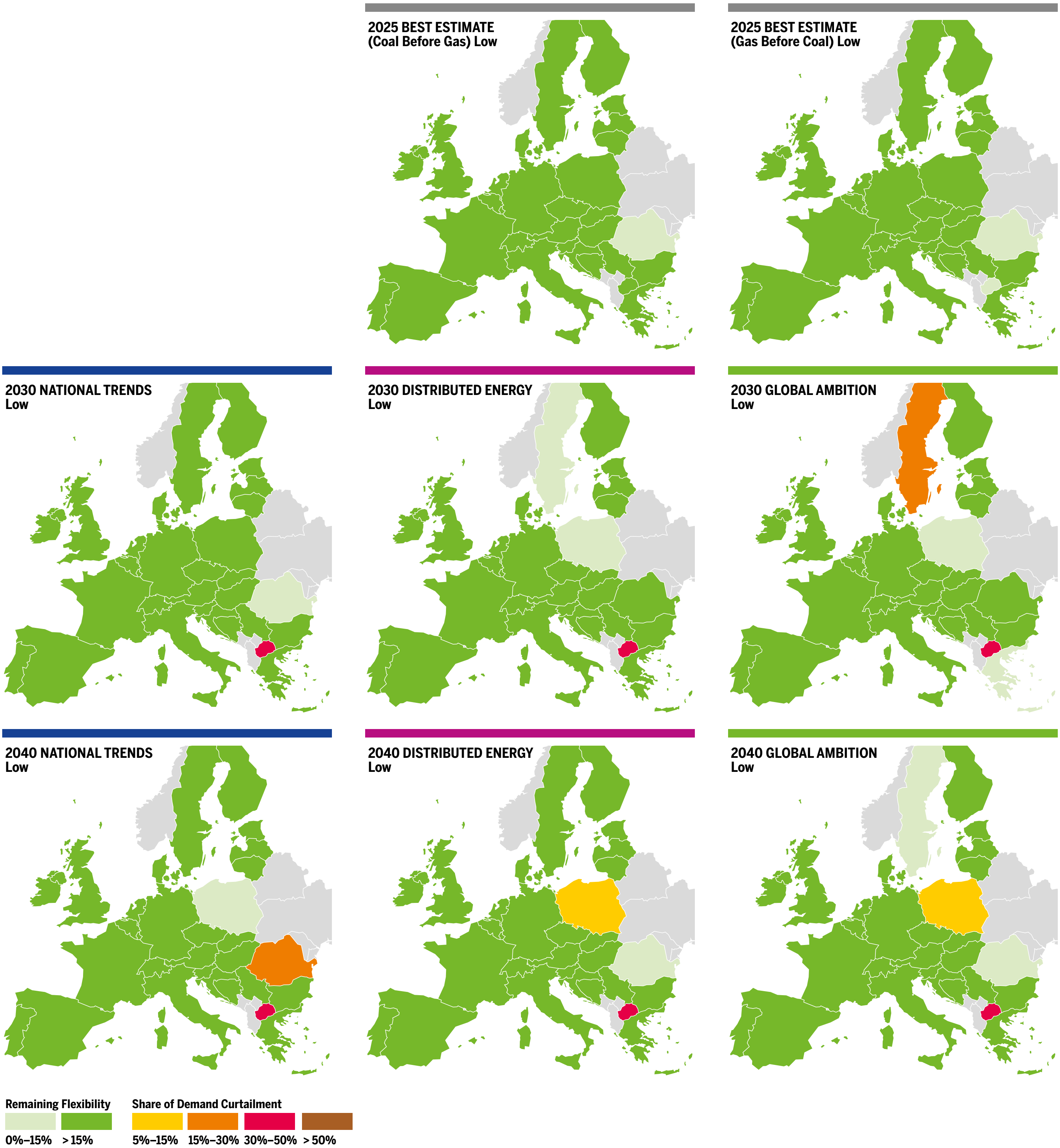

Figure 4.56 Low infrastructure level: Ukraine transit disruption under 2-week Dunkelflaute situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that the European gas system is resilient to the Ukraine transit disruption thanks to the commissioning of Advanced-status projects. Results are shown in **Figure 4.57**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a 2-week Dunkelflaute showing higher remaining flexibility all over Europe thanks to the commissioning of advanced-status projects. Additionally, the remaining flexibility in Romania surpasses the 15 % up to 67 %.

2030–2040

NATIONAL TRENDS

Simulation results show that **Romania** fully mitigates its risk of demand curtailment in 2040 thanks to the investment of advanced-status projects.

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Simulation results show that **Poland** fully mitigates its risk of demand curtailment in 2040 for both scenarios thanks to further cooperation with neighbouring countries brought by the investment of advanced-status projects.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week Dunkelflaute demand together with Ukraine transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are shown in **Figure 4.58**.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a 2-week Dunkelflaute showing higher remaining flexibility along Europe thanks to the commissioning of PCI projects. Additionally, the remaining flexibility in Romania surpasses the 15 % up to 66 %.

2030–2040

NATIONAL TRENDS

Thanks to the commissioning of projects included in 4th PCI list Romania fully mitigates its risk of demand curtailment (National Trends 2040).

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Thanks to the commissioning of projects included in 4th PCI list **Poland** fully mitigates its risk of demand curtailment in 2040 for both scenarios ensuring further cooperation with neighbouring countries.

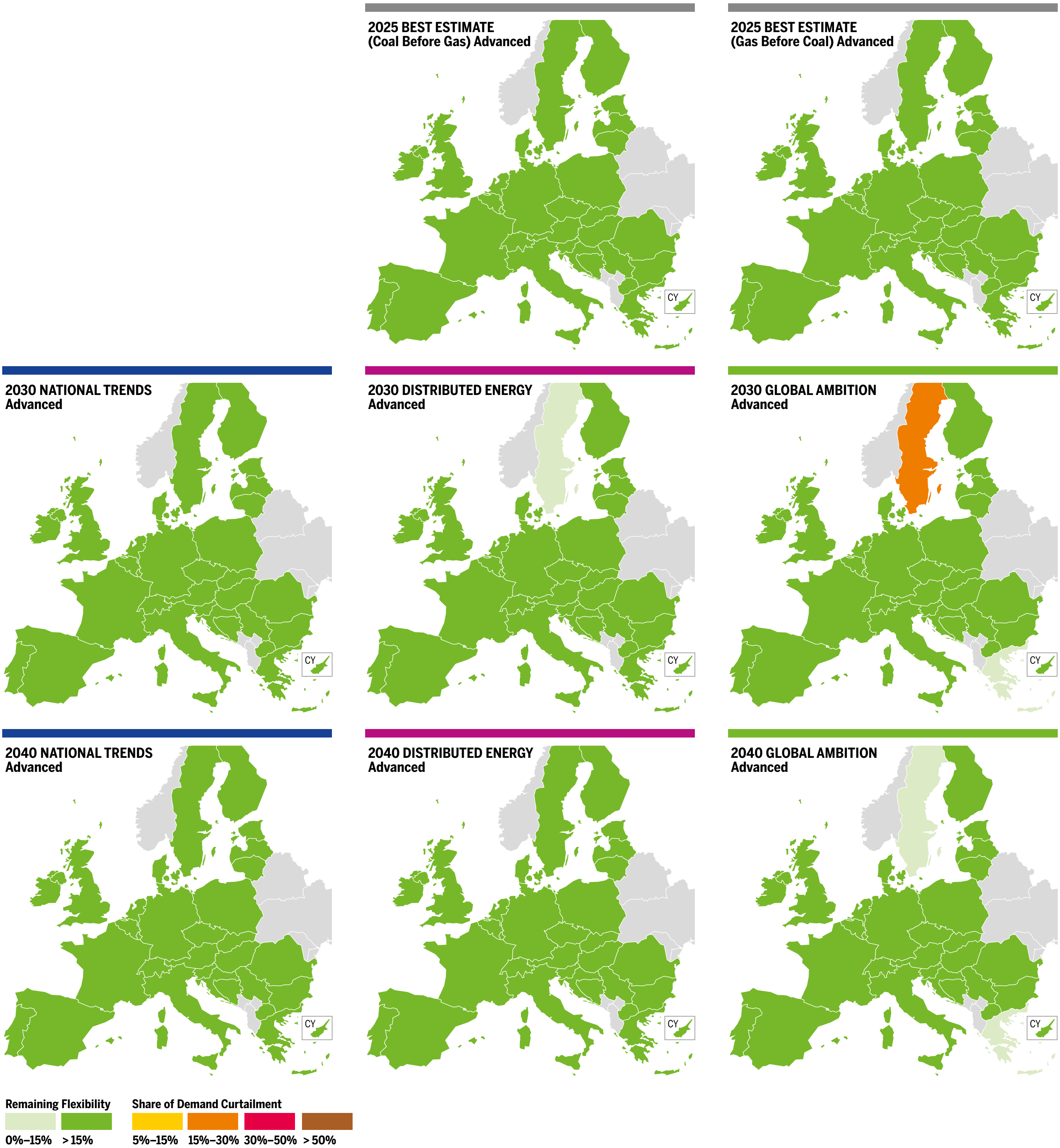

Figure 4.57 Advanced infrastructure level: Ukraine transit disruption under 2-week Dunkelflaute situation.

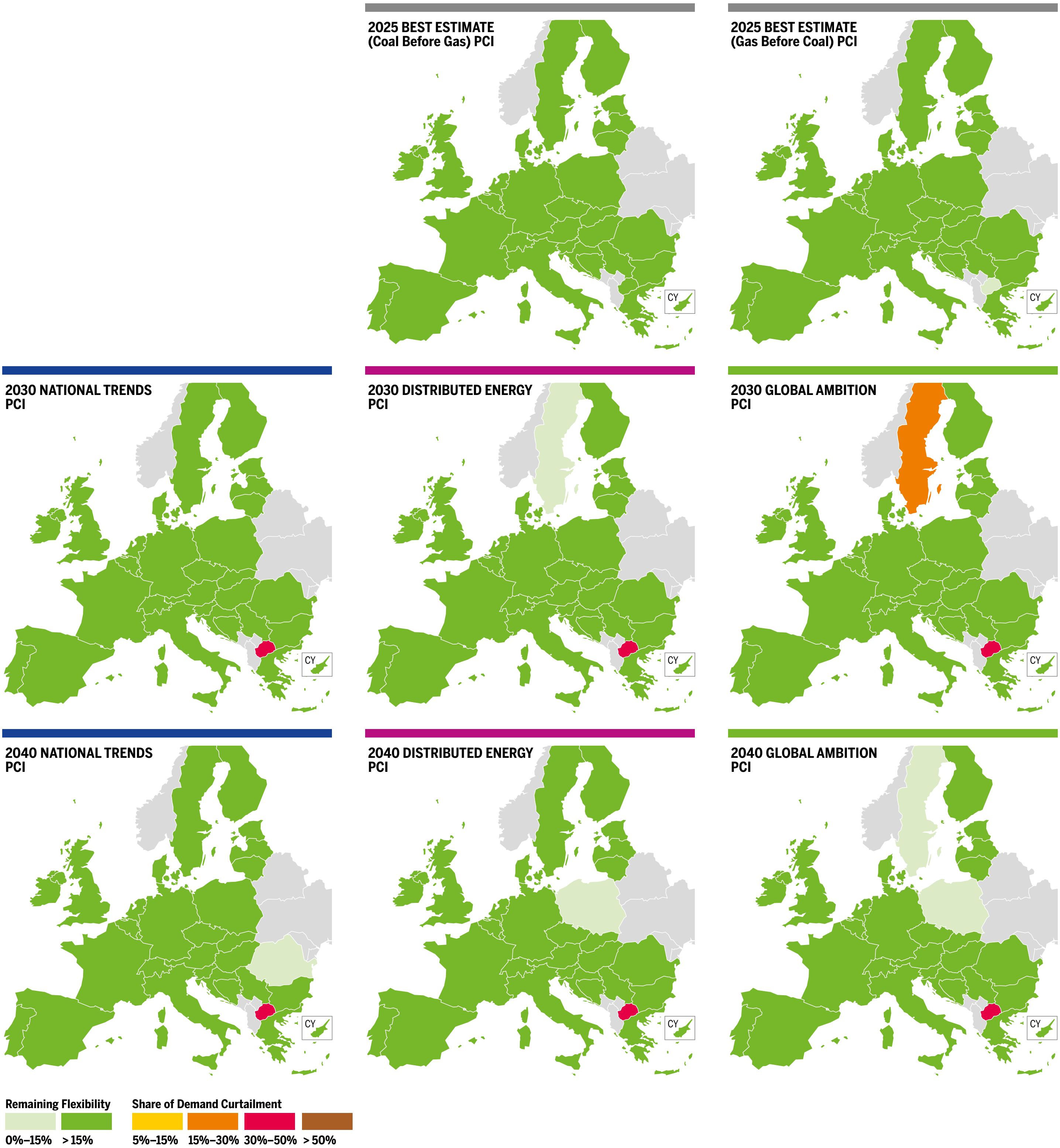

Figure 4.58 PCI infrastructure level: Ukraine transit disruption under 2-week Dunkelflaute situation.

4.2.2 BELARUS DISRUPTION

This assessment considers the disruption of all gas imports via Belarus during climatic stress situations and the risk group is formed by Czech Republic, Belgium, Finland, Estonia, Germany, Latvia, Lithuania, Luxembourg, Netherlands, Poland and Slovakia.

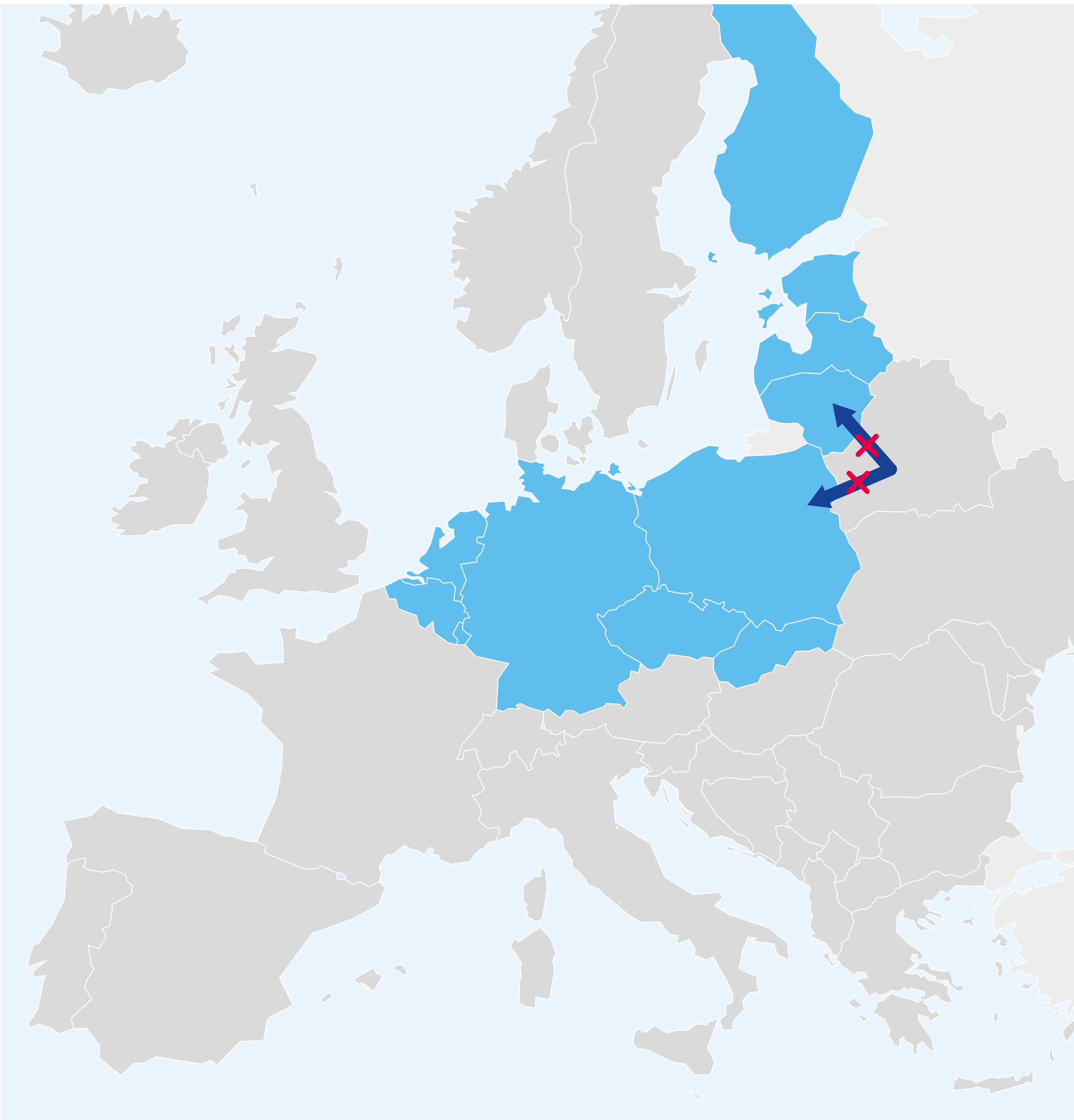

Figure 4.59 Risk group for Belarus transit disruption.

4.2.2.1 PEAK DAY

EXISTING INFRASTRUCTURE LEVEL

The existing infrastructure is generally resilient to a disruption of gas supply from Belarus in climatic stress situations. Results are very similar compared to climatic stress assessment without transit disruption. Nevertheless, Poland is exposed to additional risk of demand curtailment driven by its direct import interconnection with Belarus. **Figure 4.61** shows the evolution of the existing infrastructure level described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios results show that **Poland** faces a limited risk of demand curtailment driven by no imports supply from Belarus together with infrastructure limitations with its neighbouring countries and full utilisation of the import capacity from Ukraine. **See Figure 4.60.**

2030–2040

NATIONAL TRENDS

Poland is exposed to a limited risk of demand curtailment in 2030 (ca. 10 %) follow by a high risk of demand curtailment in 2040 (ca. 31 %) mainly driven by no imports supply from Belarus, together with infrastructure limitations with its neighbouring countries and full utilisation of the import capacity from Ukraine. The increase of polish demand from 2030 to 2040 could be mainly explain by the displacement of coal and oil in heating and power generation sector.

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Poland faces an additional risk of demand curtailment under a Belarus transit disruption due to infrastructure limitations with its neighbouring countries and full utilisation of the import capacity from Ukraine. Aditionally, despite the development of conventional and renewable gases generation, the transition away from coal in the power and heating generation increases of its peak demand. Throughout 2030 to 2040, the risk of demand curtailment increases from 39–38 % in 2030 and from 44–46 % in 2040 in 2040 Distributed Energy and Global Ambition scenarios, respectively.

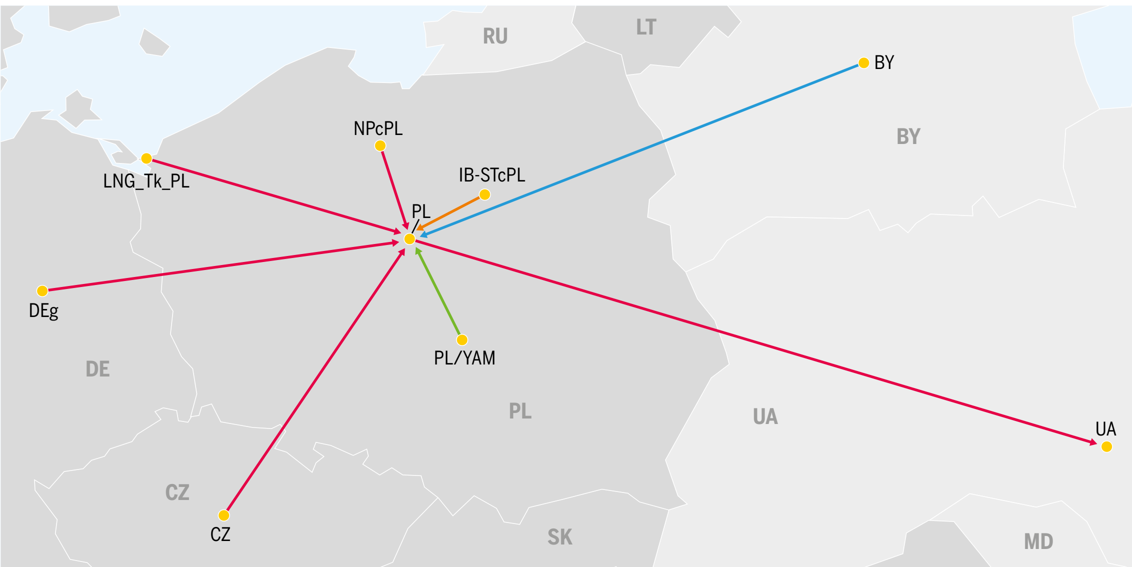

Figure 4.60 Infrastructure limitations towards Poland under Belarus transit disruption, Existing infrastructure, 2025.

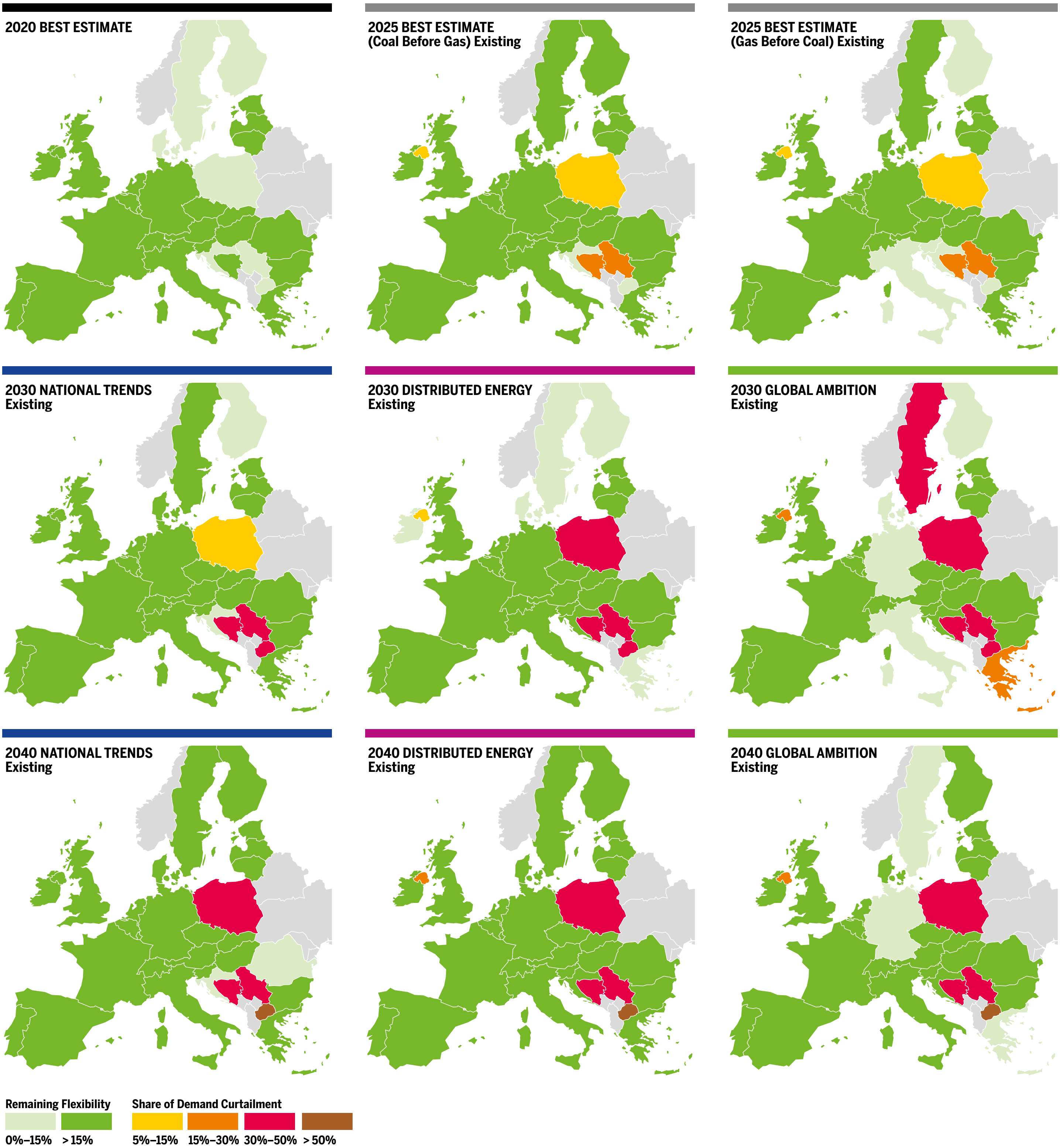

Figure 4.61 Existing infrastructure level: Belarus transit disruption under peak day situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that FID projects improve the situation for those countries affected by the Belarus transit disruption. **Figure 4.64** shows the Low Infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The commissioning of FID projects fully mitigate the risk of demand curtailment in **Poland**.

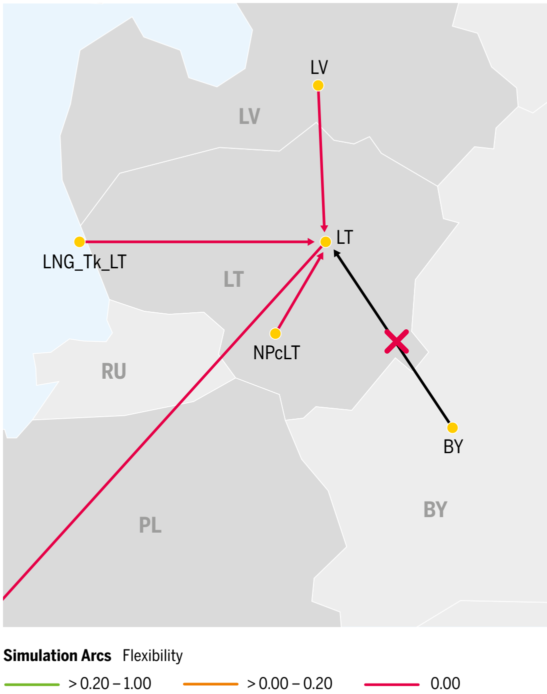

Figure 4.63 Infrastructure limitations towards Lithuania under Belarus transit disruption, Low infrastructure, Global Ambition, 2040.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2030 reaching a remaining flexibility of 15 % and reduces its risk of demand curtailment from 31 % in Existing infrastructure level to 12 % in Low infrastructure level thanks to the commissioning of FID projects. The commissioning of the FID project Lithuania-Poland interconnection enables the cooperation between both countries reducing Lithuania's remaining flexibility to 6 % in 2040.

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Poland reduces its risk of demand curtailment in both scenarios and years, nevertheless, the commissioning of FID projects is not enough to fully mitigate the gap of infrastructure in Poland. Poland has an infrastructure limitation restricting the flow from Germany, Czech Republic, Slovakia, Ukraine, and Lithuania to Poland. **See Figure 4.62.**

To a lesser extent, **Lithuania** faces a limited risk of demand curtailment in Global Ambition 2040 (9 %) driven by the commissioning of the interconnection Lithuania-Poland enabling the cooperation between both countries, together with an infrastructure limitation restricting the flow from Latvia to Lithuania. Lithuania is exposed to risk of demand curtailment despite the fact that it is able to satisfy its demand. **See Figure 4.63.**

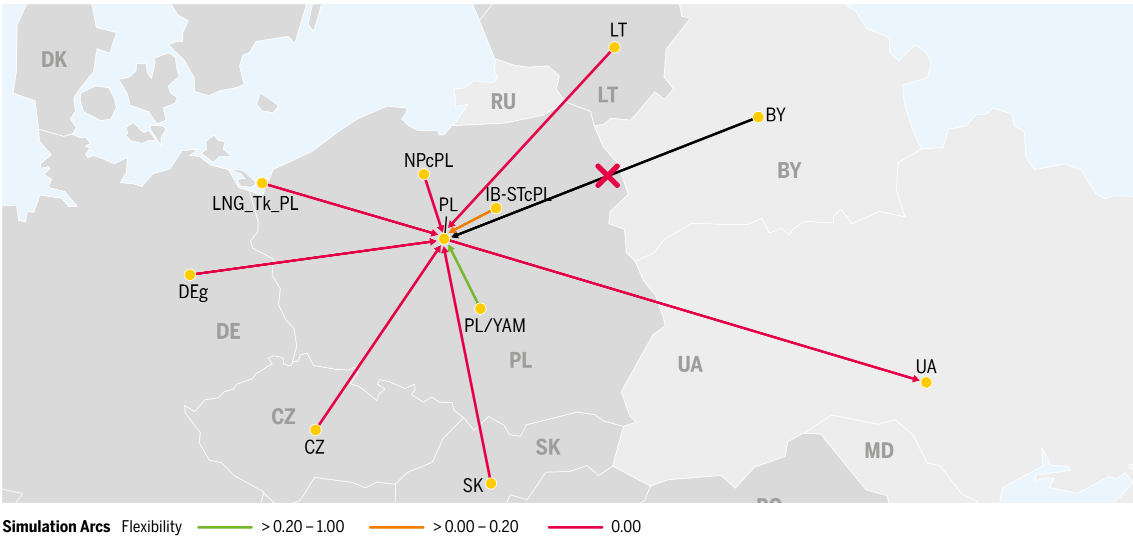

Figure 4.62 Infrastructure limitations towards Poland under Belarus transit disruption, Low infrastructure, Global Ambition, 2040

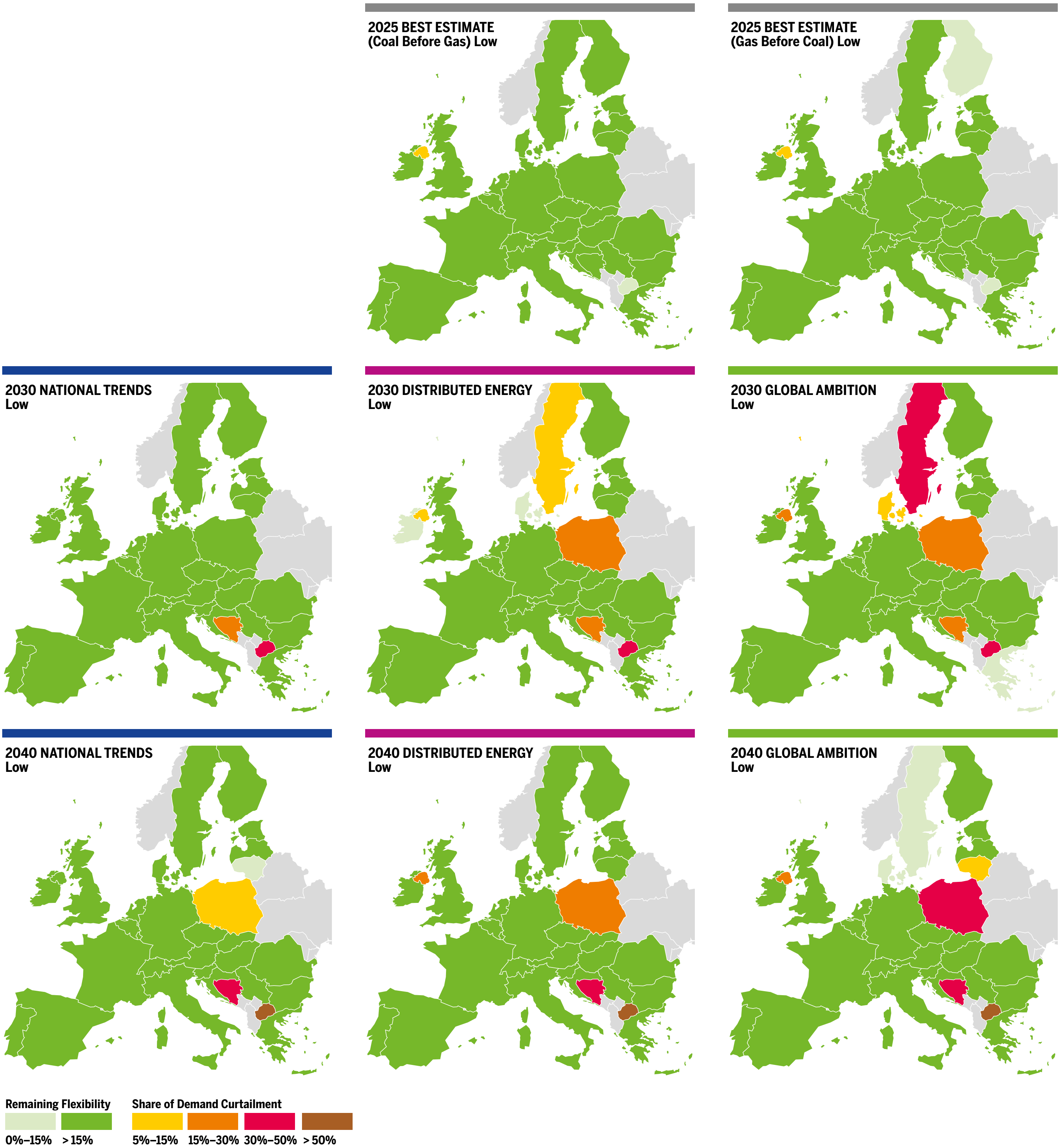

Figure 4.64 Low infrastructure level: Belarus transit disruption under peak day situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that the inclusion of advanced-status projects help to cope with demand curtailments caused by Belarus transit disruption. **Figure 4.65** shows the Advanced infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system is resilient to a Peak day situation in case of Belarus transit disruption.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2040 reaching a remaining flexibility of 30 % thanks to the commissioning of advanced-status projects. Lithuania's remaining flexibility increases in 2040 from 6 % in Low infrastructure level to 100 % Advanced infrastructure level thanks to the commissioning of advanced-status projects.

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Poland fully mitigates its risk of demand curtailment in both scenarios and years, the commissioning of advanced-status projects help to mitigate the gap of infrastructure in Poland.

Lithuania fully mitigate its risk of demand curtailment as well in Global Ambition 2040 reaching a remaining flexibility of 27 %. Advanced-status projects cope with the infrastructure limitation in the area.

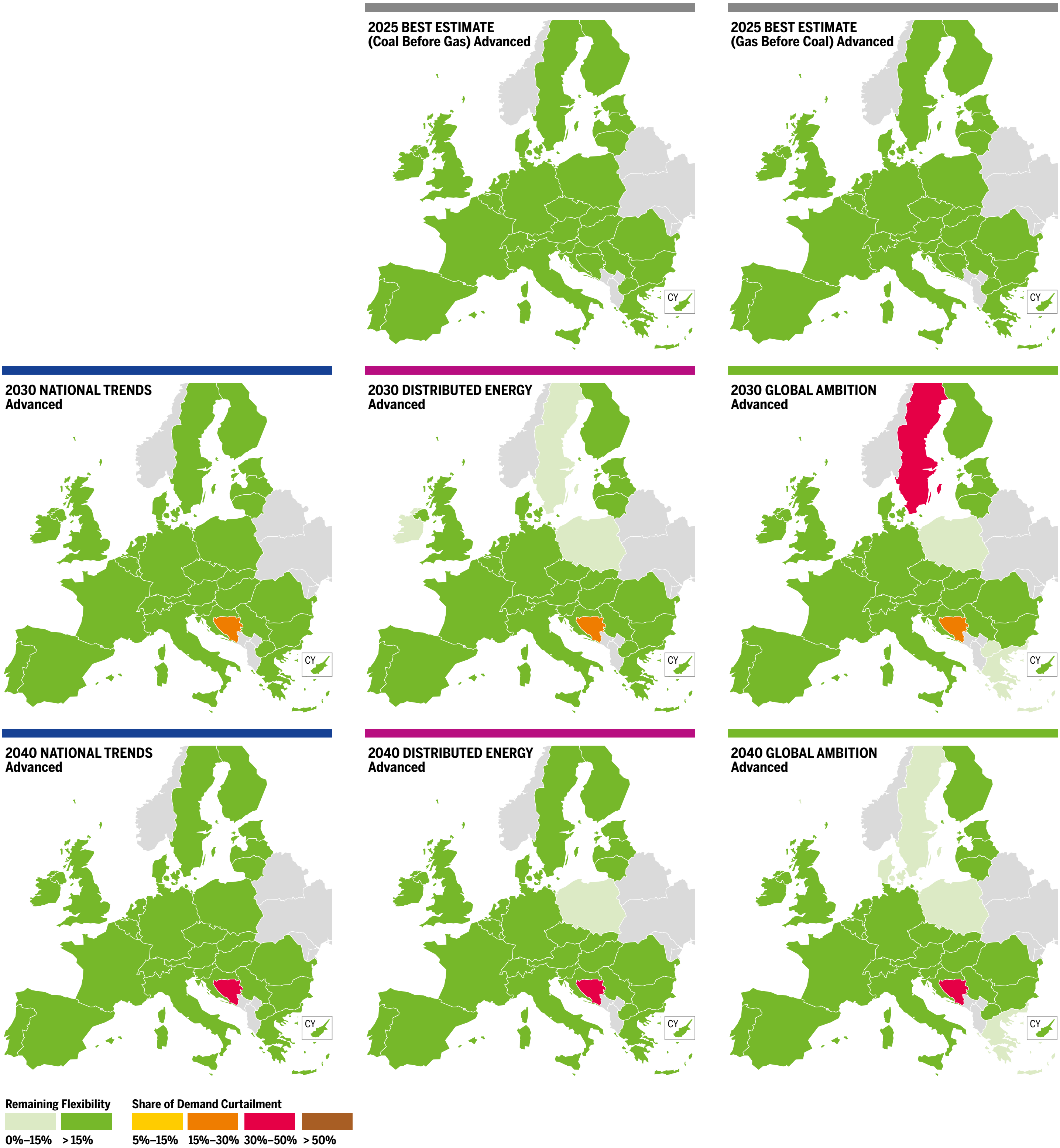

Figure 4.65 Advanced infrastructure level: Belarus transit disruption under peak day situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under peak day demand and Belarus transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list. The results show the benefits stemming from the implementation of the latest PCI list. **Figure 4.66** shows the evolution of the PCI infrastructure level.

2025

COAL BEFORE GAS/GAS BEFORE COAL

The European gas system, including FID projects is resilient to a peak day situation in case of Belarus transit disruption.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2040 reaching a remaining flexibility of 10 % thanks to the commissioning of advanced-status projects. Lithuania's remaining flexibility increases in 2040 from 6 % in Low infrastructure level to 100 % in PCI infrastructure level.

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Poland reduces its risk of demand curtailment in both scenarios and years[16]:

- In 2030: from 22–21 % in Low infrastructure level to 11–9 % in PCI infrastructure level for Distributed Energy and Global Ambition respectively,
- in 2040: from 30–32 % in Low infrastructure level to 12–21 % in PCI infrastructure level for Distributed Energy and Global Ambition respectively.

Nevertheless, the commissioning of PCI projects is not enough to mitigate the gap of infrastructure in Poland.

Lithuania fully mitigates its risk of demand curtailment in Global Ambition 2040 reaching a remaining flexibility of 27 % thanks to the commissioning of PCI projects.

16 Differing from the climatic stress conditions assessment without transit disruption (section 4.1 of this Assessment Report) Denmark and Sweden are not exposed to a risk of demand curtailment in Global Ambition scenario 2040 driven by the lower cooperation between Denmark and Poland which increases the cooperation between Denmark and Sweden. Note that transit disruption cases simulations are based on the regional assessment, in this regard, countries outside the regional zone are not asked to cooperate further.

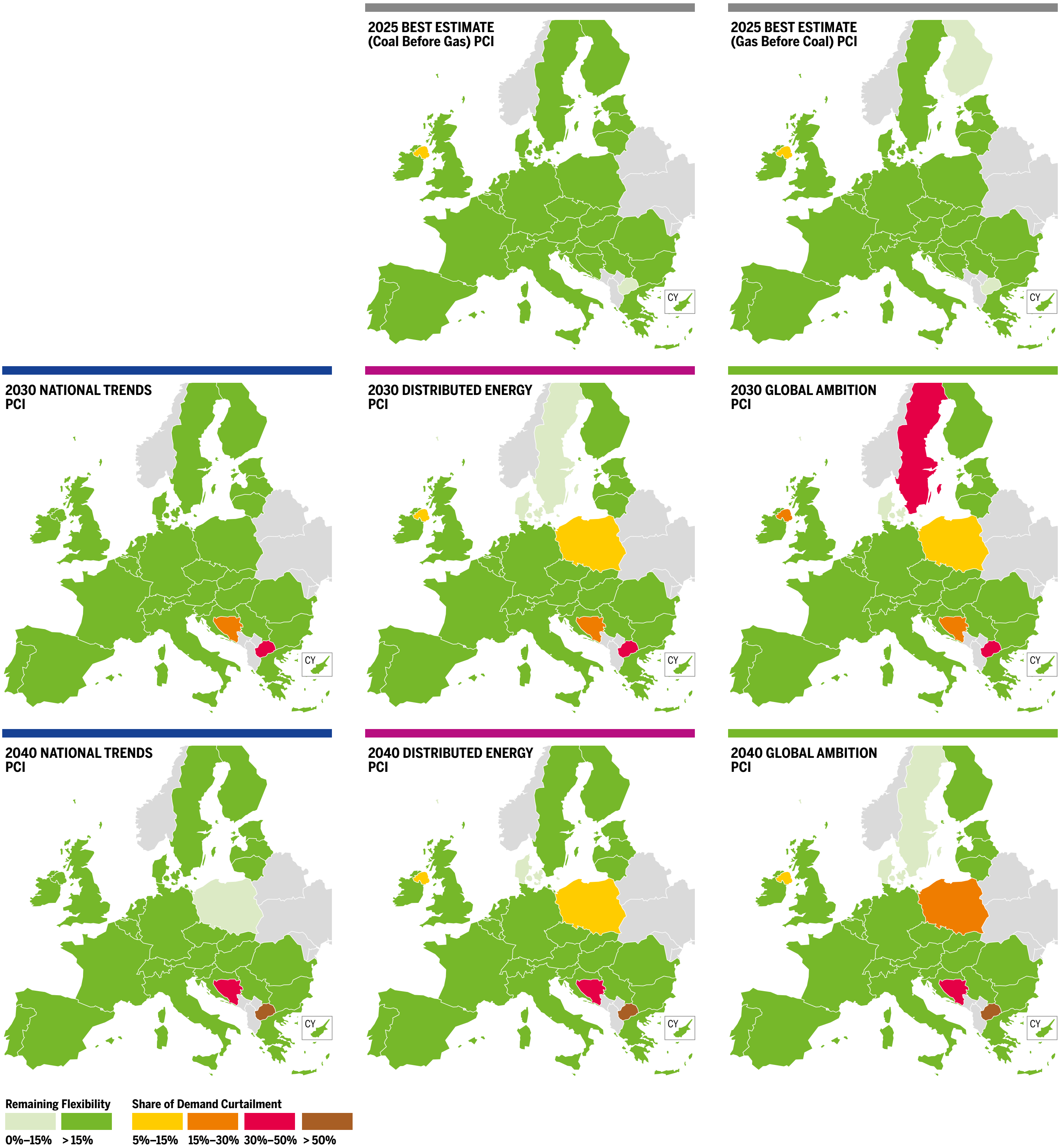

Figure 4.66 PCI infrastructure level: Belarus transit disruption under peak day situation.

4.2.2.2 2-WEEK COLD SPELL

EXISTING INFRASTRUCTURE LEVEL

Simulation results show that during 2-week cold spell demand situation the EU gas system is resilient to a Belarus transit disruption. Apart from the countries impacted during climatic stress conditions (without transit disruption), Poland is additionally exposed to a risk of demand curtailment due to its direct connection with Belarus. **Figure 4.68** shows the results of the assessment.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Poland faces a limited risk of demand curtailment (5 %) in Gas Before Coal scenario driven by no imports supply coming from Belarus and infrastructure limitation with its neighbouring countries. In Coal Before Gas, Poland has 0 % remaining flexibility. **See Figure 4.67.**

2030–2040

NATIONAL TRENDS

Poland has 0 % remaining flexibility in 2030 while in 2040 is exposed to a risk of demand curtailment of 19 % mainly driven by no imports supply from Belarus, infrastructure limitation and higher ademand (principally explained by the displacement of coal and oil in heating in the power generation sector).

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Simulation results show an increased risk of demand curtailment in **Poland** (from 30–28 % in 2030 to 32–35 % in 2040 in Distributed Energy and Global Ambition scenarios respectively) mainly driven by no imports supply from Belarus and infrastructure limitations with its neighbouring countries.

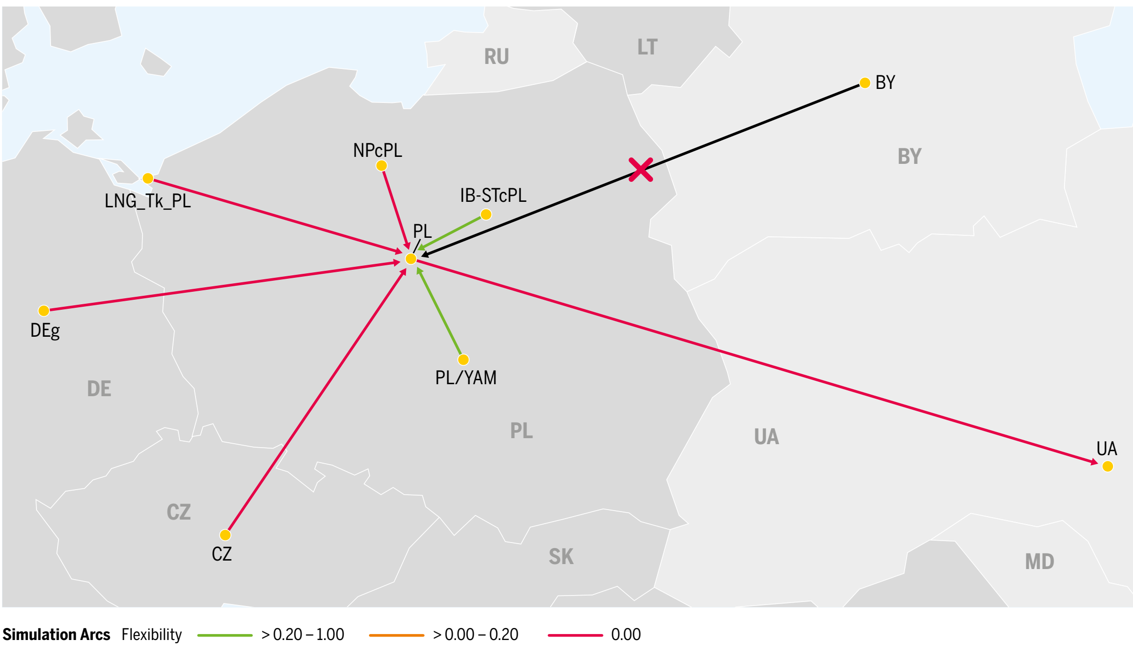

Figure 4.67 Infrastructure limitations towards Poland under Belarus disruption, Existing infrastructure, Gas Before Coal, 2025.

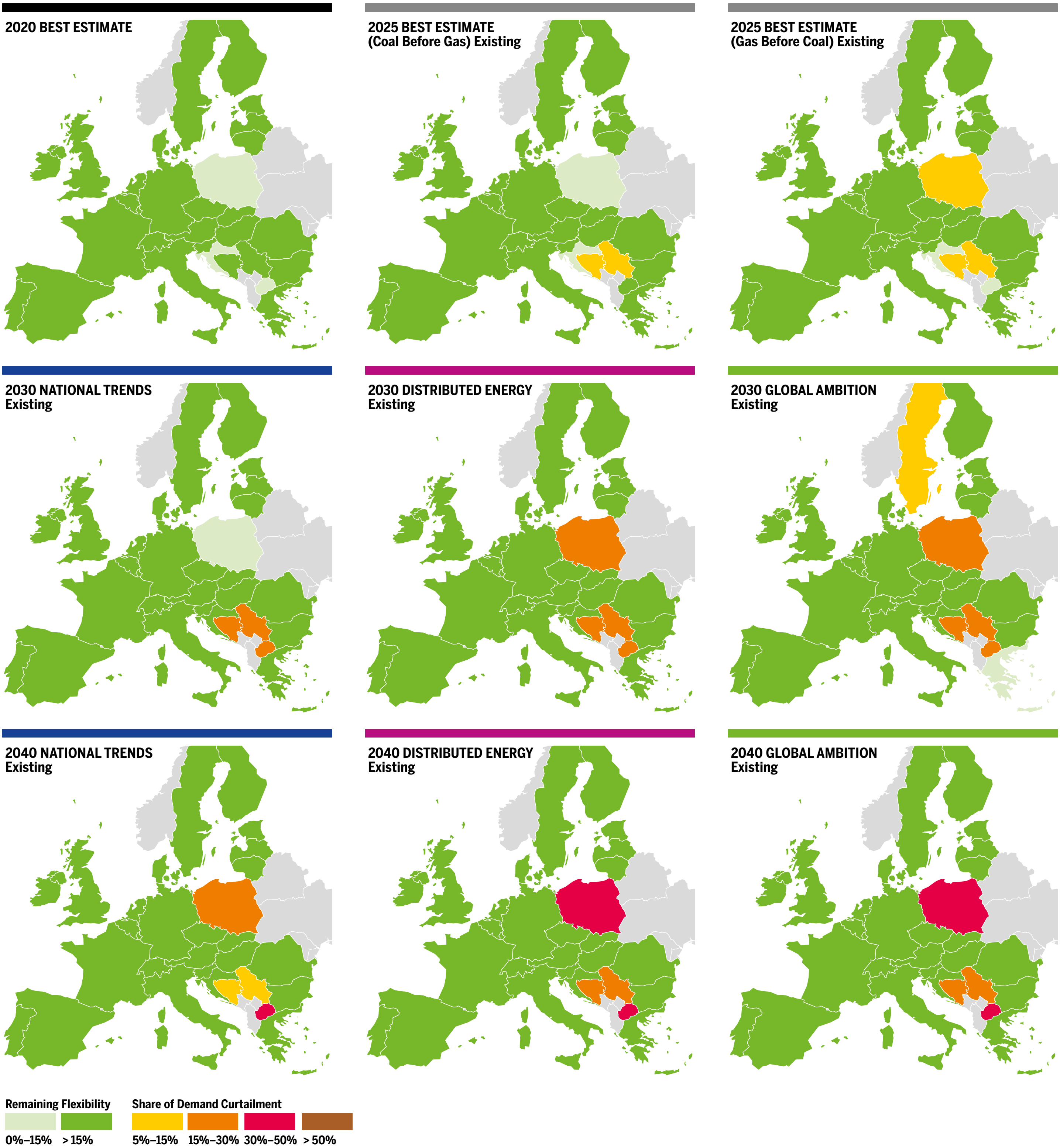

Figure 4.68 Existing infrastructure level: Belarus transit disruption under 2-week cold spell situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the implementation of FID projects improve the situation in Poland, nevertheless, there are still some infrastructure gaps to be solved. **Figure 4.69** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Poland fully mitigates its risk of demand curtailment in Gas Before Coal scenario up to 25 % remaining flexibility. In Coal Before Gas, Poland reaches 26 % remaining flexibility as well, above 15 % thanks to the commissioning of FID Projects.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2040 reaching 5 % of remaining flexibility while in 2030 surpasses the 15 % remaining flexibility up to 27 % thanks to the commissioning of FID projects.

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Global Ambition

Simulation results show that the commissioning of FID projects is not enough to cope with the risk of demand curtailment in **Poland**. Nevertheless, Poland decreases its risk of demand curtailment compared to Existing infrastructure level from 30–28 % to 10–7 % in 2030 and from 32–35 % to 14–17 % for Distributed Energy and Global Ambition scenarios, respectively.

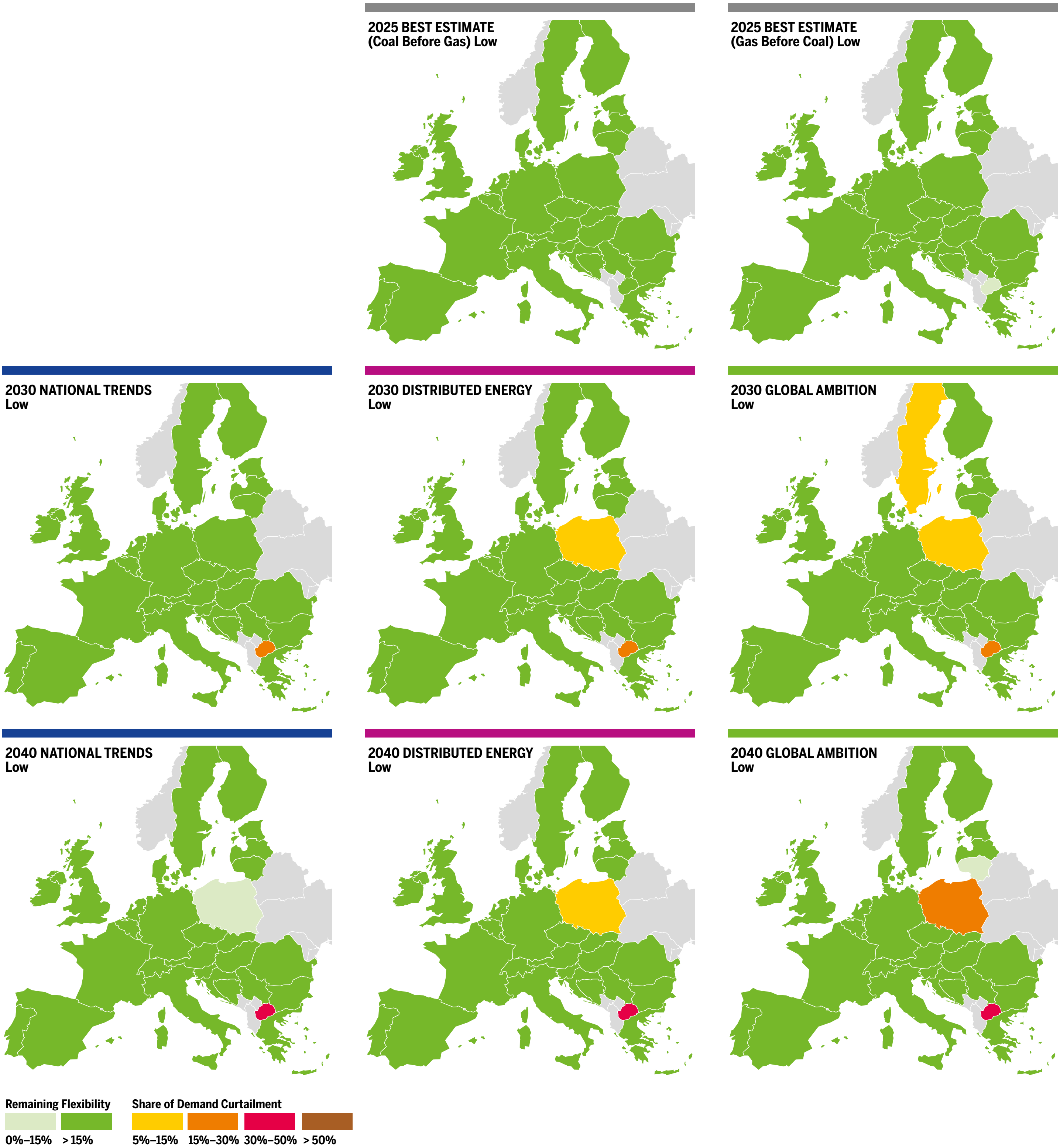

Figure 4.69 Low infrastructure level: Belarus transit disruption under 2-week cold spell situation.

ADVANCED INFRASTRUCTURE LEVEL

Advanced infrastructure level assesses the different scenarios under 2-week cold spell demand and Belarus transit disruption against the current European gas system infrastructure complemented with all advanced-status projects submitted during TYNDP 2020 data collection. Results show further improvements in terms of infrastructure gaps. Results are shown in **Figure 4.70**.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

The commissioning of advanced-status projects in the area increase the remaining flexibility in **Poland** up to 89 %.

2030–2040

NATIONAL TRENDS

Poland increases its remaining flexibility from 27 % up to 90 % in 2030 and from 5 % up to 56 % in 2040 thanks to the commissioning of advanced-status projects in the area.

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Simulation results show that the commissioning of advanced-status projects in the area cope with the risk of demand curtailment in **Poland** in both scenarios and years surpassing a 15 % remaining flexibility.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week cold spell demand together with Belarus transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are shown in **Figure 4.71**.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Coal Before Gas and Gas Before Coal, the commissioning of PCI projects help to increase the remaining flexibility in **Poland** up to 49–48 % in both scenarios, respectively.

2030–2040

NATIONAL TRENDS

Poland increases its remaining flexibility from 27 % up to 71 % in 2030 and from 5 % up to 37 % in 2040 thanks to the commissioning of PCI projects in the area.

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- Global Ambition

Simulation results show that thanks to the commissioning of PCI projects in the area help **Poland** to fully mitigate its risk of demand curtailment in both scenarios and years.

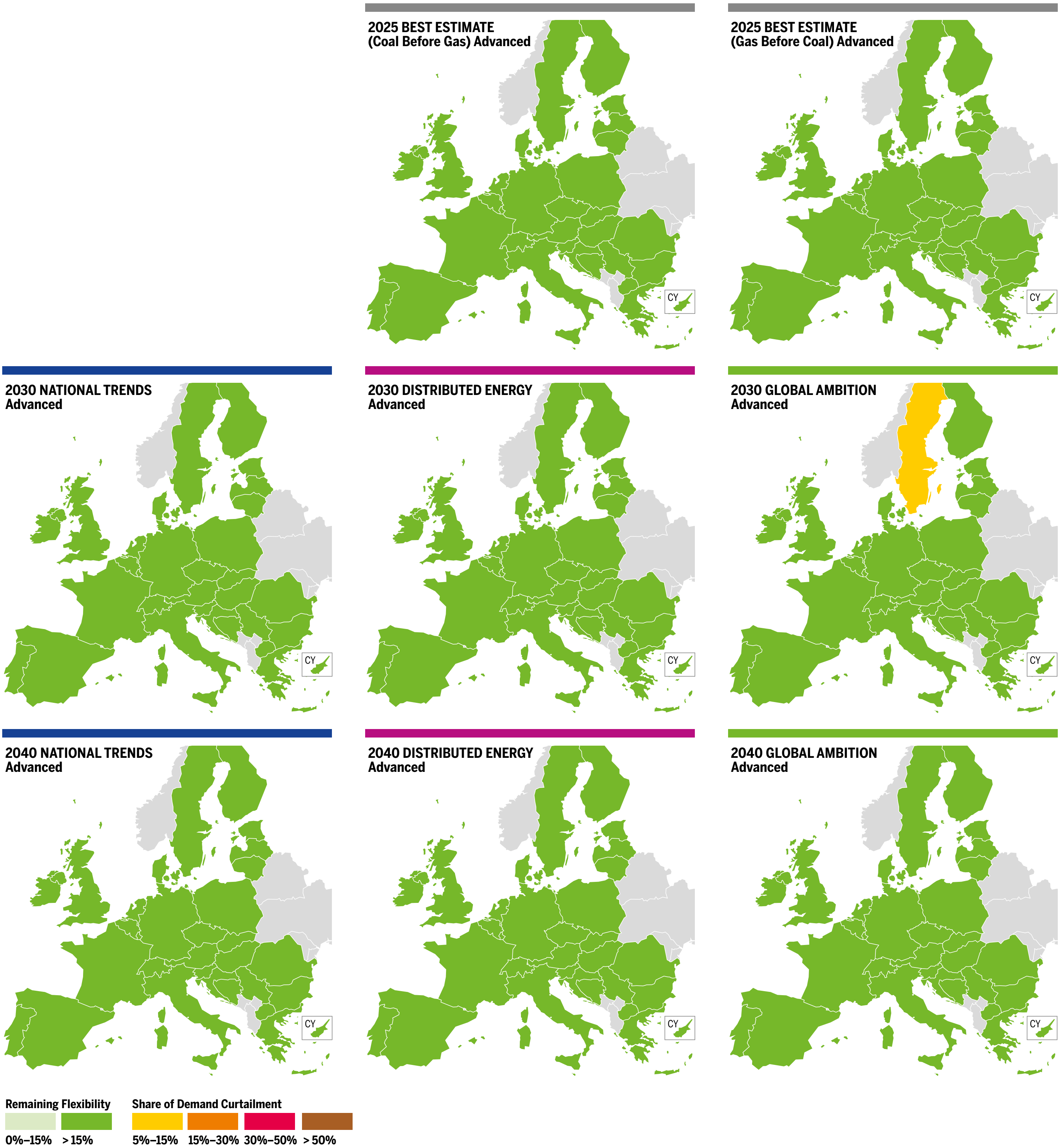

Figure 4.70 Advanced infrastructure level: Belarus transit disruption under 2-week cold spell situation.

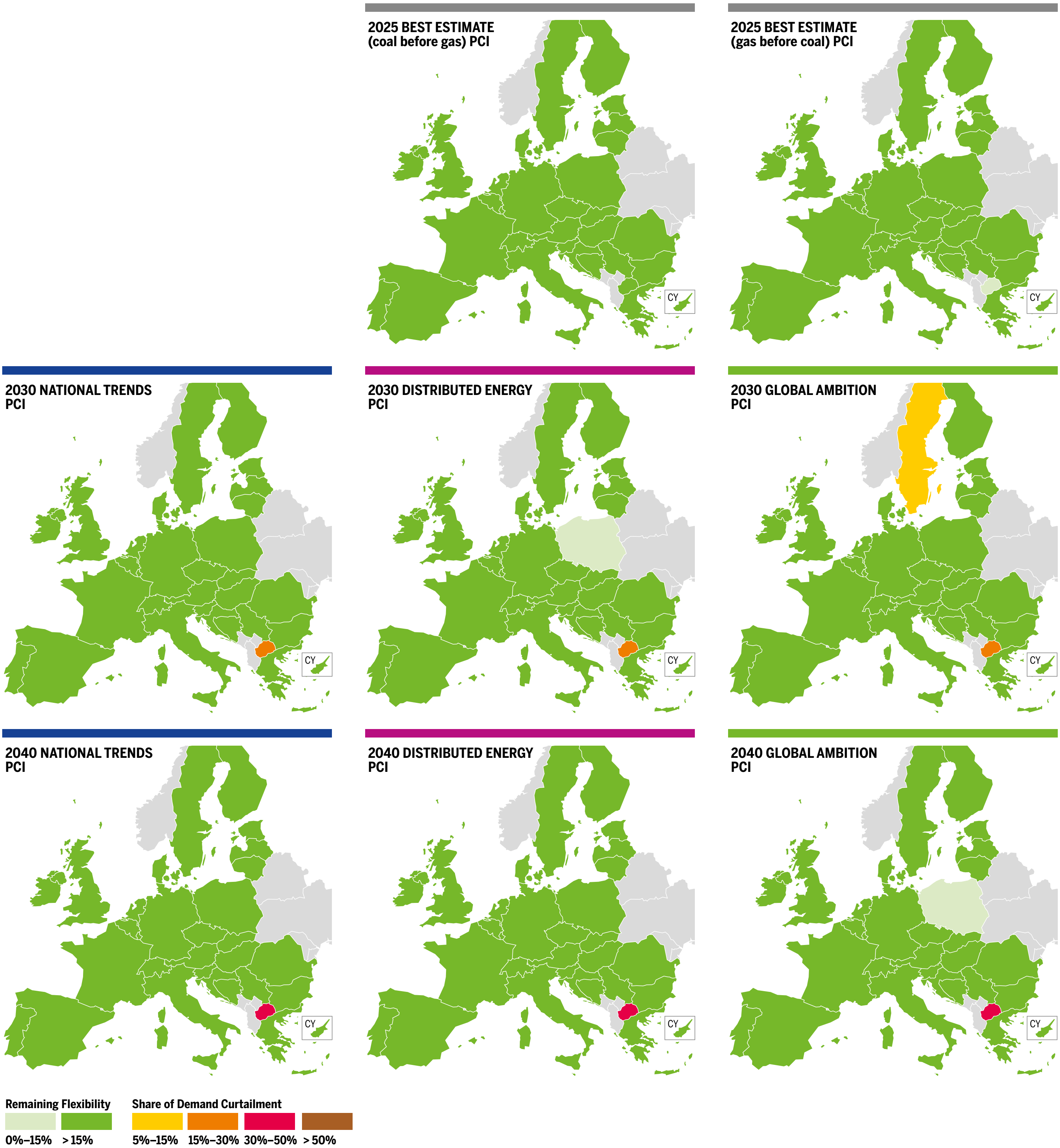

Figure 4.71 PCI infrastructure level: Belarus transit disruption under 2-week cold spell situation.

4.2.2.3 2-WEEK DUNKELFLAUTE

EXISTING INFRASTRUCTURE LEVEL

As for peak day and 2-week cold spell and apart from the countries already exposed to risk of demand curtailment without any transit disruption, simulation result show that Poland faces of additional demand curtailment due to its direct connection with Belarus. **Figure 4.73** shows the results of the assessment.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Poland faces a limited risk of demand curtailment (ca. 5 %) in both scenarios driven by no imports supply coming from Belarus together with infrastructure limitation from its neighbouring countries and the import capacity from Ukraine fully used. The increased of the risk of demand curtailment compared to the assessment of climatic stress conditions without transit disruption shows that Poland is being additionally impacted by the Belarus transit disruption. **See Figure 4.72.**

2030–2040

NATIONAL TRENDS

Poland is exposed to a risk of demand curtailment of 12 % in 2030 and 19 % in 2040 mainly driven by infrastructure limitation from its neighbouring countries and the import capacity from Ukraine fully used.

Distributed Energy and
Global Ambition

Some infrastructure limitations between Poland and its neighbouring countries expose **Poland** to a risk of demand curtailment in both scenarios and years (31–29 % in 2030 and 48–48 % in 2040 for both scenarios).

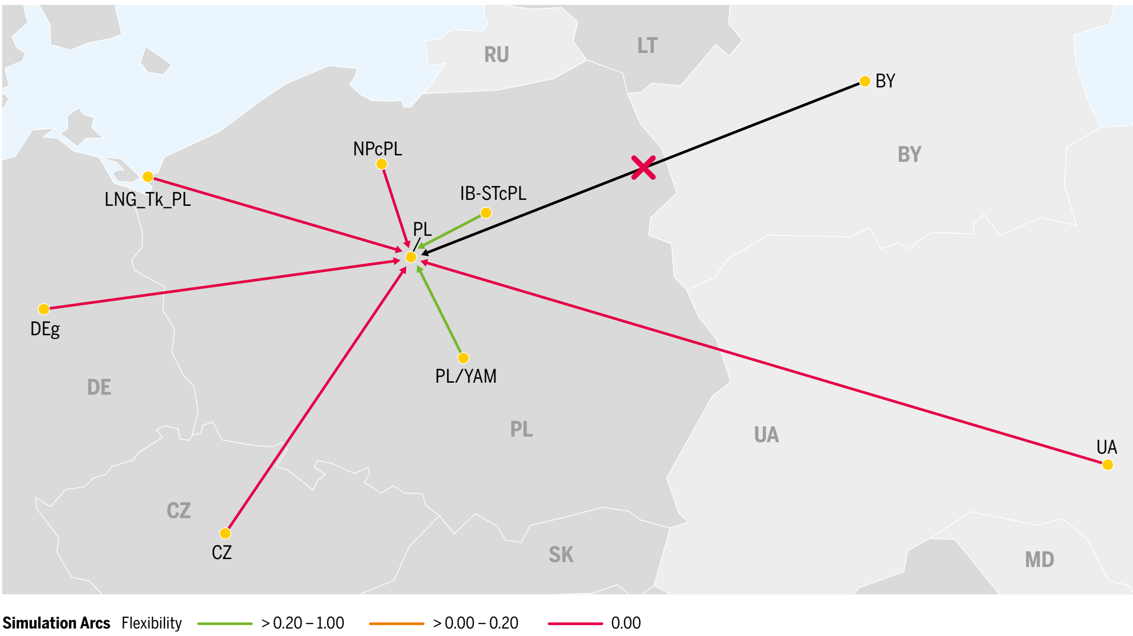

Figure 4.72 Infrastructure limitations towards Poland under Belarus transit disruption, Existing infrastructure, 2025.

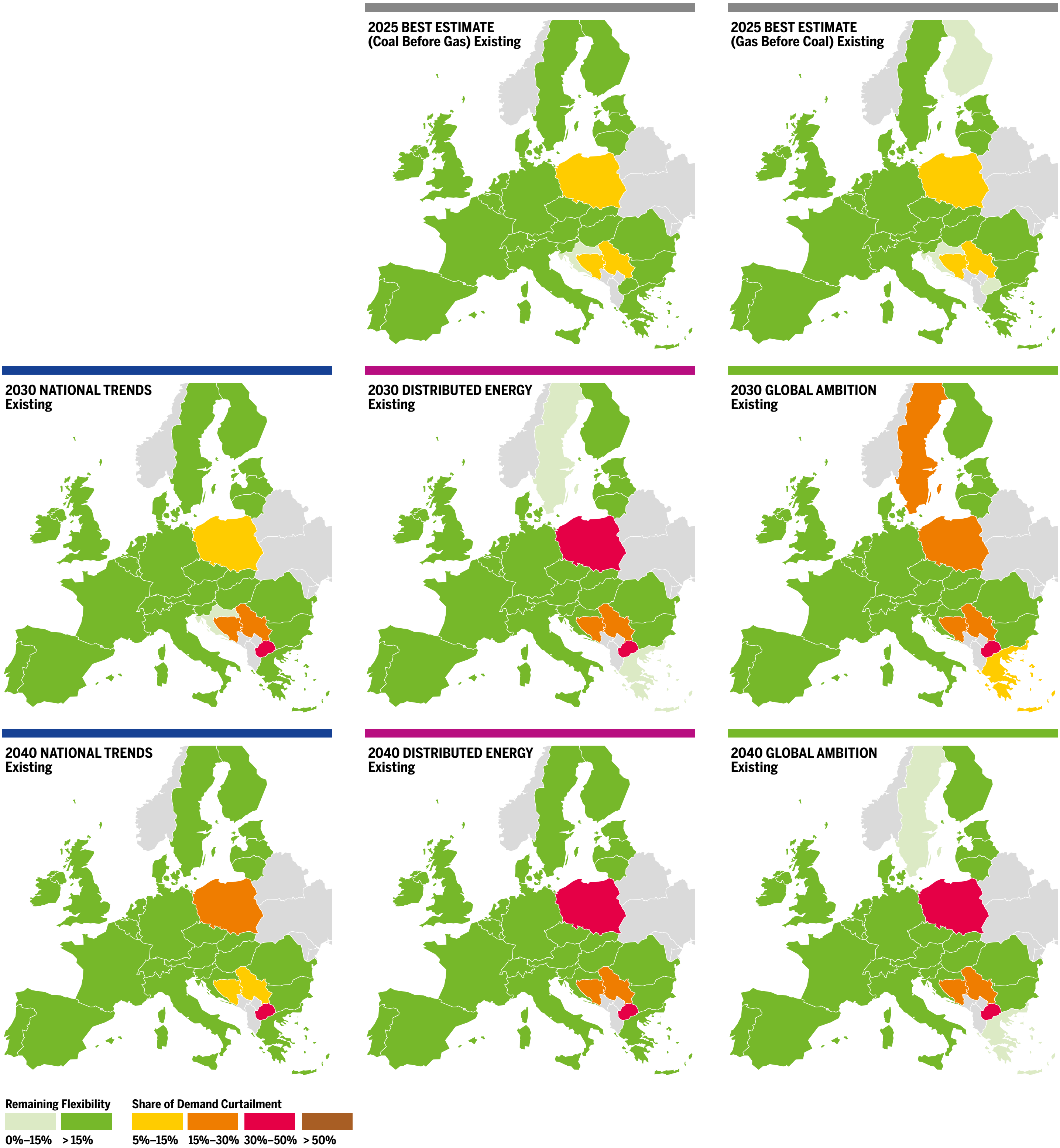

Figure 4.73 Existing infrastructure level: Belarus transit disruption under 2-week Dunkelflaute situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the implementation of FID projects improve the situation of the countries affected by the Belarus transit disruption. **Figure 4.74** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Poland fully mitigates its risk of demand curtailment increasing its remaining flexibility up to 24 % in both scenarios, thanks to the commissioning of FID projects in the area.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2030 increasing its remaining flexibility up to 14 % while decreases its risk of demand curtailment in 2040 from 27 % in Existing infrastructure level to 6 % in Low infrastructure level thanks to the commissioning of FID projects in the area that allow neighbouring countries to cooperate with Poland.

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Simulation results show that the commissioning of FID projects improve the cooperation between **Poland** and its neighbouring countries lowering its risk of demand curtailment from 31–29 % in Existing infrastructure level to 16–13 % in 2030 for both scenarios and from 35–36 % in Existing infrastructure to 17–18 % in 2040 for both scenarios.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show further improvements in terms of infrastructure gaps thanks to the commissioning of Advanced-status projects. **Figure 4.75)** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Thanks to the commissioning of advanced-status projects in the area **Poland** increases its remaining flexibility up to 87 % in both scenarios.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2040 increasing its remaining flexibility up to 40 % thanks to the commissioning of advanced-status projects in the area that allow neighbouring countries to further cooperate with Poland.

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Distributed Energy and
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Simulation results show that the commissioning of advanced-status projects improve the cooperation between **Poland** and its neighbouring countries fully mitigating its risk of demand curtailment in both scenarios and increasing its remaining flexibility above 15 %.

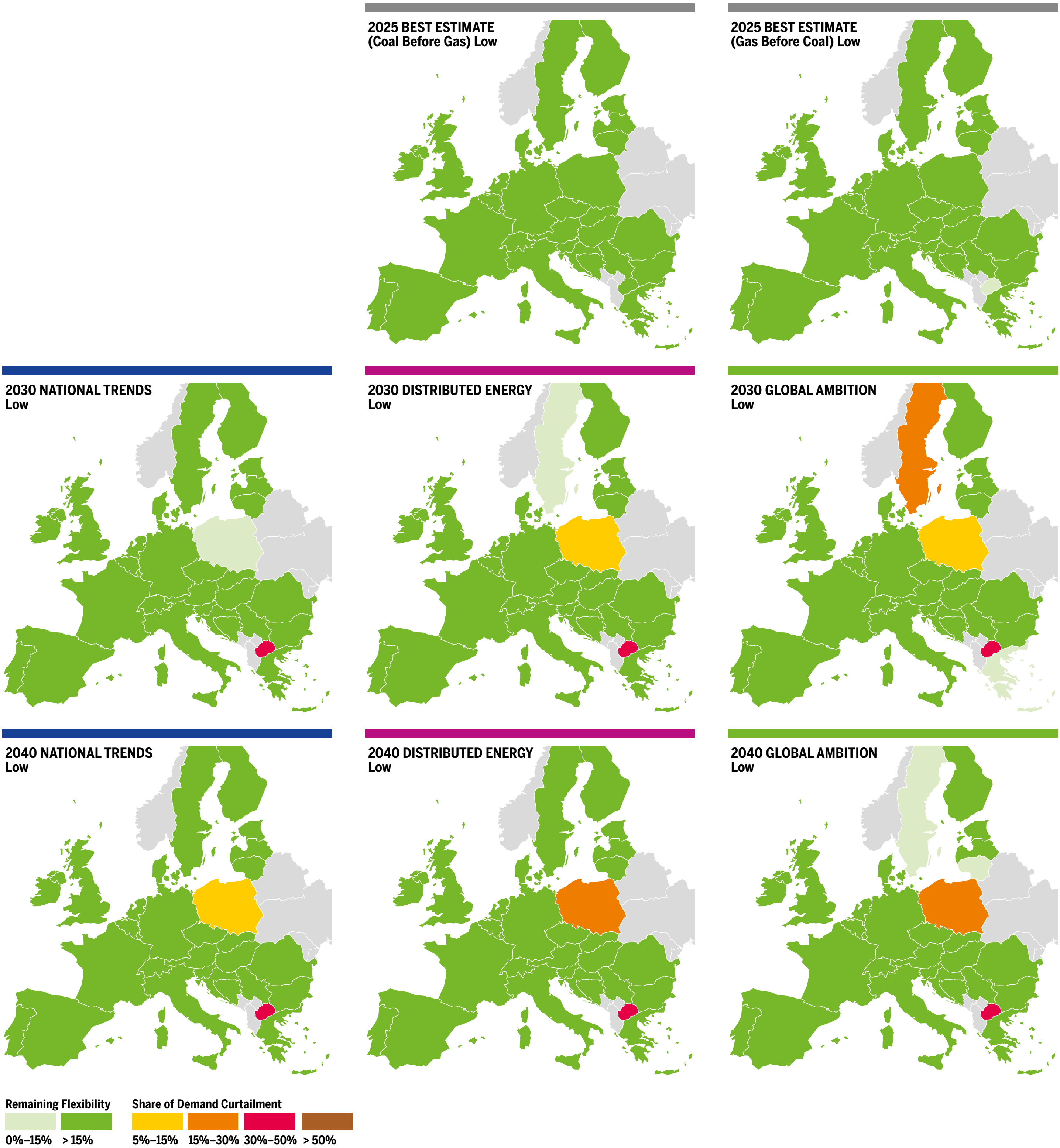

Figure 4.74 Low infrastructure level: Belarus transit disruption under 2-week Dunkelflaute situation.

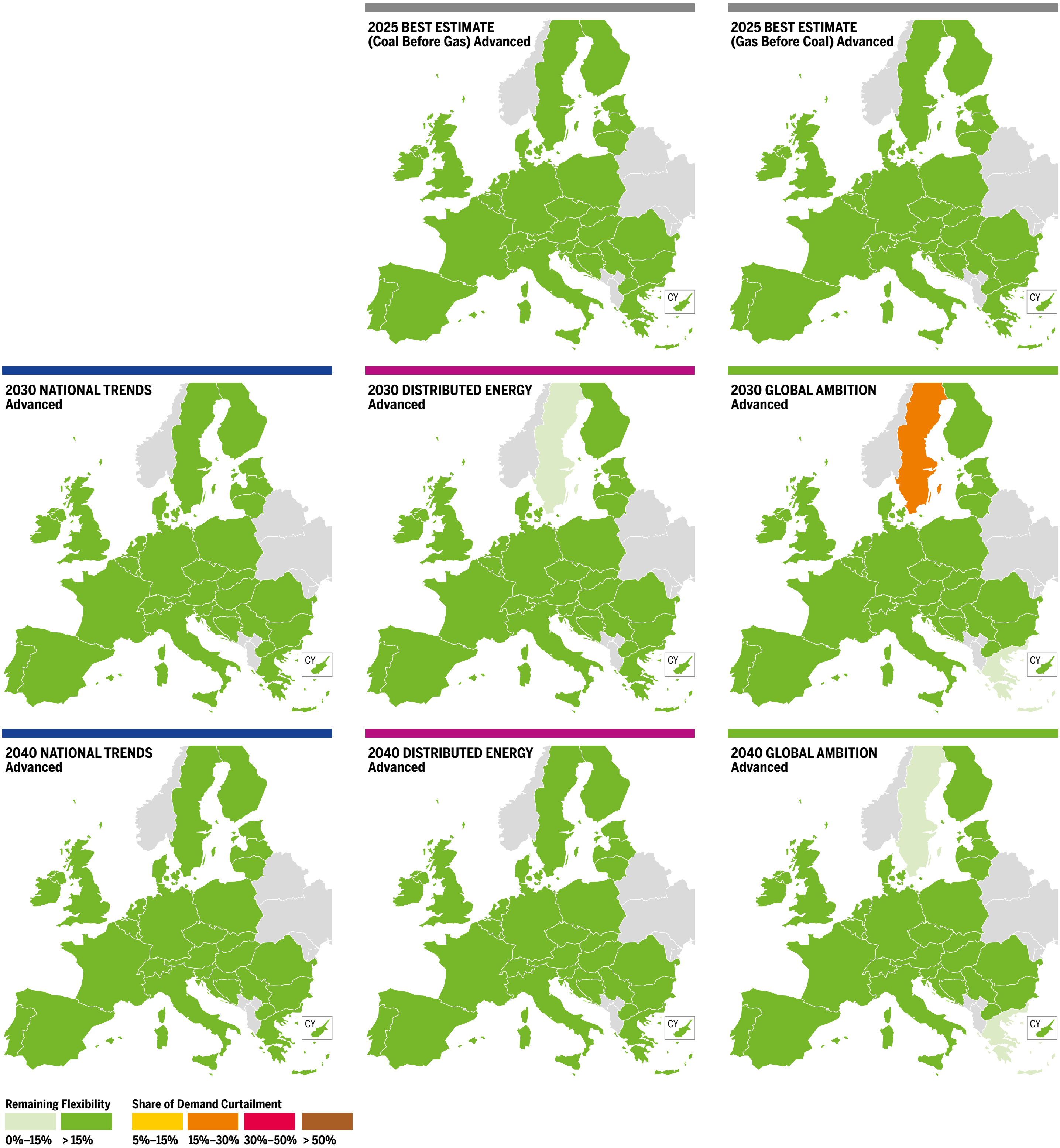

Figure 4.75 Advanced infrastructure level: Belarus transit disruption under 2-week Dunkelflaute situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week Dunkelflaute demand together with Belarus transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. **Figure 4.76** shows the results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Thanks to the commissioning of PCI projects in the area **Poland** increases its remaining flexibility up to 46 % in both scenarios.

2030–2040

NATIONAL TRENDS

Poland fully mitigates its risk of demand curtailment in 2040 increasing its remaining flexibility up to 22 % thanks to the commissioning of PCI projects in the area that allow neighbouring countries to cooperate with Poland.

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Simulation results show that the commissioning of PCI projects improve the cooperation between **Poland** and its neighbouring countries fully mitigating its risk of demand curtailment in both scenarios. Nevertheless, its remaining flexibility is still below 15 % for both scenarios and years, being 0 % in Global Ambition 2040.

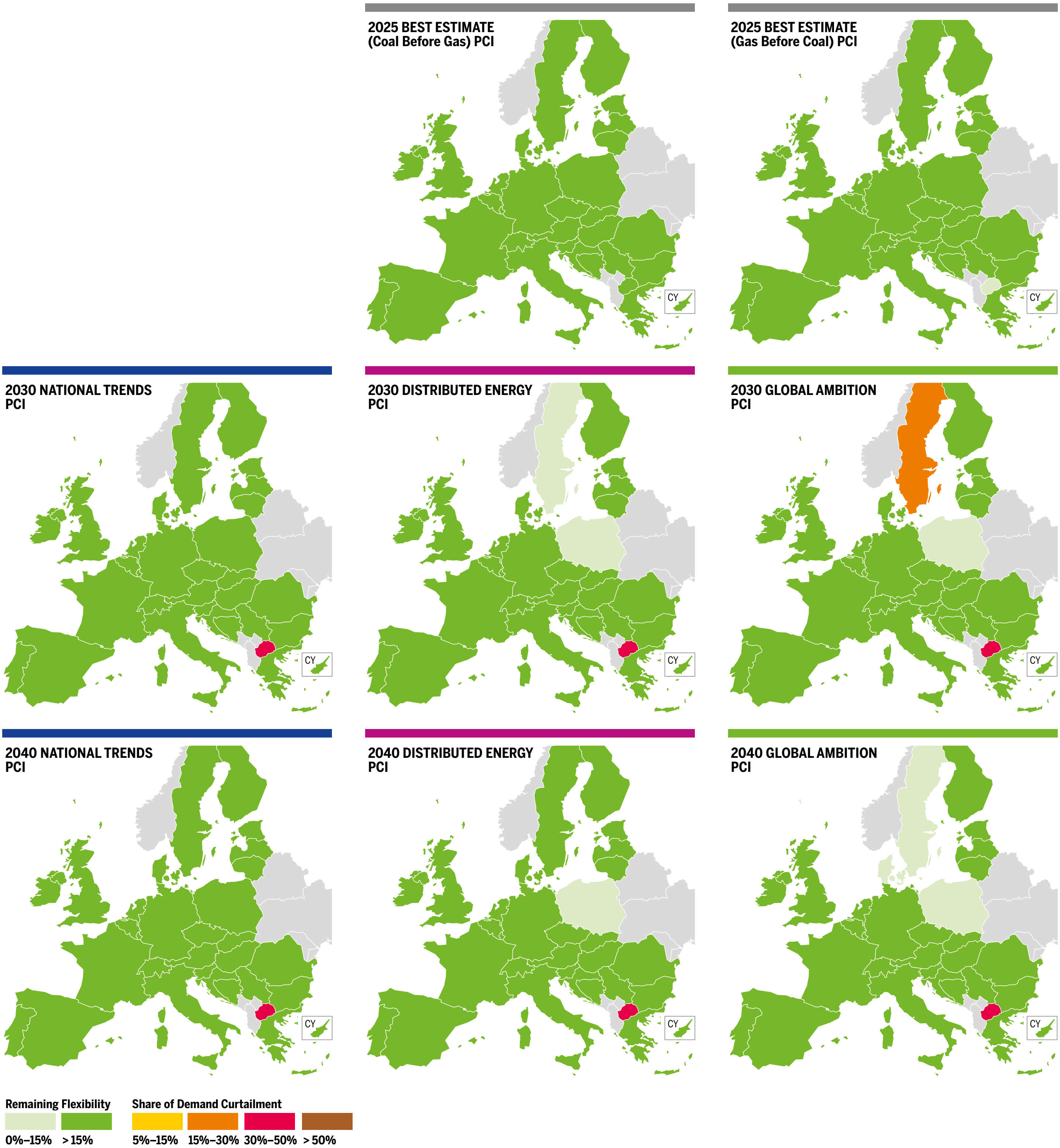

Figure 4.76 PCI infrastructure level: Belarus transit disruption under 2-week Dunkelflaute situation.

4.2.3 PIPELINE IMPORTS TO THE BALTIC STATES AND FINLAND DISRUPTION

This assessment considers the disruption of all imports in Finland, Estonia and Latvia during climatic stress situations and the risk group is formed by Estonia, Finland, Latvia, Lithuania and Czech Republic, Belgium, Germany, Luxembourg, Netherlands, Poland and Slovakia.

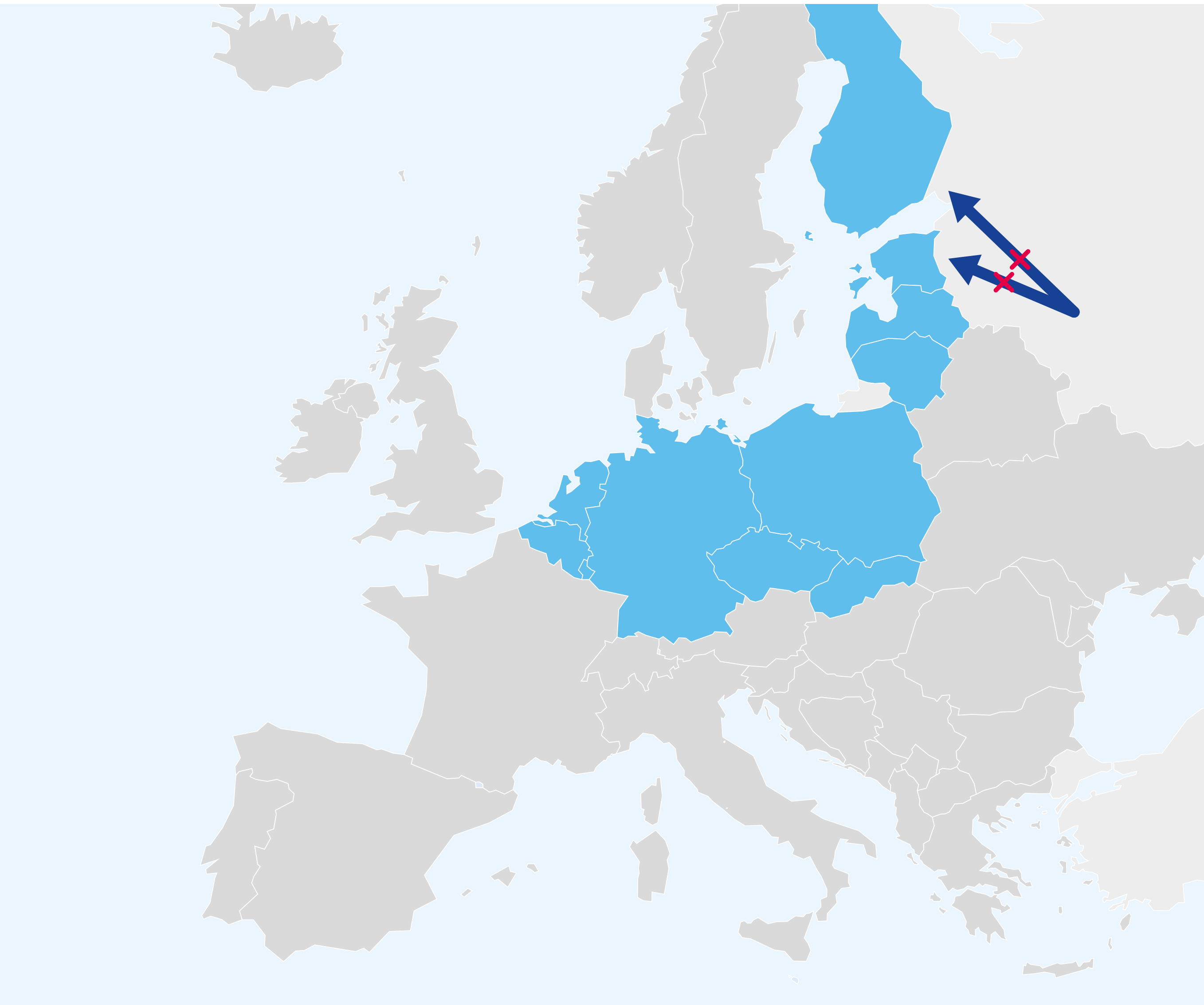

Figure 4.77 Risk group for Baltic states and Finland disruption.

4.2.3.1 PEAK DAY

EXISTING INFRASTRUCTURE LEVEL

Simulation results are in line with the assessment of climatic stress conditions without transit disruption assessment. Apart from the countries already facing risk of demand curtailment, results show a high impact in Finland and to a lesser extend in Estonia. **Figure 4.80** shows the evolution of the Existing infrastructure level described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results show that **Finland** is exposed to a high risk of demand curtailment and to a lesser extent **Estonia** is exposed to a risk of demand curtailment as well in both scenarios. There are some infrastructure limitations in the area, restricting the flow from Latvia to Estonia and from Estonia to Finland, combined with the absence of indigenous production in Finland and very limited production in Estonia coming from biomethane.

2030–2040

NATIONAL TRENDS

Simulation results are in line with 2025 scenarios, with limited demand variations in **Finland** and **Estonia** from 2025 onwards. The capacity from Latvia to Estonia and from Estonia to Finland is fully used, showing some infrastructure limitation in the area. Additionally, the very limited indigenous production in Finland and Estonia coming from biomethane does not help to cope with the risk of demand curtailment.

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Distributed Energy and
Global Ambition

Simulation results show that Estonia-Finland cooperation is used to its full capacity through the Baltic-connector.

Finland reduces its risk of demand curtailment in 2030 compared to National Trends, from 86 % to 74 % in Distributed Energy and 79 % in Global Ambition, thanks to the increase of indigenous production coming from renewables (biomethane and power to gas). In 2040, Finland further decreases its risk of demand curtailment compared to National Trends scenario, from 84 % to 18 % in Distributed Energy and 51 % in Global Ambition, thanks to a further increase of the indigenous production coming from renewables (biomethane and power to gas) in both scenarios and a decrease of its demand. **See Figure 4.78 and 4.79.**

As a result of the cooperation with Finland, Estonia is exposed to lesser extent to a risk of demand curtailment in 2030 for both scenarios. In 2040, Estonia is not exposed to risk of demand curtailment reaching a significant level of remaining flexibility in both scenarios thanks to lower demand combined with higher indigenous production coming from renewables (biomethane and power to gas).

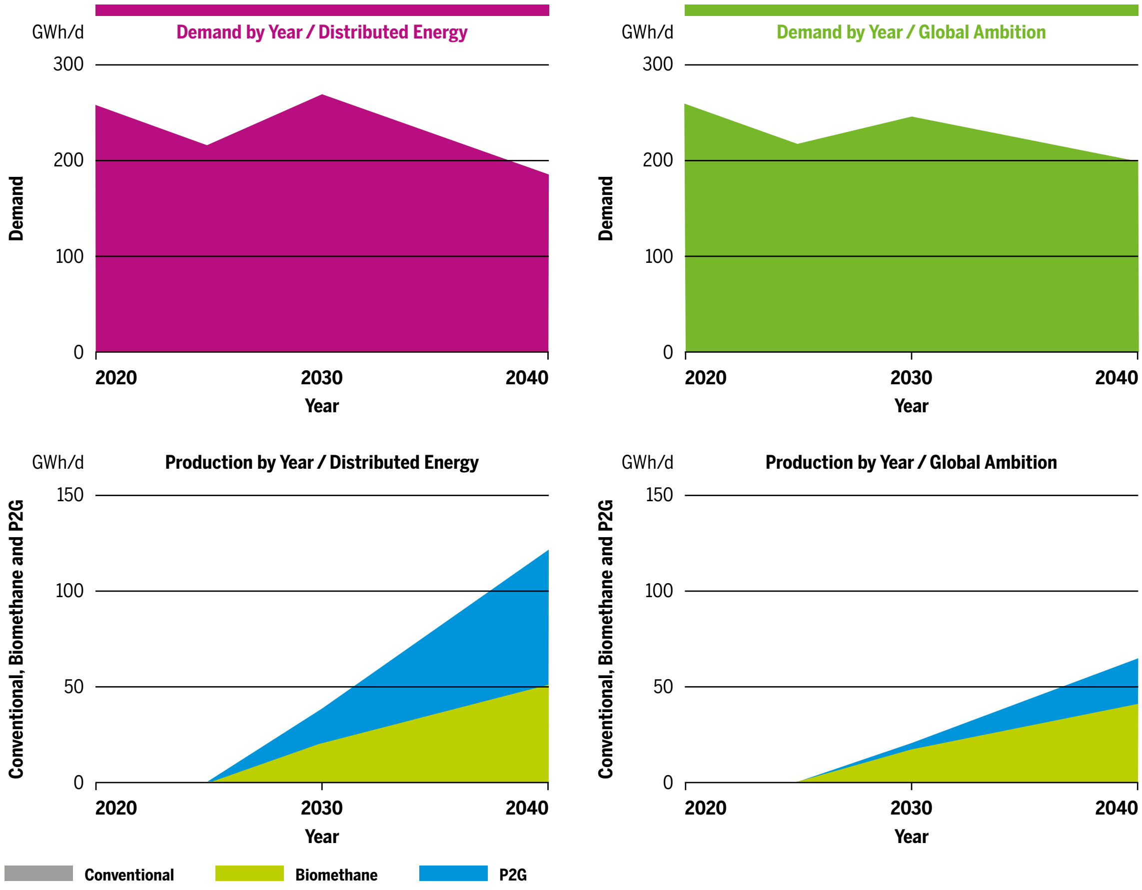

Figure 4.78 Peak demand and production in Finland in COP 21 scenarios in GWh/d.

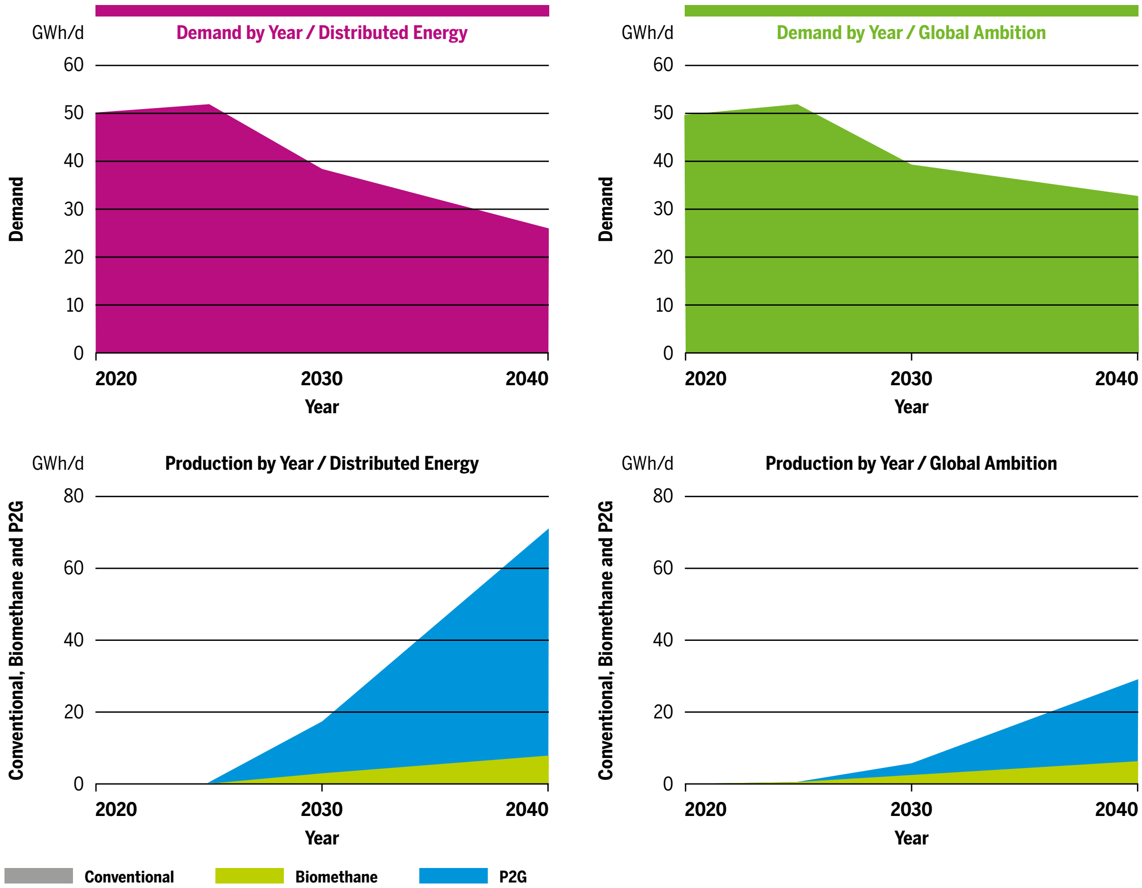

Figure 4.79 Peak demand and production in Estonia in COP 21 scenarios in GWh.

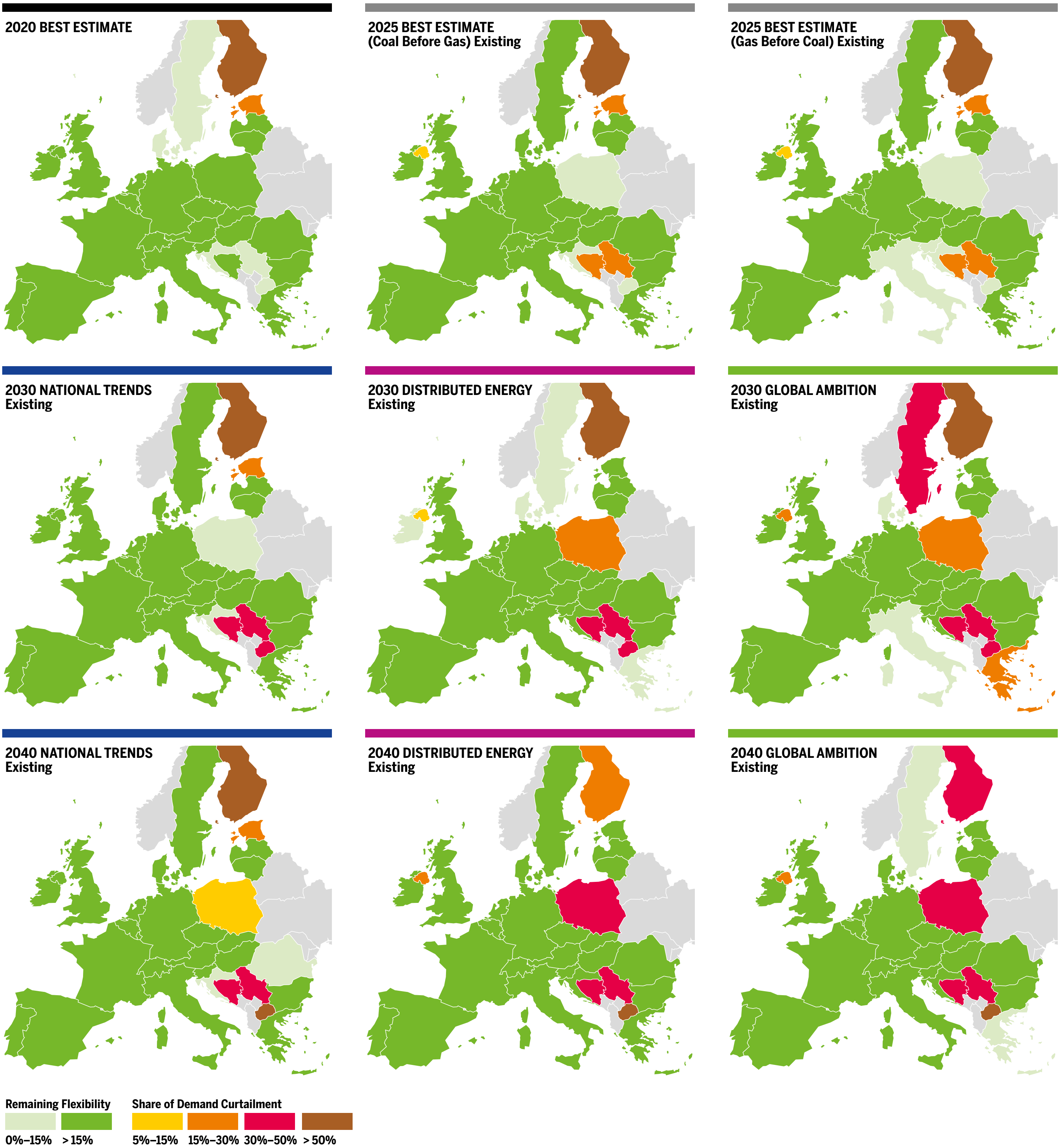

Figure 4.80 Existing infrastructure level: Baltics States and Finland transit disruption under peak day situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the commissioning of some FID projects increases the cooperation between neighbouring countries in the Baltic states area. Nevertheless, there is still a lack of infrastructure in the area. **Figure 4.81** shows the Low Infrastructure level results described below.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Simulation results show that **Finland** and **Estonia** are exposed to a high risk of demand curtailment in both scenarios.

The risk of demand curtailment in **Finland** decreases from 88–85 % (Coal before Gas and Gas before Coal respectively) in Existing infrastructure level to 73–75 % in Low infrastructure level thanks to the commissioning of the second capacity increment of the FID Project Balticconnector.

The capacity increment in Balticconnector increases the cooperation between Estonia and Finland, as a result Estonia shares Finland's risk of demand curtailment up to the same extend 72–74 % (Coal before Gas and Gas before Coal respectively).

Additionally, there is an infrastructure limitation towards Estonia, restricting the flow from Latvia to Estonia, combined with no indigenous production in Finland and very low in Estonia coming from biomethane.

2030–2040

NATIONAL TRENDS

Simulation results are in line with 2025 scenarios. The increment capacity in Balticconnector increases the cooperation between Estonia-Finland, as a result **Finland** decreases its risk of demand curtailment, from 86–84 % (2030–2040 respectively) in Existing infrastructure level to 74–71 % (2030–2040 respectively) in Low infrastructure level.

Nevertheless, **Estonia** shares Finland's risk of demand curtailment up to the same extend 72–70 % (2030–2040 respectively). The capacity from Latvia to Estonia is fully used, showing infrastructure gaps in the area, combined with very low indigenous production in Finland and Estonia coming from biomethane.

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Distributed Energy and Global Ambition

In 2030,as for National Trends and 2025 scenarios, the increment capacity in Balticconnector increases the cooperation between Estonia-Finland, as a result **Finland** decreases its risk of demand curtailment while **Estonia** shares Finland's risk of demand curtailment up to the same extent.

In 2040 the situation improves, fully mitigating the risk of demand curtailment in Distributed Energy and reducing the risk of demand curtailment in Global Ambition, thanks to the increment capacity in Balticconnector together with the reduction of the demand and increase of the indigenous production in Finland and Estonia coming from renewables (biomethane and power to gas).

Moreover, **Lithuania** faces a limited risk of demand curtailment in Distributed Energy 2030 and Global Ambition 2030–2040, even though is able to satisfy its demand, driven by the GIPL project to be commissioned in 2021 that connects Poland to Lithuania and therefore enables the cooperation between both countries from 2022 onwards.

Latvia faces a limited risk of demand curtailment in Distributed Energy and Global Ambition 2030 scenario driven by its cooperation with Estonia and Lithuania. In 2040, the demand in Estonia (in both COP21 scenarios) and Lithuania (only in Distributed Energy scenario) has a remarkable decrease combined with an increase of their national production coming from renewables (biomethane and power to gas) therefore is not exposed to a risk of demand curtailment.

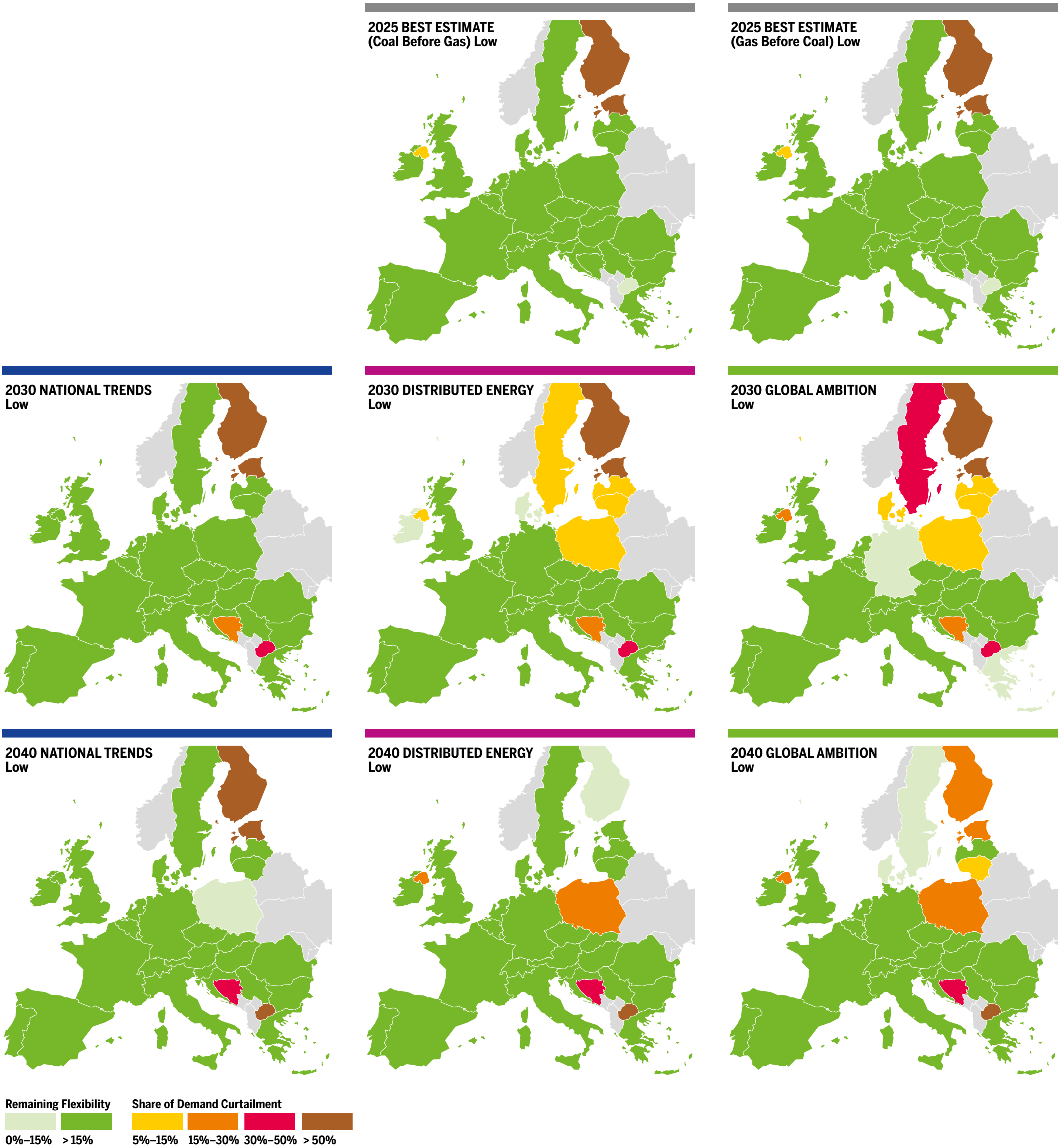

Figure 4.81 Low infrastructure level: Baltics States and Finland transit disruption under peak day situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that advanced-status projects provide an infrastructure reinforcement in the Baltic countries required to cope with high demand situations, nevertheless, Finland is still exposed to a risk of demand curtailment in most of the scenarios. **Figure 4.82** shows the Advanced infrastructure level results described below.

2025

COAL BEFORE GAS AND GAS BEFORE COAL

Simulation results show that advanced-status projects fully mitigate the risk of demand curtailment in **Estonia** from 2025 onwards thanks to the commissioning of one LNG terminal project in 2022. **Finland** is still exposed, but to a lesser extent, to a risk demand curtailment (63–67 % in Coal Before Gas and Gas Before Coal respectively), being the cooperation between Estonia-Finland limited by the Balticconnector capacity showing infrastructure limitation in the area.

2030–2040

NATIONAL TRENDS

Results show the same situation as for 2025 scenarios. **Estonia** fully mitigates its risk of demand curtailment thanks to the commissioning of one LNG terminal project in 2025. The cooperation between Estonia-Finland is limited by the Baltic-connector capacity, making **Finland** still face a risk of demand curtailment but to a lesser extent and showing infrastructure limitation in the area.

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As for National Trends and 2025 scenarios, **Estonia** fully mitigates its risk of demand curtailment in Distributed Energy 2030 and Global Ambition 2030/2040 thanks to the commissioning of one LNG terminal project in 2025. Additionally, **Finland** reduces its risk of demand curtailment in Distributed Energy 2030 and Global Ambition 2030/2040 being the capacity between both countries fully used, showing infrastructure limitation in the area.

Lithuania fully mitigates its risk of demand curtailment in Distributed Energy 2030 and Global Ambition 2030–2040 thanks to the commissioning of advanced-status projects in the area.

Moreover, **Latvia** fully mitigates its risk of demand curtailment in Distributed Energy and Global Ambition 2030 thanks to the reduction of the cooperation between Latvia-Estonia driven by the commissioning of advanced-status project in the area.

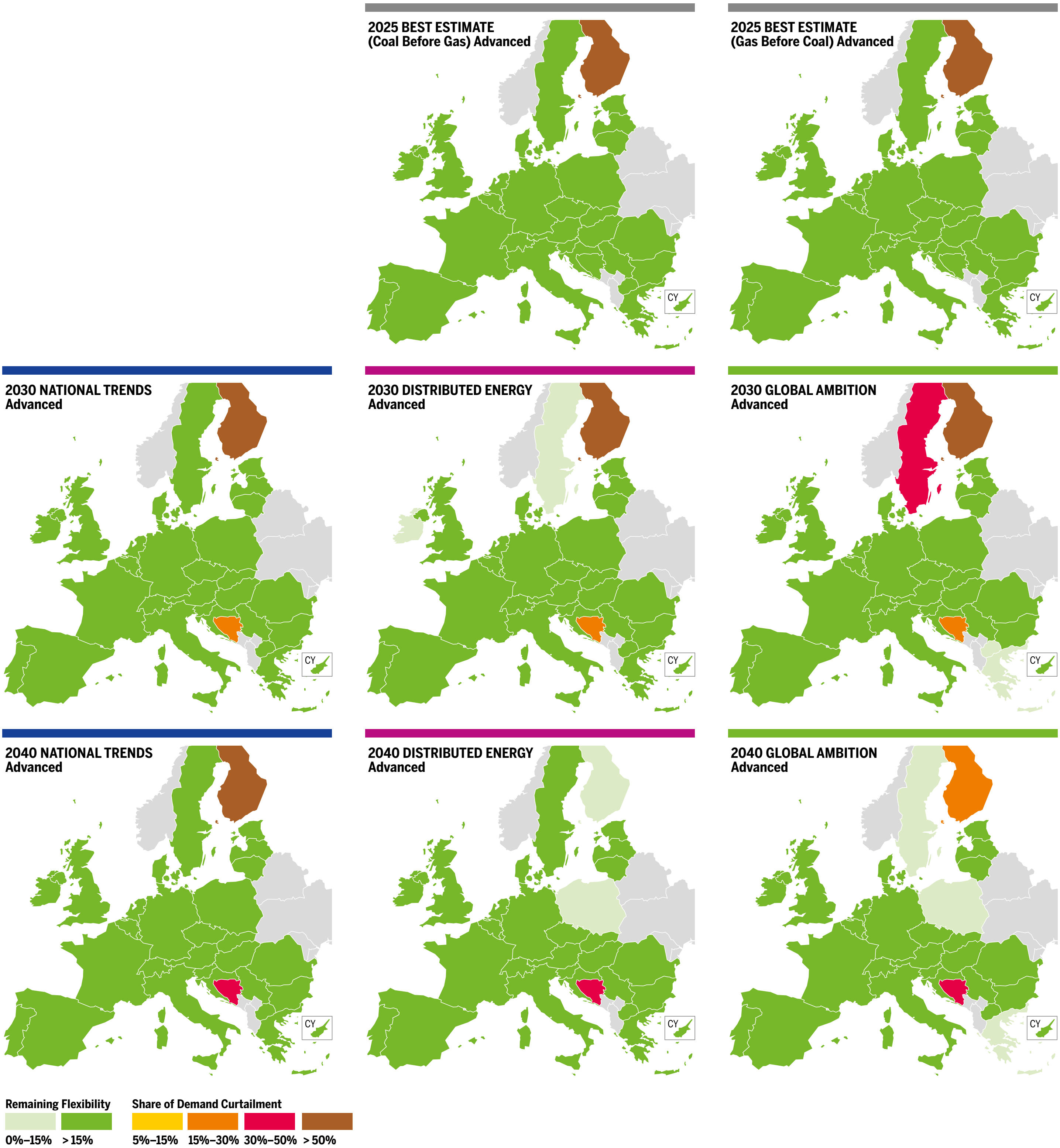

Figure 4.82 Advanced infrastructure level: Baltics States and Finland transit disruption under peak day situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under peak day demand together with Baltics States and Finland transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. **Figure 4.83** shows the evolution of the PCI infrastructure level.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results are in line with Low infrastructure level assessment. **Finland** and **Estonia** are exposed to the same extent of risk of demand curtailment as in Low infrastructure level. There are no PCI projects improving the situation in the area.

2030–2040

NATIONAL TRENDS

As for 2025 scenarios, the results are in line with Low infrastructure level assessment. **Finland** and **Estonia** are exposed to the same extent of risk of demand curtailment as in Low infrastructure level. There are no PCI projects improving the situation in the area.

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The results for **Finland** and **Estonia** are in line with Low infrastructure level assessment. Finland and Estonia are exposed to the same extent of risk of demand curtailment as in Low infrastructure level showing that there are no PCI projects investments in the area improving the situation.[17]

Nevertheless, **Lithuania** and **Latvia** fully mitigate their risk of demand curtailment thanks to the commissioning of projects included in the 4th PCI list in neighbouring countries.

17 Differing from the climatic stress conditions assessment without transit disruption (section 4.1 of this Assessment Chapter) Denmark and Sweden are not exposed to a risk of demand curtailment in Global Ambition 2040 scenario mainly driven by the lower cooperation between Denmark and Poland which increases the cooperation between Denmark and Sweden. Note that transit disruption cases simulations are based on the Regional Assessment, in this regard, countries outside the regional zone are not asked to cooperate further.

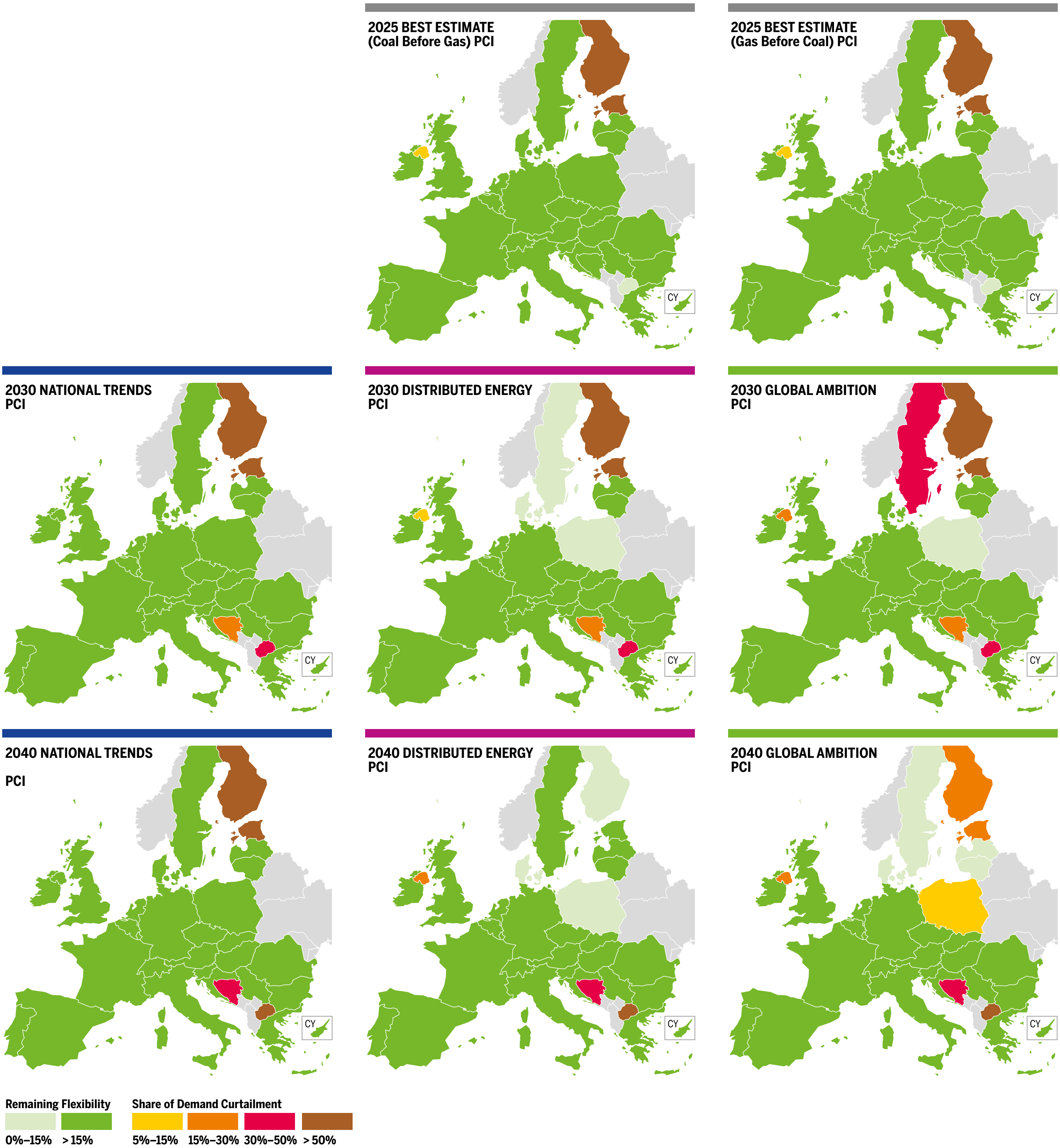

Figure 4.83 PCI infrastructure level: Baltics States and Finland transit disruption under peak day situation.

4.2.3.2 2-WEEK COLD SPELL

EXISTING INFRASTRUCTURE LEVEL

Simulation results show some needs of infrastructure in the Baltic states and Finland area. **Figure 4.85** shows the evolution of the Existing infrastructure level described below:

2025

COAL BEFORE GAS/GAS BEFORE COAL

Coal Before Gas and Gas Before Coal scenarios, results show that **Finland** is exposed to a high risk of demand curtailment (83–84 % in Coal Before Gas and Gas Before Coal scenarios respectively), being the Balticconnector capacity fully used and no indigenous production in Finland. **Estonia** has a remaining flexibility below 15 % (11–10 % in Coal Before Gas and Gas Before Coal scenarios respectively).

2030–2040

NATIONAL TRENDS

Simulation results show a high risk of demand curtailment in **Finland** mainly driven by an infrastructure limitation, being the capacity from Estonia to Finland fully used, combined with a low indigenous production in Finland coming from biomethane. **Estonia** has a remaining flexibility below 15 % (13–14 % in 2030 and 2040 respectively).

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Estonia-Finland cooperation is limited by the already available capacity of Balticonnector pipeline, first phase, being fully used. **Finland** faces a high risk of demand curtailment in Distributed Energy 2030 and Global Ambition 2030/2040.

In 2040, Finland is not exposed to a risk of demand curtailment in Distributed Energy thanks to a remarkable increase of the indigenous production coming from renewables (biomethane and power to gas) and a decrease of its demand. Moreover, in Global Ambition scenario, the lower risk of demand curtailment in Finland (ca. 38 %) compared to 2030 (ca. 72 %) is mainly driven by the increase of the indigenous production in the country coming from renewables (biomethane and power to gas).

Estonia's remaining flexibility is above 15 % thanks to a lower demand combined with higher indigenous production coming from renewables (biomethane and power to gas). **See Figure 4.84.**

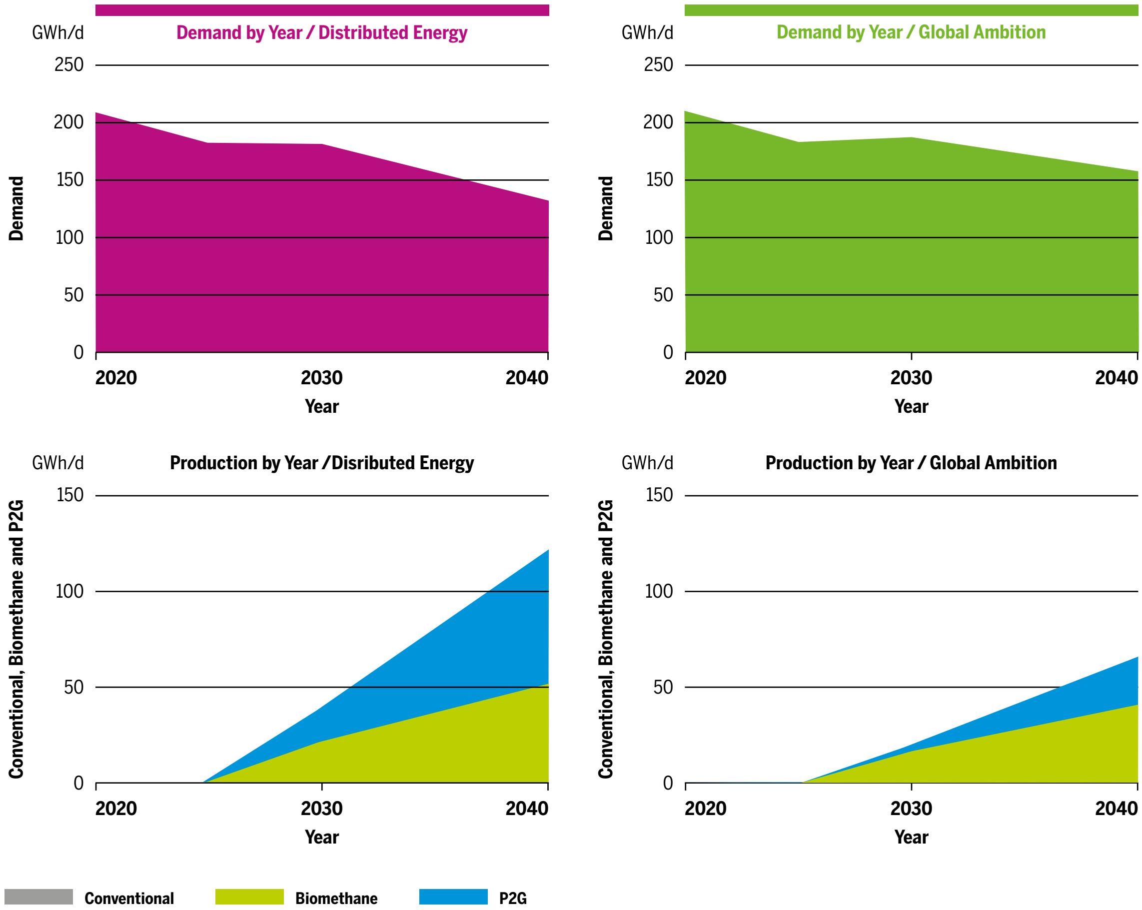

Figure 4.84 2-week cold spell demand and production in Finland in COP 21 scenarios in GWh/d.

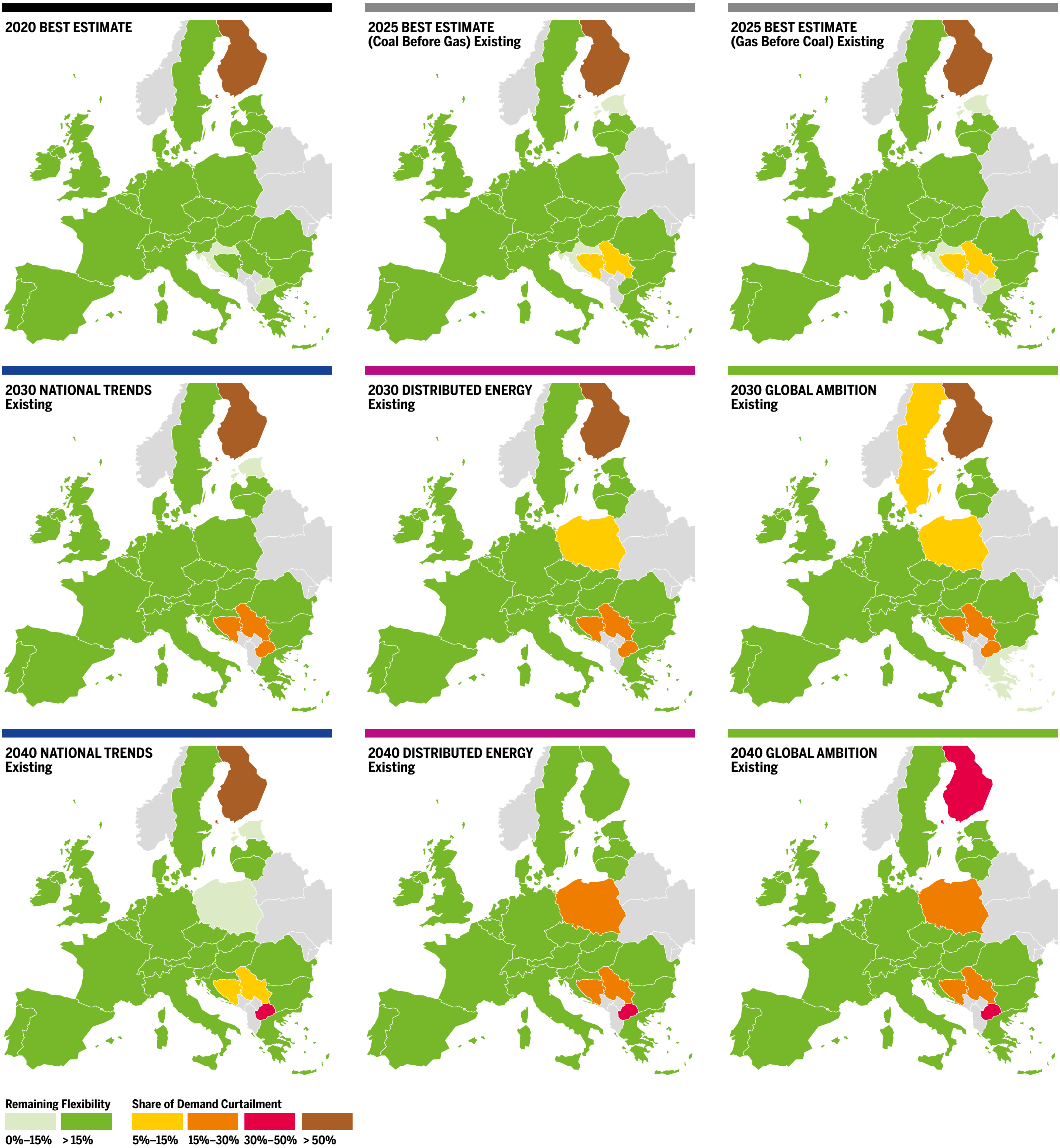

Figure 4.85 Existing infrastructure level: Baltics States and Finland transit disruption under 2-week cold sell situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the commissioning of some FID projects increases the cooperation between neighbouring countries in the Baltic states and Finland area. **Figure 4.86** shows the Low Infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Simulation results show that **Finland** is still exposed to a risk of demand curtailment in both scenarios. The risk of demand curtailment in Finland decreases, from 85–83 % (Coal before Gas and Gas before Coal respectively) in Existing infrastructure level to 67–69 %(Coal before Gas and Gas before Coal respectively) in Low infrastructure level, thanks to the commissioning of the second capacity increment of the FID Project Balticconnector, which allows more gas to flow from Estonia to Finland.

While the capacity increment in Balticconnector increases the cooperation between Estonia and Finland, **Estonia** shares Finland's risk of demand curtailment up to the same extend 66–68 % (Coal before Gas and Gas before Coal respectively).

Additionally, there is infrastructure limitation in the area, restricting the flow from Latvia to Estonia, combined with no indigenous production in Finland and very low in Estonia coming from biomethane production.

2030–2040

NATIONAL TRENDS

As for 2025 scenarios, the increment capacity in Balticconnector increases the cooperation between Estonia-Finland. As a result, **Finland** decreases its risk of demand curtailment while **Estonia** shares Finland's risk of demand curtailment up to the same extend.

There is infrastructure limitation, restricting the flow from Latvia to Estonia, combined with low indigenous production in Finland and Estonia coming from biomethane.

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In 2030, as for National Trends and 2025 scenarios, the increment capacity in Balticconnector increases the cooperation between Estonia-Finland. As a result, **Finland** decreases its risk of demand curtailment while **Estonia** shares Finland's risk of demand curtailment up to the same extent.

In 2040, the situation improves thanks to the reduction of the demand and increase of the indigenous production in Finland and Estonia in Distributed Energy and Global Ambition scenarios. In Global Ambition 2040 Finland and Estonia reduce their risk of demand curtailment from 54 % in 2030 (both countries) to 10–8 % in 2040 (Finland and Estonia respectively) thanks to the commissioning of FID projects in the Baltic area. In Distributed Energy 2040, Finland and Estonia fully mitigate their risk of demand curtailment.

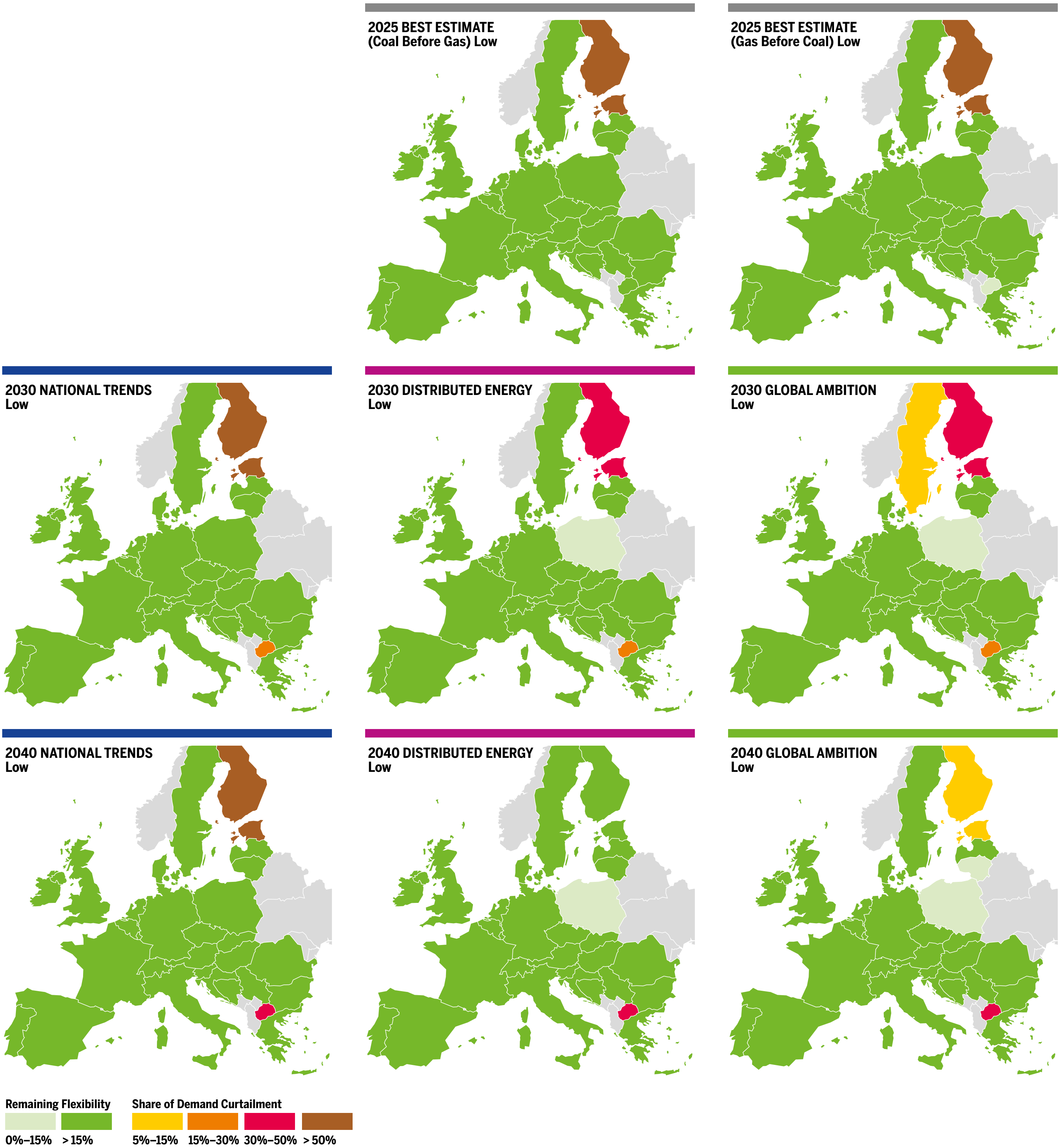

Figure 4.86 Low infrastructure level: Baltics States and Finland transit disruption under 2-week cold sell situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that advanced-status projects provide an infrastructure reinforcement in the Baltic countries required to cope with high demand situations. **Figure 4.87** shows the Advanced infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Results show that advanced-status projects fully mitigate the risk of demand curtailment in **Estonia** from 2025 onwards with the commissioning of one LNG terminal project in 2022. **Finland** is still exposed, to a lesser extent (56–60 % in Coal Before Gas and Gas Before Coal respectively), to a risk of demand curtailment, being the capacity between both countries fully used.

2030–2040

NATIONAL TRENDS

Simulation results are in line with 2025 scenarios. **Estonia** fully mitigates its risk of demand curtailment thanks to the commissioning of one LNG terminal project in 2025.

The cooperation between Estonia-Finland is limited by the capacity of the interconnection, allowing **Finland** to reduce its risk of demand curtailment from 67 % in Low infrastructure level to 57 % in the Advanced infrastructure level.

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Simulation results show that **Estonia** fully mitigates its risk of demand curtailment in 2030 for both scenarios and Global Ambition 2040 thanks to the commissioning of one LNG terminal project in 2025.

Finland slightly reduces its risk of demand curtailment in 2030 for both scenarios and Global Ambition 2040, nevertheless, the cooperation between Estonia-Finland is limited by the capacity of the interconnection.

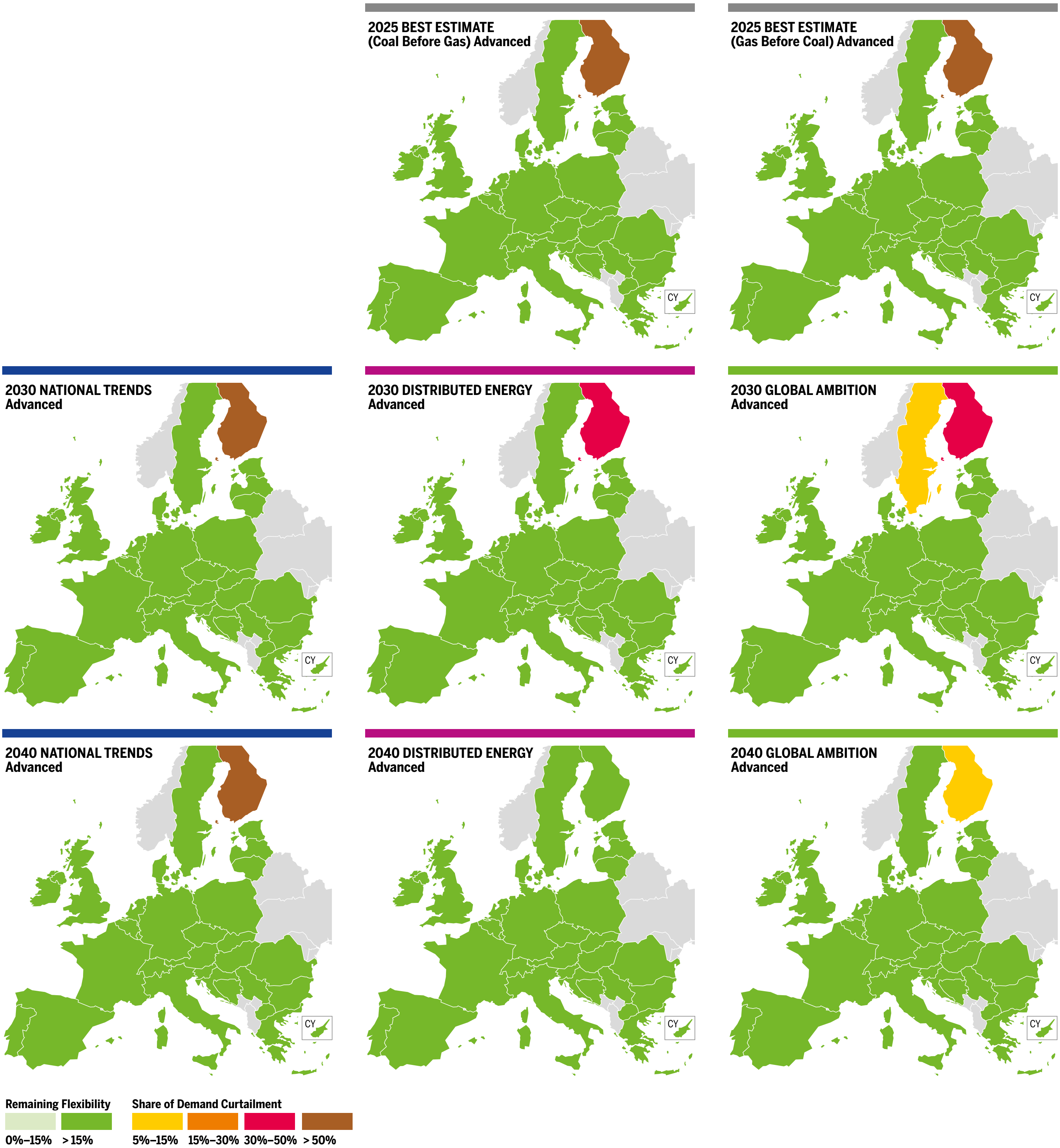

Figure 4.87 Advanced infrastructure level: Baltics States and Finland transit disruption under 2-week cold sell situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week cold spell demand together with Baltics States and Finland transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are in line with Low infrastructure level assessment. **Figure 4.88** shows the PCI infrastructure level results.

Picture courtesy of Teréga

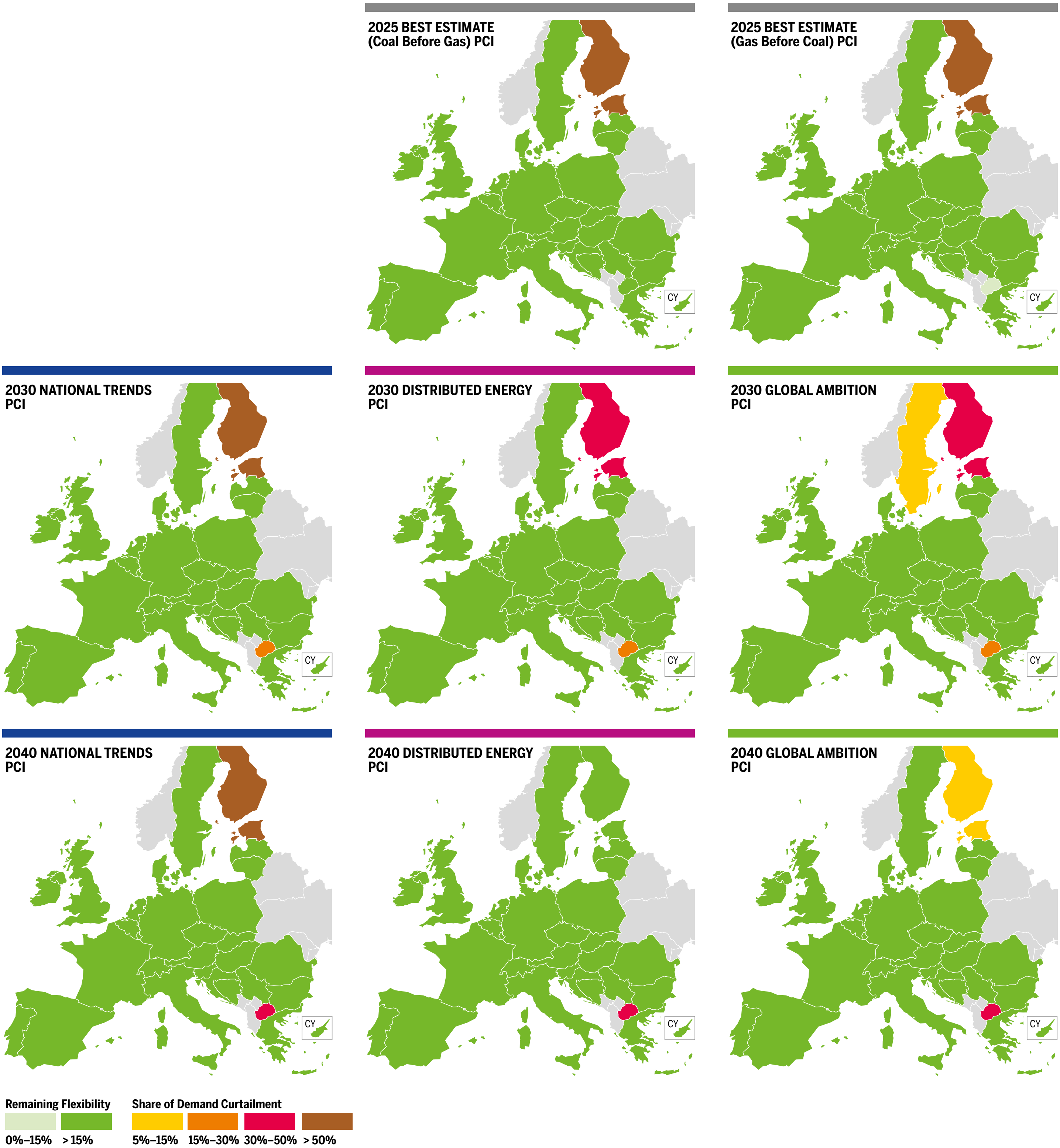

Figure 4.88 PCI infrastructure level: Baltics States and Finland transit disruption under 2-week cold sell situation.

4.2.3.3 2-WEEK DUNKELFLAUTE

EXISTING INFRASTRUCTURE LEVEL

Simulation results show similar behaviour than for a 2-week cold spell. **Figure 4.90** shows the evolution of the Existing infrastructure level described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Simulation results show that **Finland** is exposed to demand curtailment (84–85 % in Coal Before Gas and Gas Before Coal scenarios respectively) due to infrastructure limitation, being the Balticconnector capacity fully used, combined with the absence of indigenous production in Finland. Regarding **Estonia**, the remaining flexibility is below 15 %.

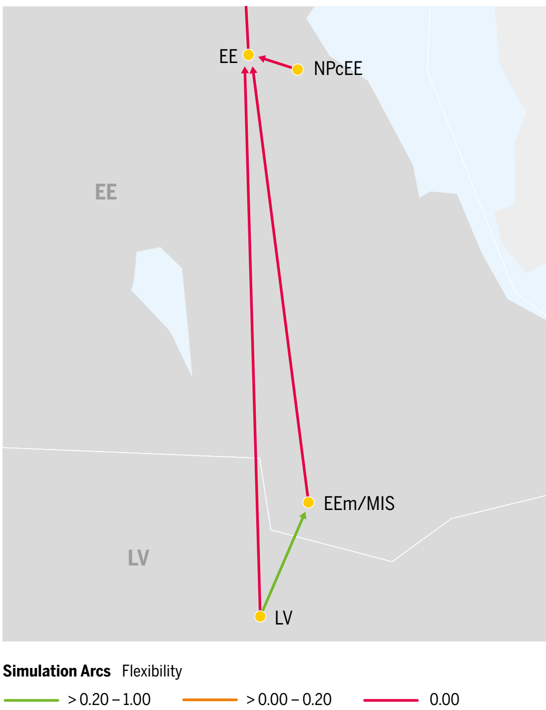

Figure 4.89 Infrastructure limitations towards Estonia under Baltic states and Finland transit disruption, Existing infrastructure, National Trends 2030

2030–2040

NATIONAL TRENDS

Finland is exposed to a high risk of demand curtailment driven by infrastructure limitation in the area, being the Balticconnector capacity fully used, and very low indigenous production in the country coming from biomethane.

Furthermore, **Estonia** is exposed to a limited risk of demand curtailment in 2030 driven by an increase of its gas demand for power generation, being the gas system a backup of the intermittent renewable power generation coming from wind and solar, together with infrastructure limitation from Latvia to Estonia. **See Figure 4.89.**

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Global Ambition

Simulation results show that in case of a 2-week Dunkelflaute demand case, **Finland** faces a higher risk of demand curtailment, compare to 2-week cold spell, in all scenarios and years driven by an increase of its gas demand for power generation due to the limited availability of renewable power generation for two weeks.

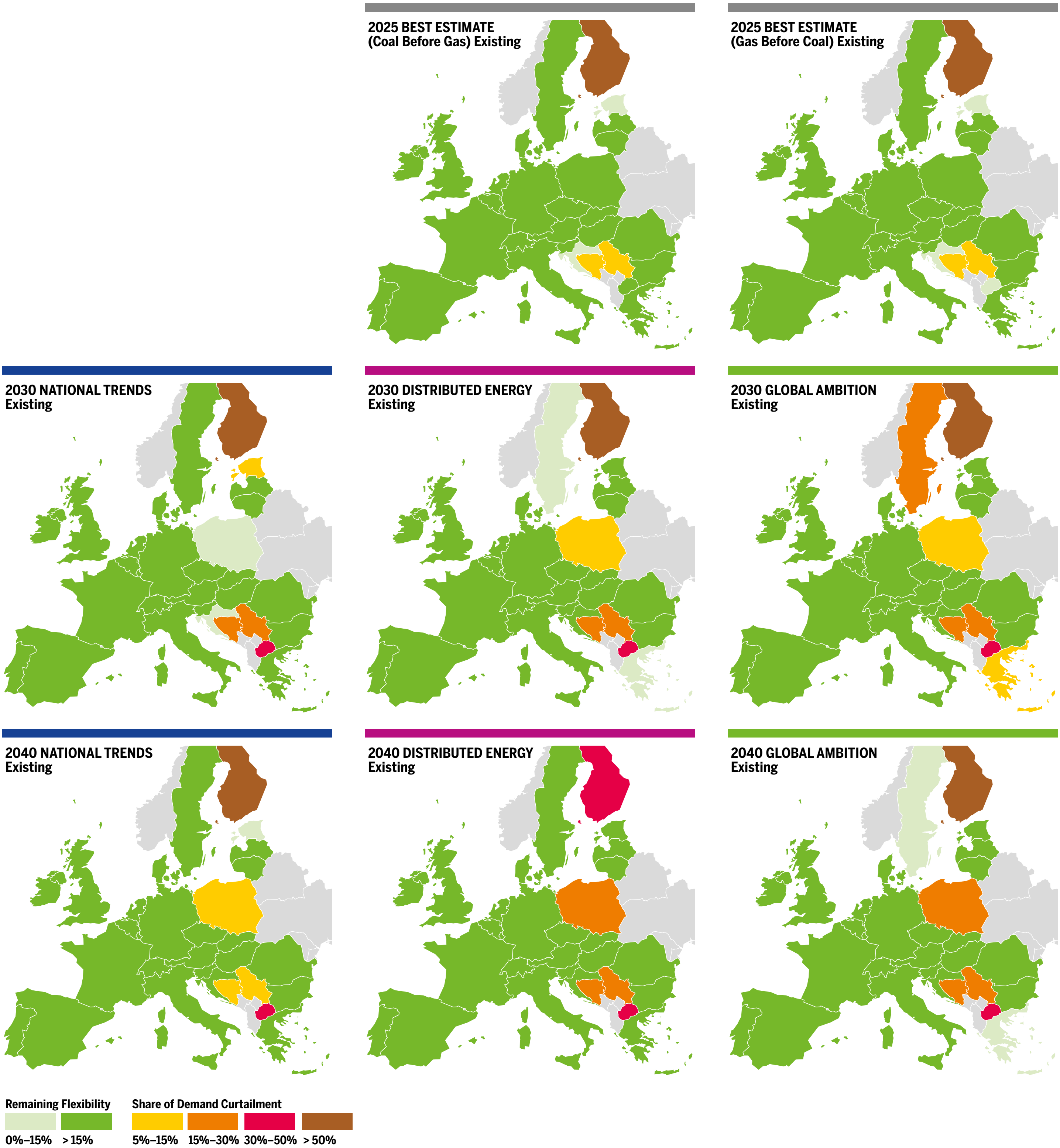

Figure 4.90 Existing infrastructure level: Baltics States and Finland transit disruption under 2-week Dunkelflaute situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the commissioning of some FID projects increases the cooperation between neighbouring countries in the area. **Figure 4.91** shows the Low infrastructure level results described below:

2025

COAL BEFORE GAS/GAS BEFORE COAL

Finland is still exposed to a risk of demand curtailment in both scenarios. The risk of demand curtailment in Finland decreases from 84–85 % (Coal before Gas and Gas before Coal respectively) in Existing infrastructure level to 69–72 % thanks to the second capacity increment of the FID Project Balticconnector.

As a result of the increase of the cooperation between Estonia-Finland, **Estonia** shares Finland's risk of demand curtailment up to the same extend 68–70 % (Coal before Gas and Gas before Coal respectively).

Additionally, result show infrastructure gaps in the area, with limited capacity from Latvia to Estonia together with absence of indigenous production in Finland and a very low indigenous production coming from biomethane in Estonia.

2030–2040

NATIONAL TRENDS

As for 2025 scenarios, the commissioning of the capacity increment in Balticconnector increases the cooperation between Estonia- Finland. As a result, **Finland** decreases its risk of demand curtailment while **Estonia** shares Finland's risk of demand curtailment up to the same extent.

Additionally, result show infrastructure gaps in the area, with limited capacity from Latvia to Estonia combined with a very low indigenous production coming from biomethane in Finland and Estonia.

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- Distributed Energy and
- Global Ambition

As for 2025 scenarios, the commissioning of the capacity increment in Balticconnector increases the cooperation between Estonia-Finland, as a result **Finland** decreases its risk of demand curtailment while **Estonia** shares Finland's risk of demand curtailment up to the same extent for both scenarios and years. In 2040 the situation improves thanks to lower demand together with higher indigenous production in both countries and scenarios.

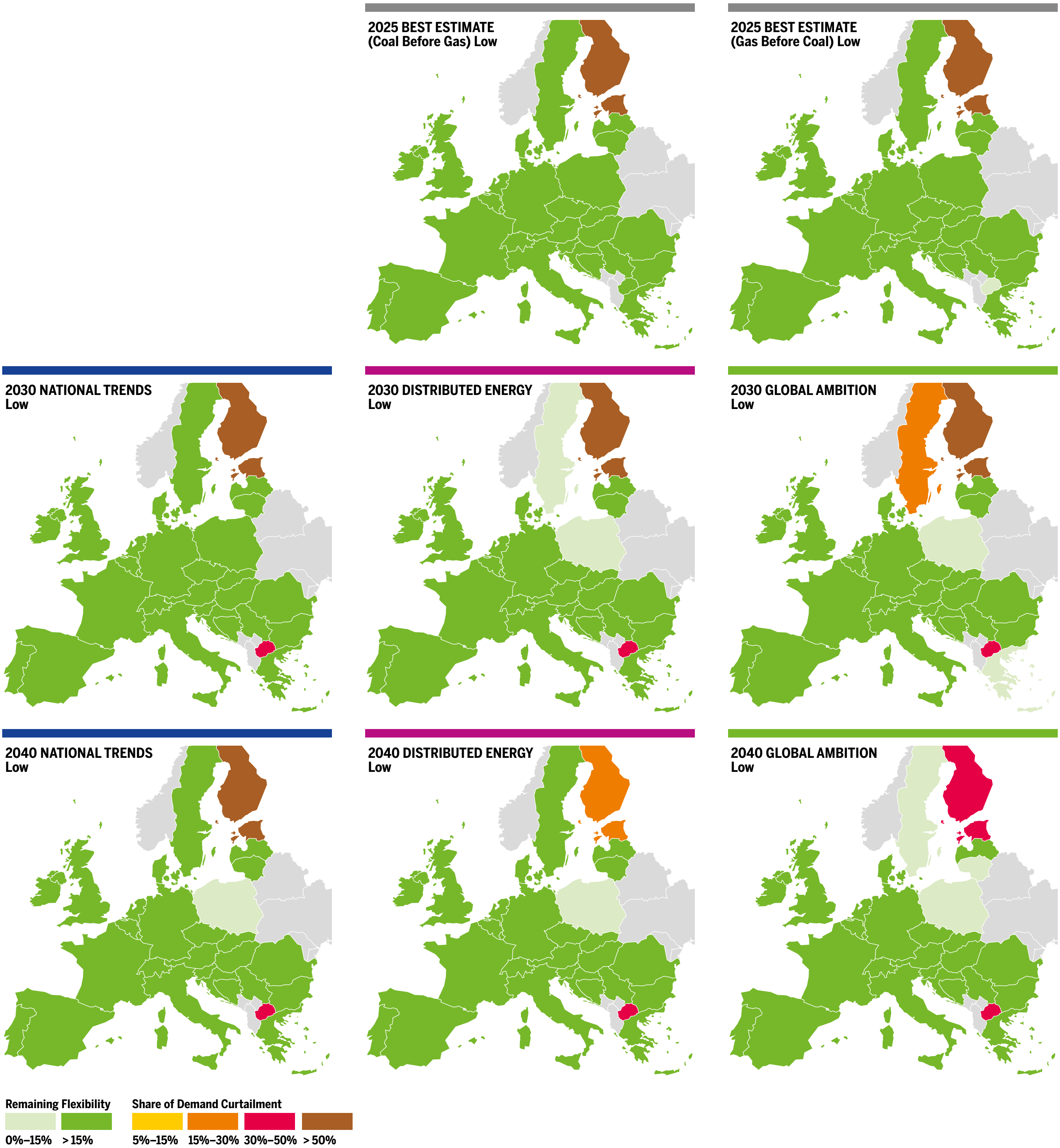

Figure 4.91 Low infrastructure level: Baltics States and Finland transit disruption under 2-week Dunkelflaute situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that advanced-status projects provide an infrastructure reinforcement in the Baltic states helping to cope with high demand situations. **Figure 4.92** shows the Advanced infrastructure level results described below.

2025

COAL BEFORE GAS/GAS BEFORE COAL

Simulation results show that advanced-status projects fully mitigate the risk of demand curtailment in **Estonia** from 2025 onwards with the commissioning of one LNG terminal project in 2022.

Nevertheless, **Finland** is still exposed to a lesser extent of risk of demand curtailment (59–64 % in Coal Before Gas and Gas Before Coal respectively), being the Balticconnector capacity fully used.

2030–2040

NATIONAL TRENDS

As for 2025 scenarios, **Estonia** fully mitigates its risk of demand curtailment thanks to the commissioning of one LNG terminal project in 2025. The cooperation between Estonia-Finland is limited by the Balticconnector's capacity, nevertheless, **Finland** reduce its risk of demand curtailment from 70–68 % (in 2030–2040 espectively) in Low infrastructure level to 61–57 % (in 2030–2040 respectively) in the Advanced infrastructure level.

COP 21 SCENARIOS

Distributed Energy and
Global Ambition

As for National Trends and 2025 scenarios, **Estonia** fully mitigates its risk of demand curtailment thanks to the commissioning of one LNG terminal project in 2025. Nevertheless, **Finland** is still exposed to a lesser extent of risk of demand curtailment, being the Balticconnector capacity fully used.

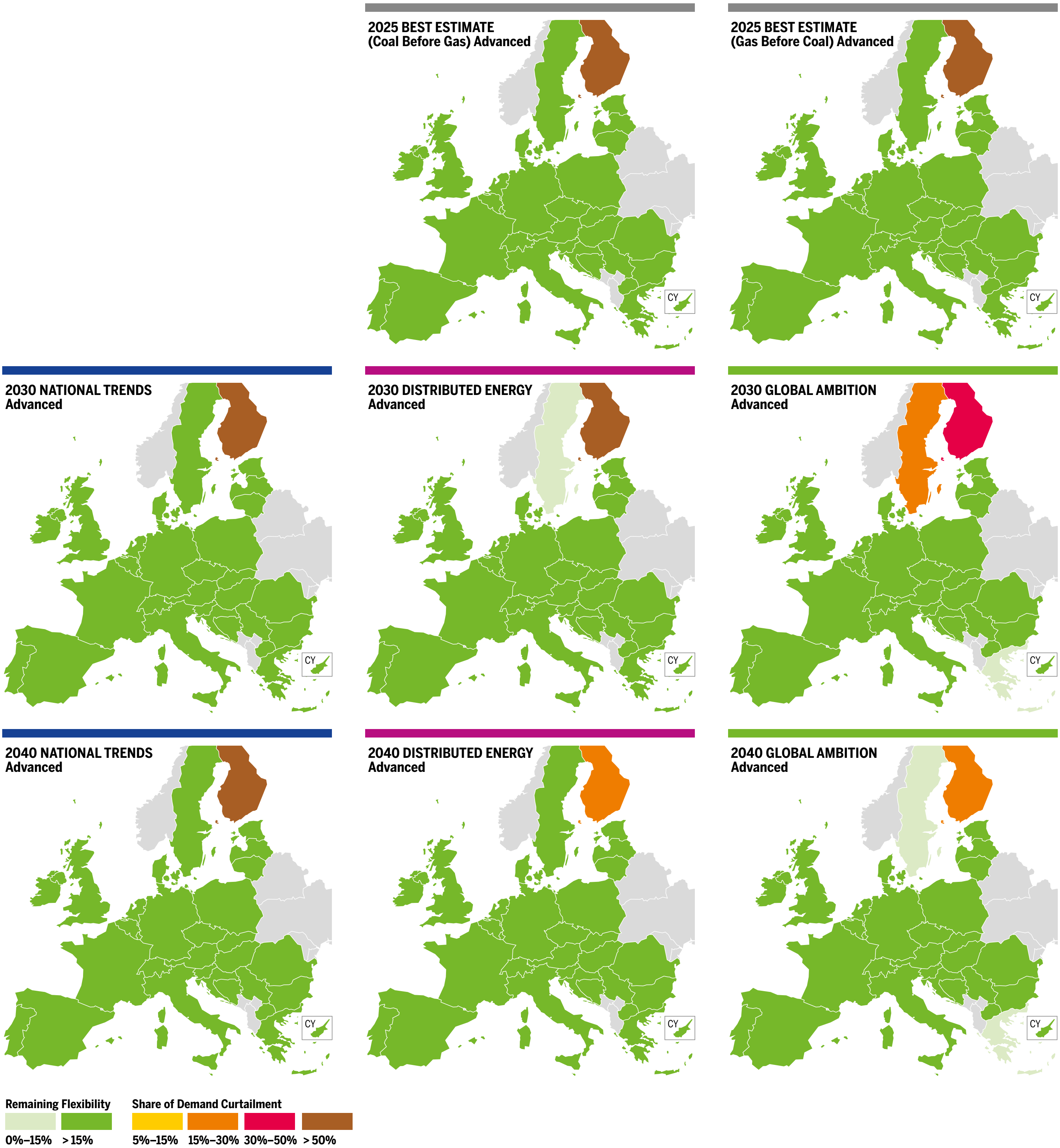

Figure 4.92 Advanced infrastructure level: Baltics States and Finland transit disruption under 2-week Dunkelflaute situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week Dunkelflaute demand together with Baltics States and Finland transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are in line with Low infrastructure level assessment. **Figure 4.93** shows the evolution of the PCI infrastructure level.

Picture courtesy of Gasum

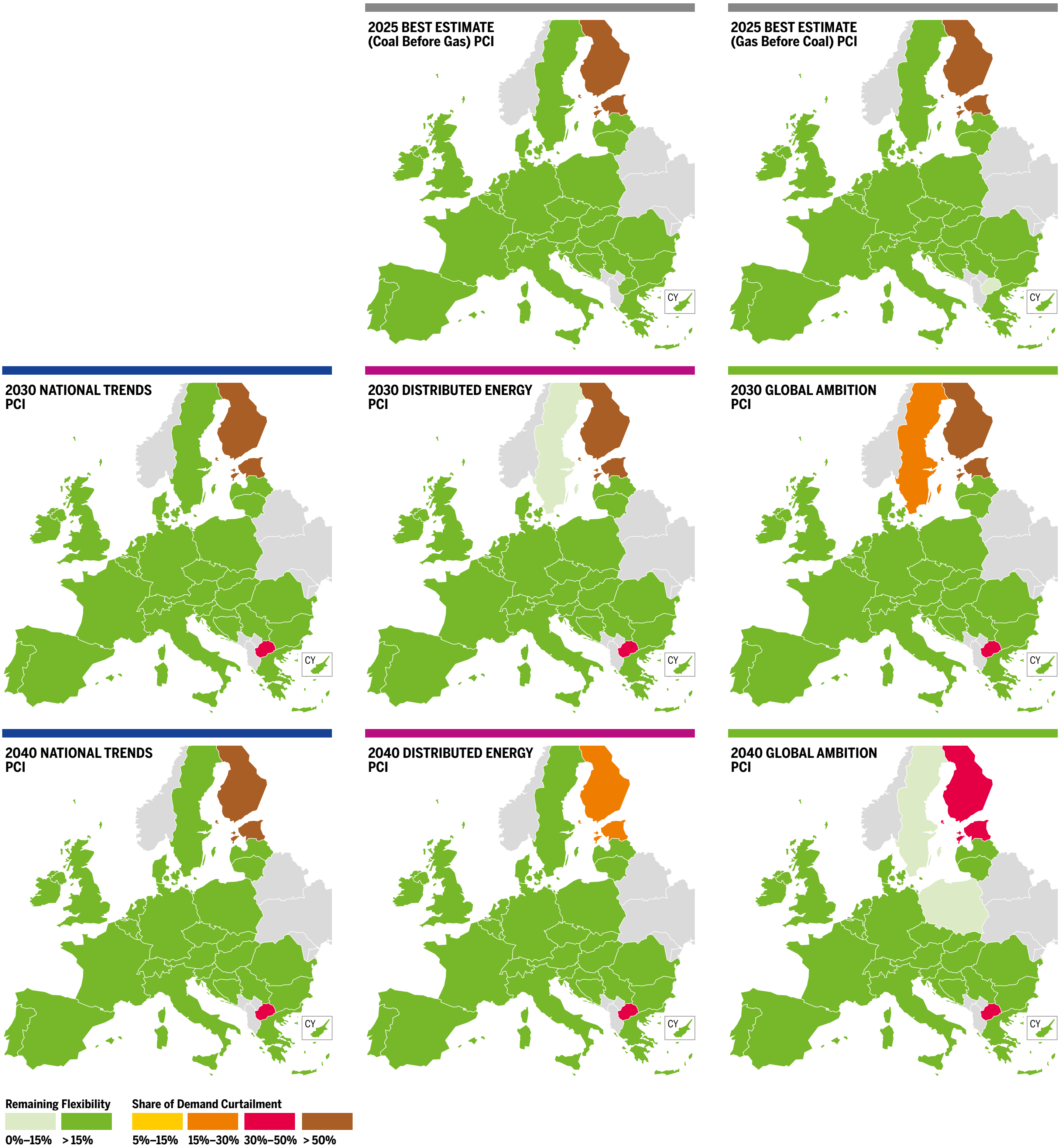

Figure 4.93 PCI infrastructure level: Baltics States and Finland transit disruption under 2-week Dunkelflaute situation.

4.2.4 ALGERIAN PIPELINE IMPORT ROUTES DISRUPTION

The simulation considers the disruption of all the imports pipelines from Algeria to the EU during climatic stress situations and the risk group is formed by Austria, Croatia, France, Greece, Italy, Malta, Portugal, Slovenia and Spain.

The Import pipelines from Algeria to EU disrupted in this case are:

- MEG Pipeline between Algeria and Spain
- MEDGAZ Pipeline between Algeria and Spain
- TRANSMED Pipeline between Algeria and Italy

Figure 4.94 Risk group for Algerian pipes disruption.

4.2.4.1 PEAK DAY

EXISTING INFRASTRUCTURE LEVEL

Simulation results are in line with the assessment of climatic stress conditions without transit disruption. **Figure 4.95** shows the evolution of the Existing infrastructure level.

Results show that mainly Italy, Portugal and Spain suffer a limited impact coming from the Algerian pipeline import route disruption. However, there is no country facing risk of demand curtailment apart from the countries already exposed in the assessment of climatic stress conditions without transit disruption.

Italy has a low remaining flexibility, bellow 15 %, in almost all scenarios and years, facing 0 % remaining flexibility in Gas Before Coal and Global Ambition 2030 driven by a high demand. National Trends 2030 is the scenario with the lowest gas demand in Italy and Distributed Energy 2040 is the scenario with the highest inclusion of renewable production coming from biomethane and power to gas.

Portugal faces 0 % remaining flexibility in Global Ambition 2030 driven by a lower national production that increases in 2040 with more production coming from renewables such as biomethane and power to gas reaching 58 % remaining flexibility.

Spain faces 0 % remaining flexibility in Global Ambition 2030 driven by high demand and low national production that increases in 2040 with more production coming from renewables such as biomethane and power to gas reaching 37 % remaining flexibility.

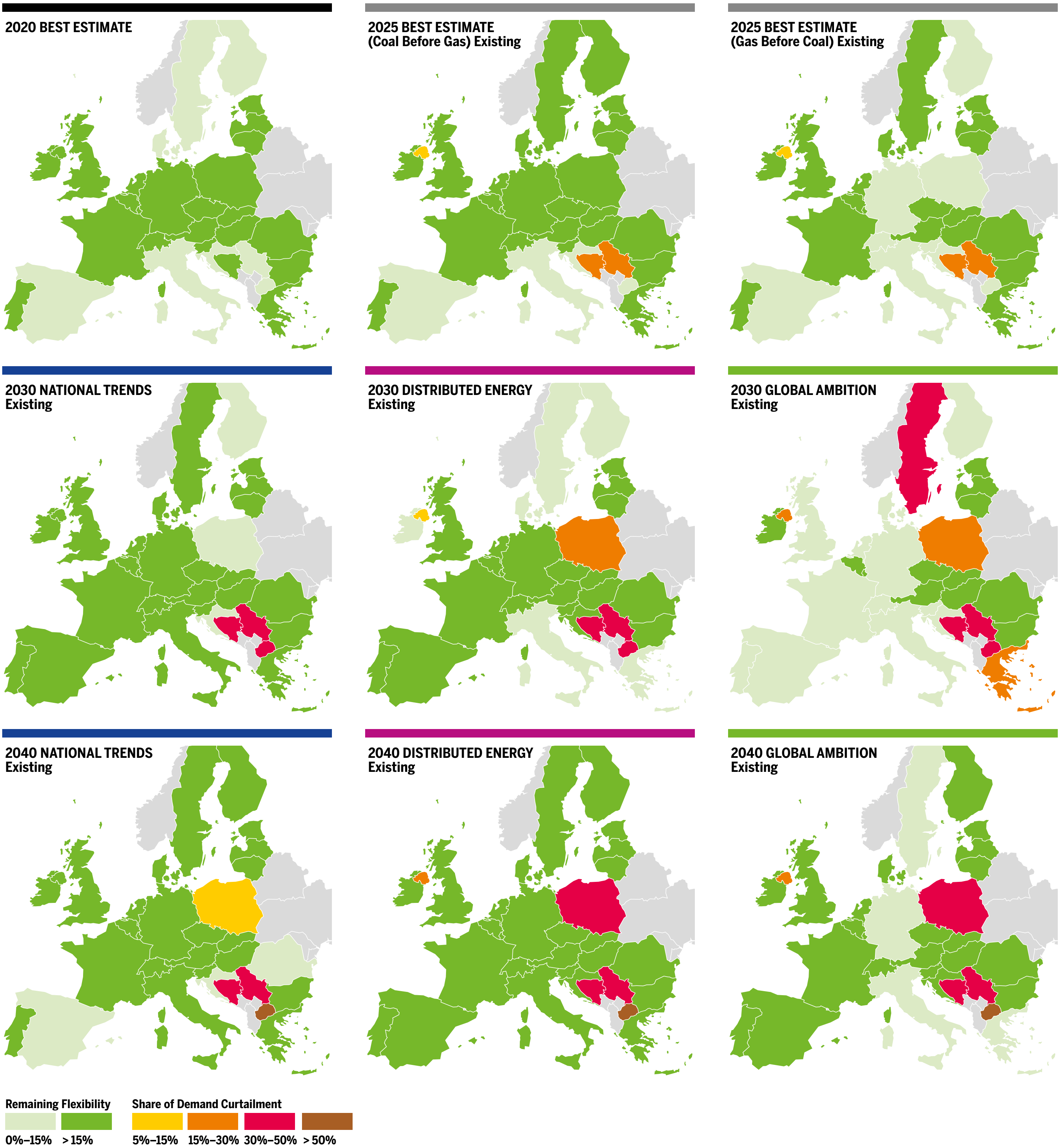

Figure 4.95 Existing infrastructure level: Algerian pipeline import route disruption under peak day situation.

LOW INFRASTRUCTURE LEVEL

Simulation results show that the commissioning of some FID projects in the area slightly improve the situation. **Figure 4.96** shows the Low Infrastructure level results.

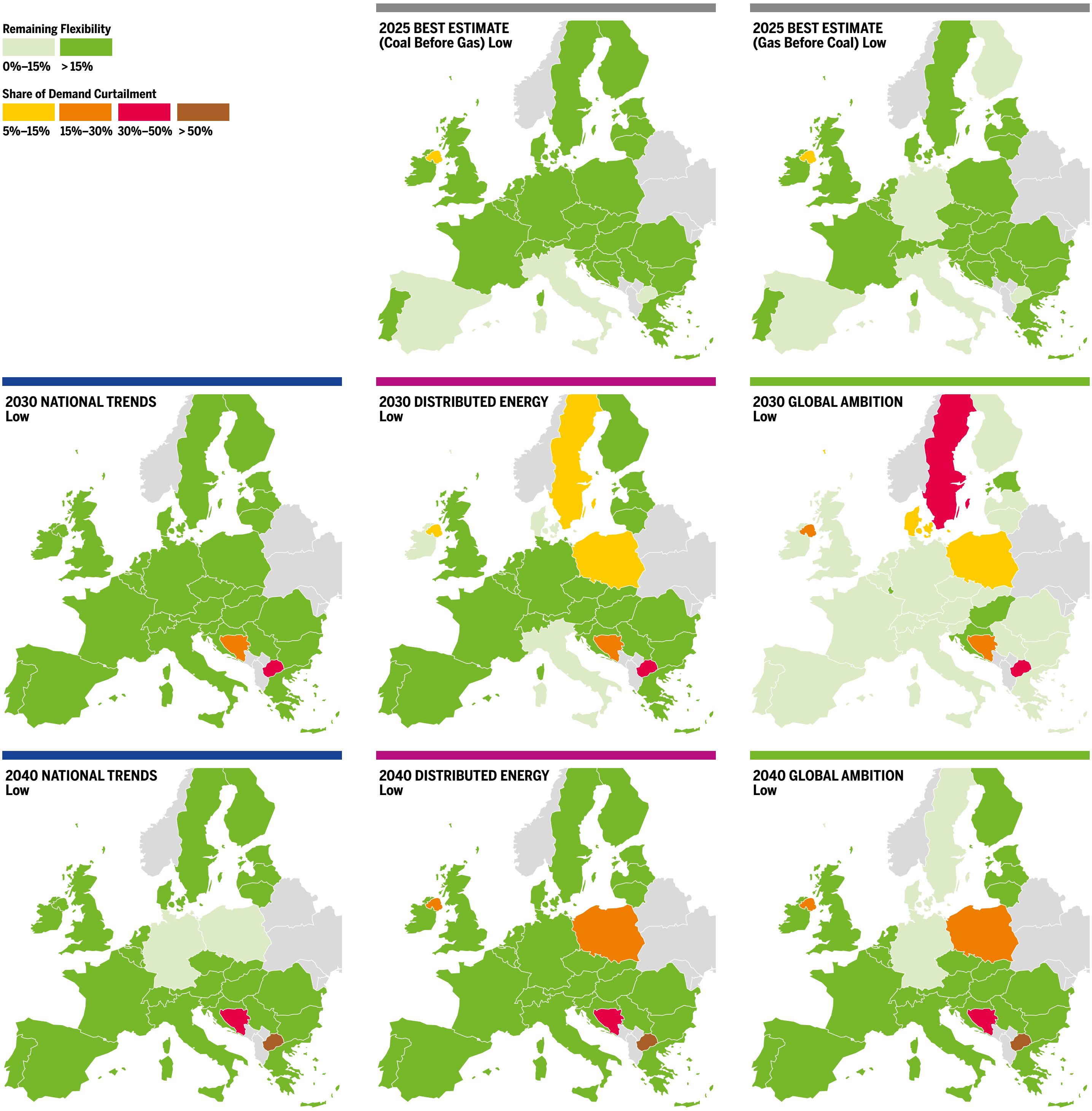

Figure 4.96 Low infrastructure level: Algerian pipeline import route disruption under peak day situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results show that advanced-status projects improve the situation increasing the remaining flexibility in Italy and the Iberian Peninsula in most of the scenarios. **Figure 4.97** shows the Advanced infrastructure level results.

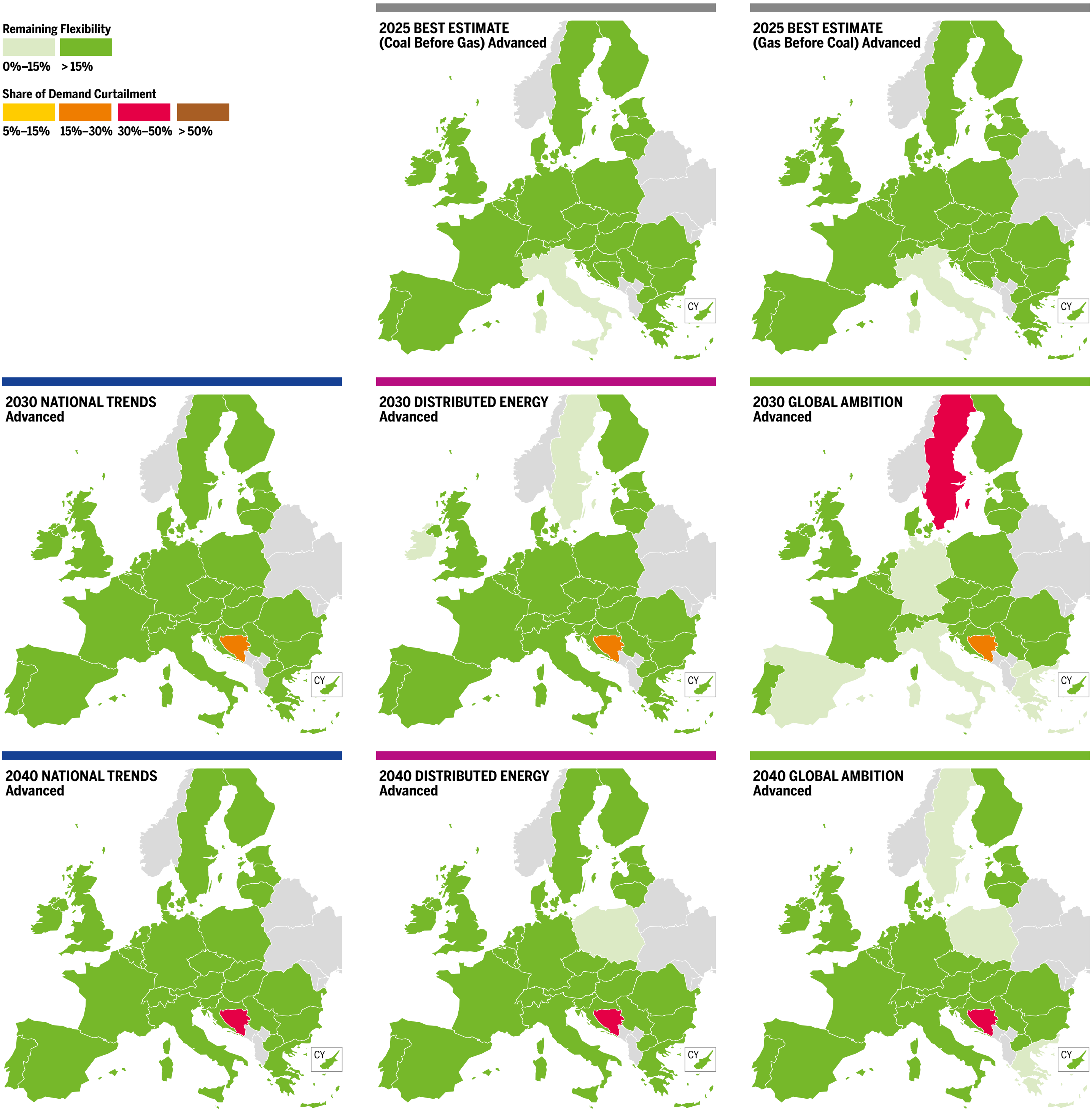

Figure 4.97 Advanced infrastructure level: Algerian pipeline import route disruption under peak day situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under peak day demand together with Algerian pipeline transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list showing the benefits stemming from the implementation of the latest PCI list. Results are mostly in line with Low infrastructure level regarding Spain and Portugal, while for Italy PCI projects help to increase the remaining flexibility. **Figure 4.98** shows the evolution of the PCI infrastructure level.

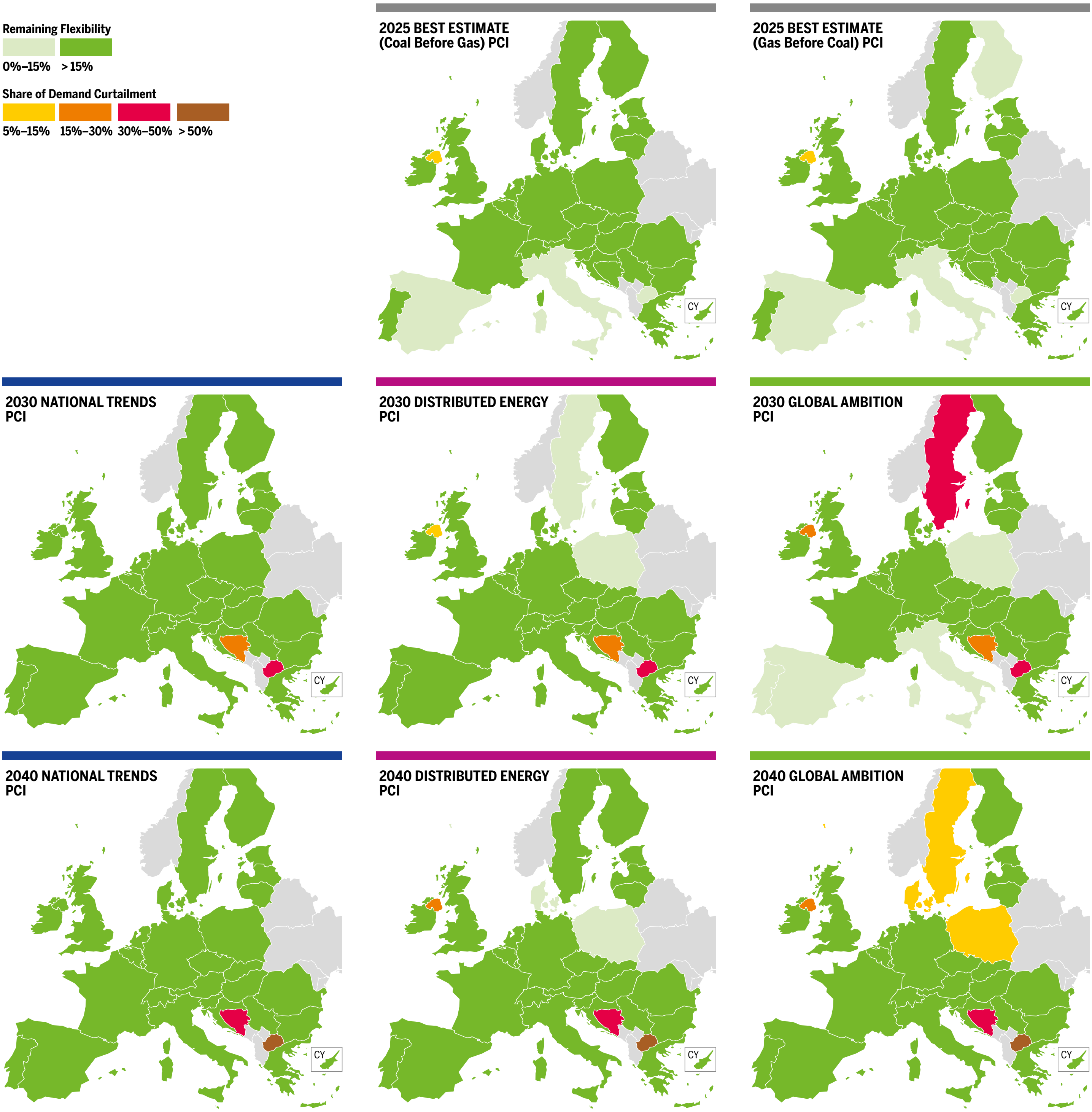

Figure 4.98 PCI infrastructure level: Algerian pipeline import route disruption under peak day situation.

4.2.4.2 2-WEEK COLD SPELL EXISTING INFRASTRUCTURE LEVEL

The EU gas system is resilient to a disruption of all pipelines from Algeria during a 2-week cold spell. No country is facing a risk of demand curtailment apart from the countries being affected for the climatic stress without disruption route case. **Figure 4.99** shows the evolution of the Existing infrastructure level. Regarding the countries with direct interconnection with Algeria supply, **Italy** surpasses a 15 % remaining flexibility in all scenarios apart from Gas Before Coal (9 %), which is the scenario with the highest demand. The Iberian Peninsula, **Portugal,** and **Spain** surpasses a 15 % remaining flexibility in all scenarios and years.

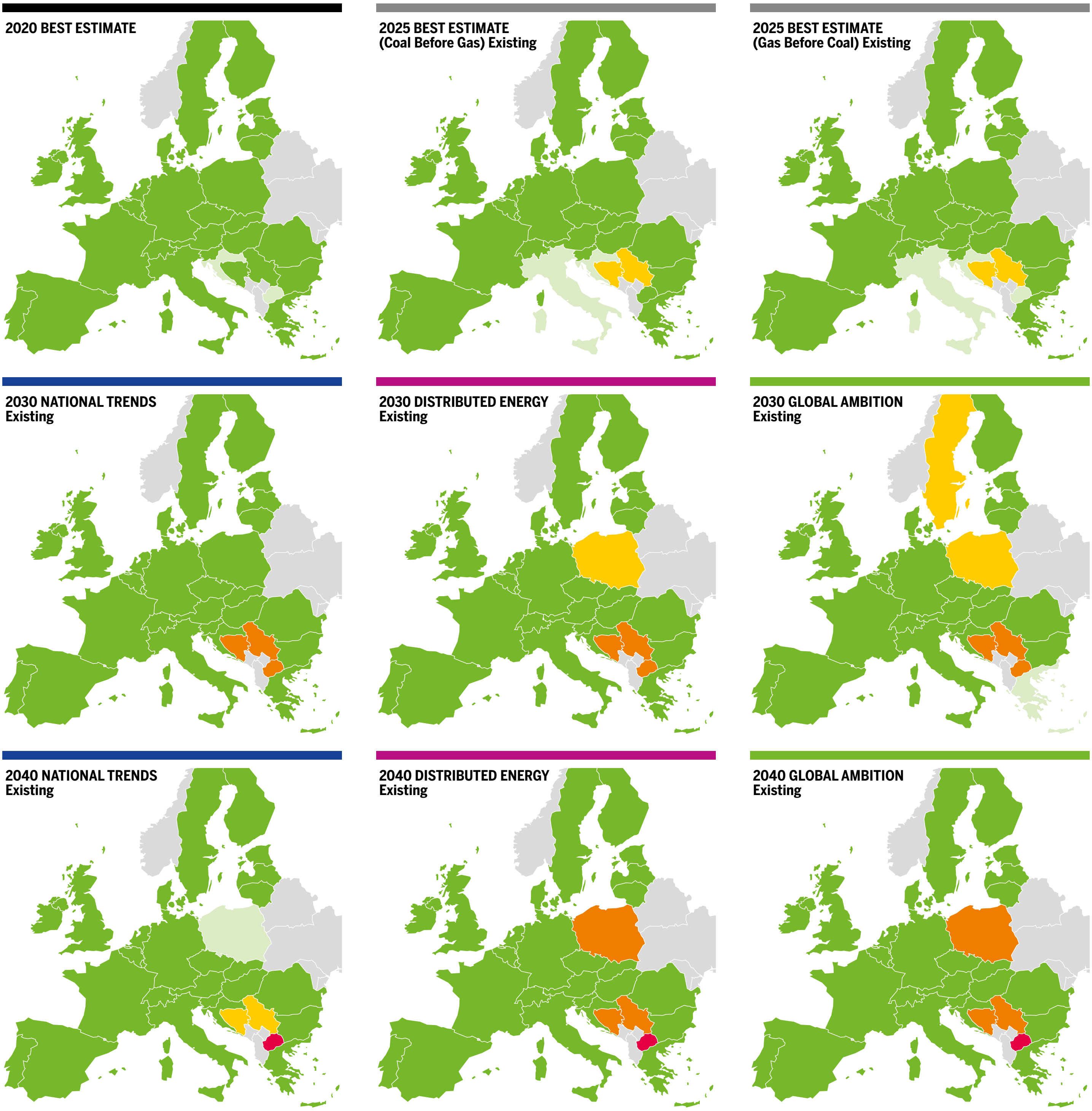

Figure 4.99 Existing infrastructure level: Algerian pipeline import route disruption under 2-week cold spell situation.

LOW INFRASTRUCTURE LEVEL

The commissioning of FID projects helps to increase the remaining flexibility all around Europe, specifically, in those countries with direct interconnection with Algeria supply. **Italy** surpasses a 15 % remaining flexibility in all scenarios and years. **Figure 4.100** shows the Low Infrastructure level results.

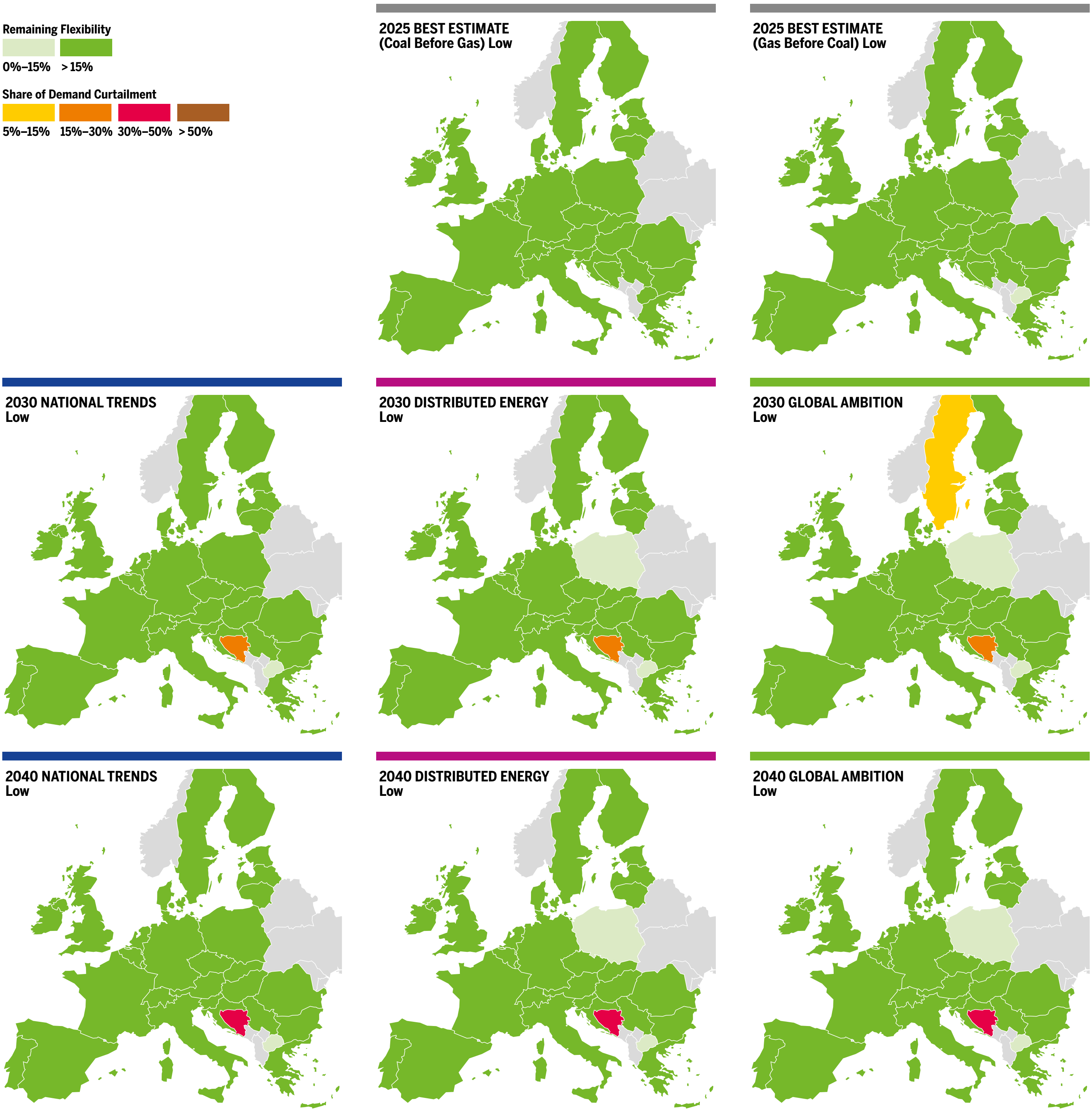

Figure 4.100 Low infrastructure level: Algerian pipeline import route disruption under 2-week cold spell situation.

ADVANCED INFRASTRUCTURE LEVEL

Results are in line with climatic stress conditions (without transit disruption) assessment. The increase of the remining flexibility, thanks to the commissioning of advanced-status projects, is notable all-around Europe, especially in those countries with direct interconnection with Algerian supply. Figure 4.101 shows the Advanced infrastructure level results.

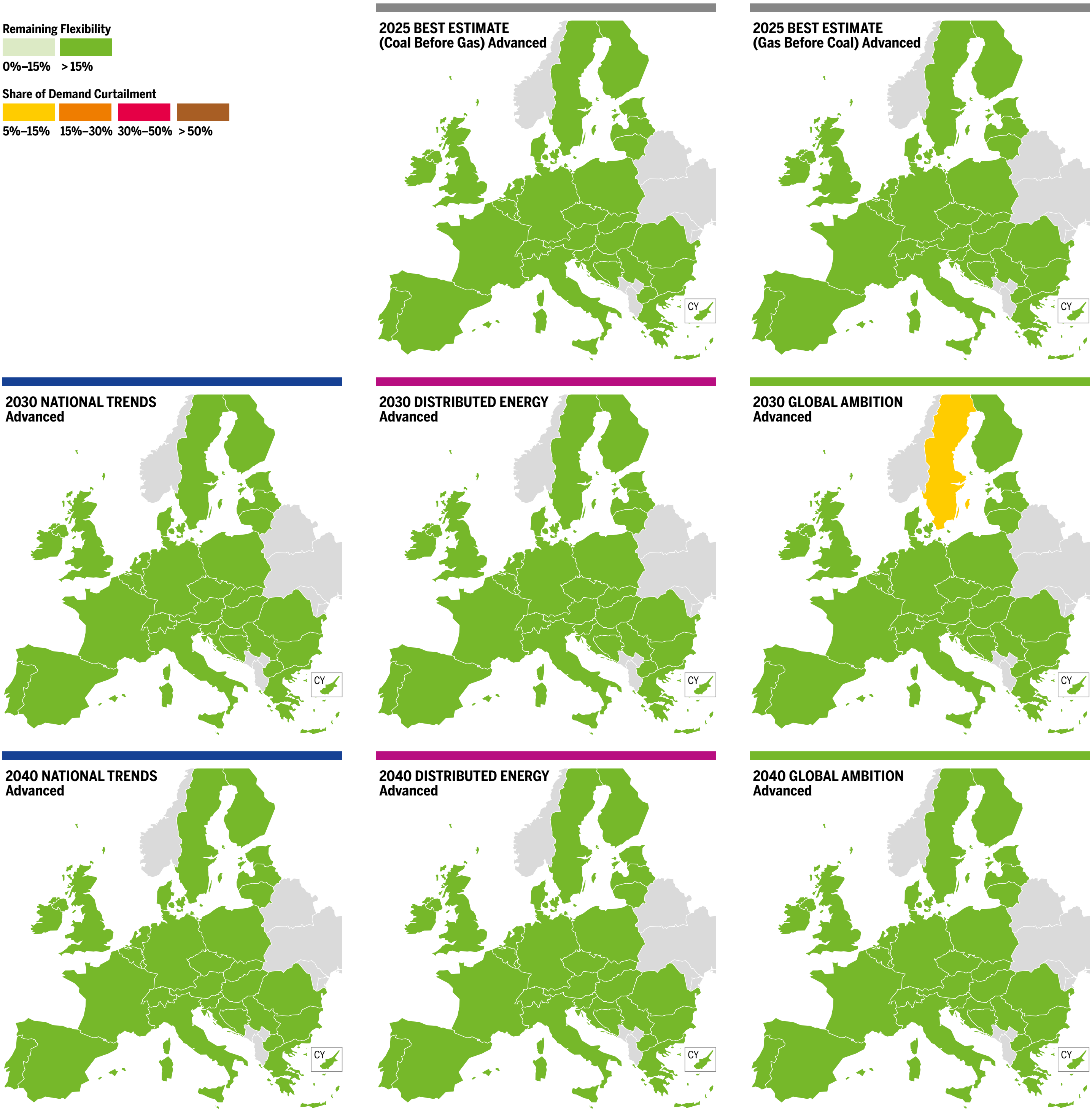

Figure 4.101 Advanced infrastructure level: Algerian pipeline import route disruption under 2-week cold spell situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week cold spell demand together with Algerian pipeline transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list. Results are in line with climatic stress conditions (without transit disruption) assessment. The increase of the remining flexibility, thanks to the commissioning of PCI projects is notable all-around Europe, especially in those countries with direct interconnection with Algerian supply showing the benefits from the implementation of the latest PCI list. **Figure 4.102** shows the PCI infrastructure level results.

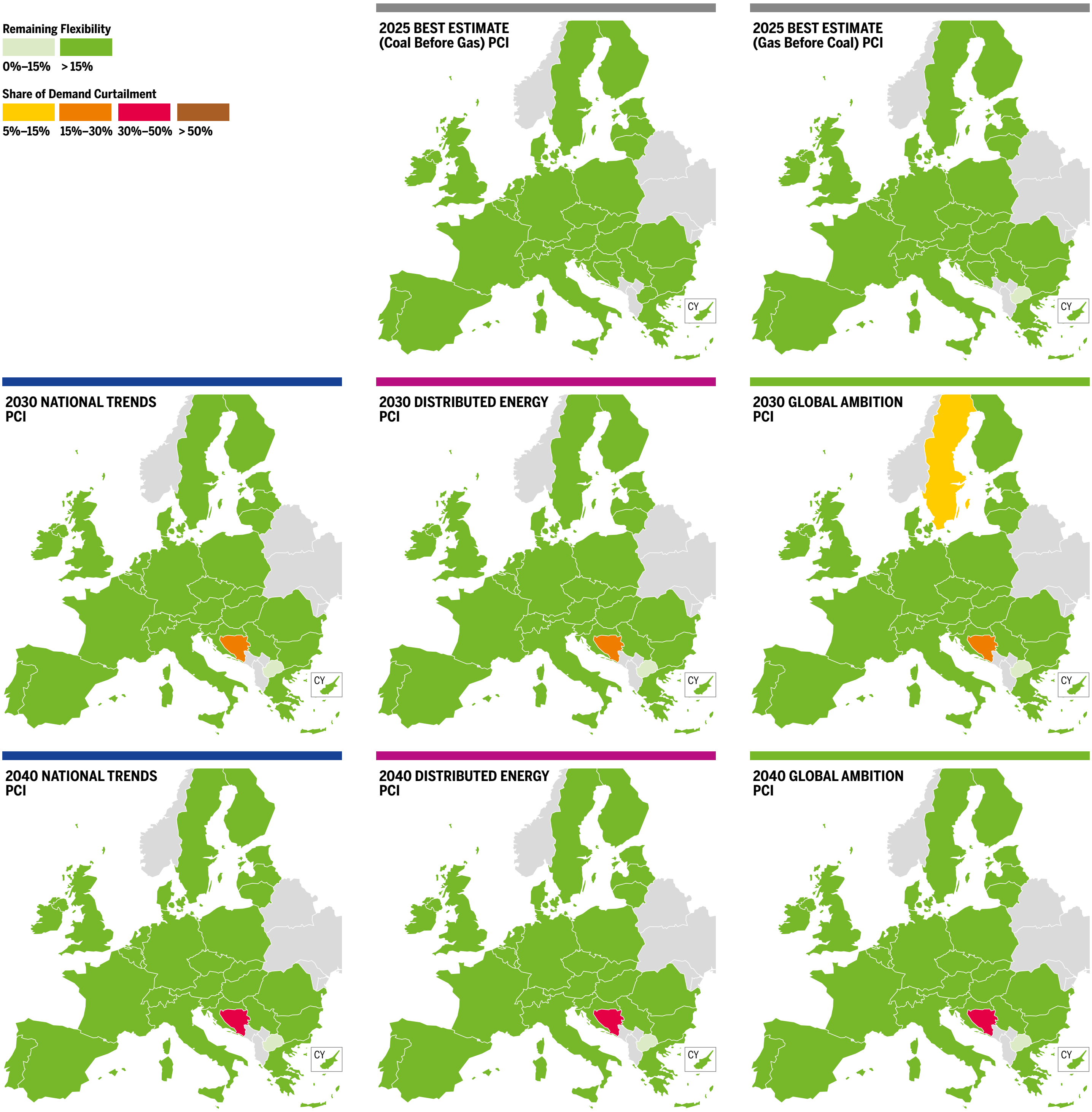

Figure 4.102 PCI infrastructure level: Algerian pipeline import route disruption under 2-week cold spell situation.

4.2.4.3 2-WEEK DUNKELFLAUTE

EXISTING INFRASTRUCTURE LEVEL

The EU gas system is resilient to a disruption of all pipelines from Algeria during a 2-week Dunkelflaute. As well as for peak day and 2-week cold spell demand cases, apart from the countries being affected for the climatic stress without disruption route case, no country is facing a risk of demand curtailment. Moreover, the gas system is able to back up the intermittent power generation ensuring flexibility to the electricity system. **Figure 4.103** shows the evolution of the Existing infrastructure level.

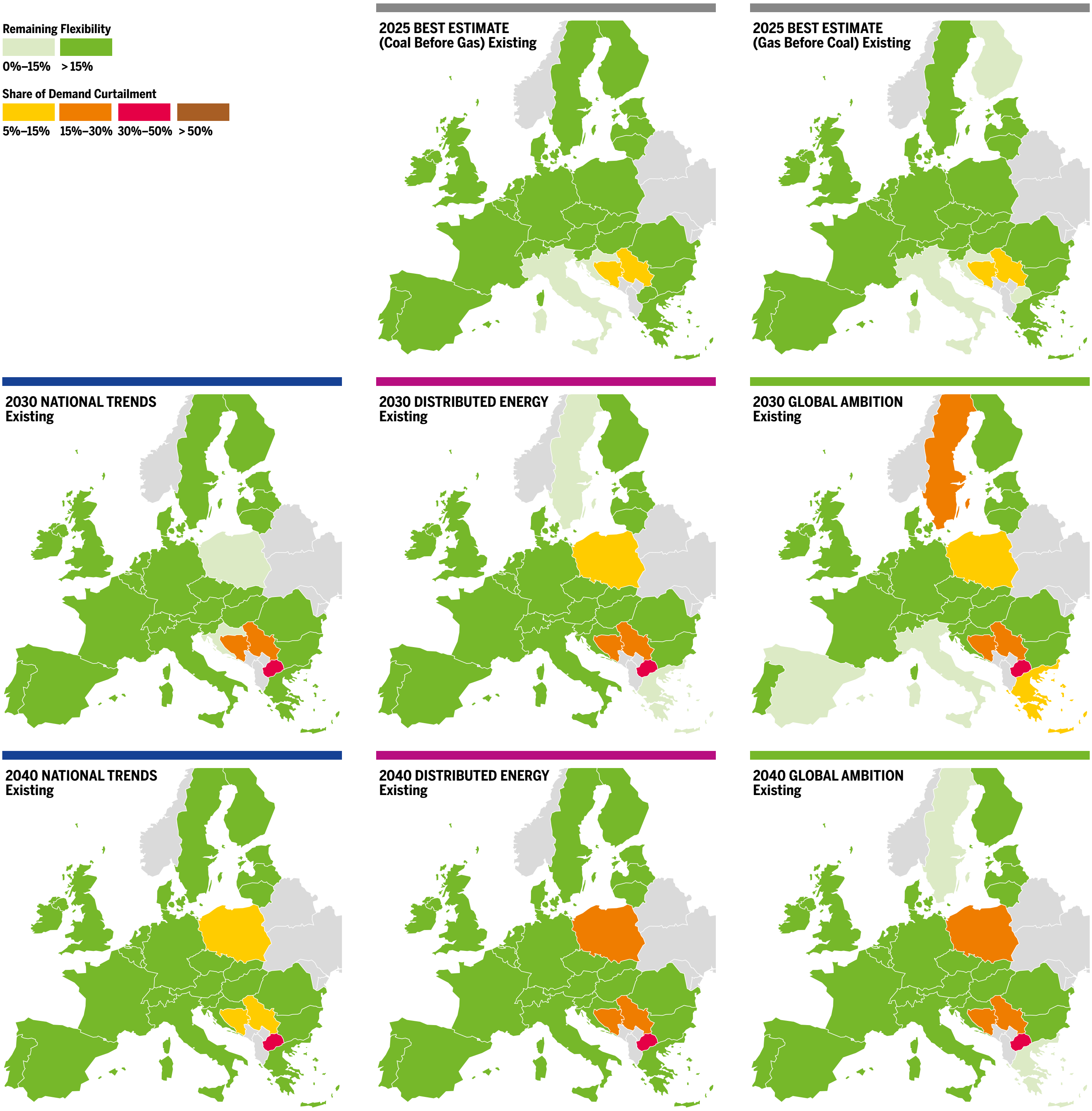

Figure 4.103 Existing infrastructure level: Algerian pipeline import route disruption under 2-week Dunkelflaute situation.

LOW INFRASTRUCTURE LEVEL

Simulation results are in line with climatic stress conditions (without transit disruption) assessment. The commissioning of FID projects helps to increase the remaining flexibility all around Europe, specifically, in those countries with direct interconnection with Algeria supply. **Figure 4.104** shows the Low Infrastructure level results.

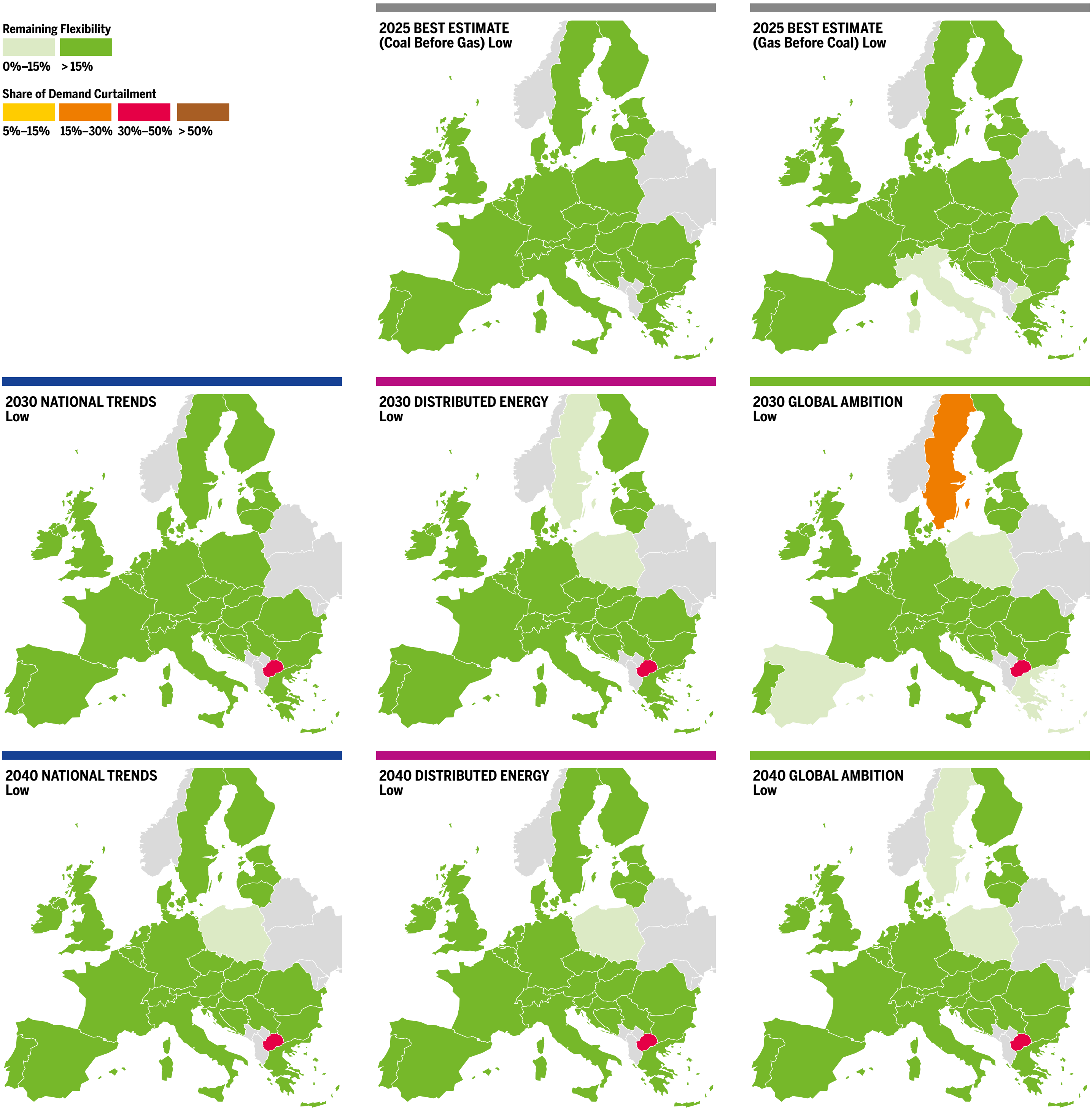

Figure 4.104 Low infrastructure level: Algerian pipeline import route disruption under 2-week Dunkelflaute situation.

ADVANCED INFRASTRUCTURE LEVEL

Simulation results are in line with climatic stress conditions (without transit disruption) assessment. The increase of the remining flexibility, thanks to the commissioning of advanced-status projects, is notable allaround Europe, especially in those countries with direct interconnection with Algerian supply. **Figure 4.105** shows the Advanced infrastructure level results.

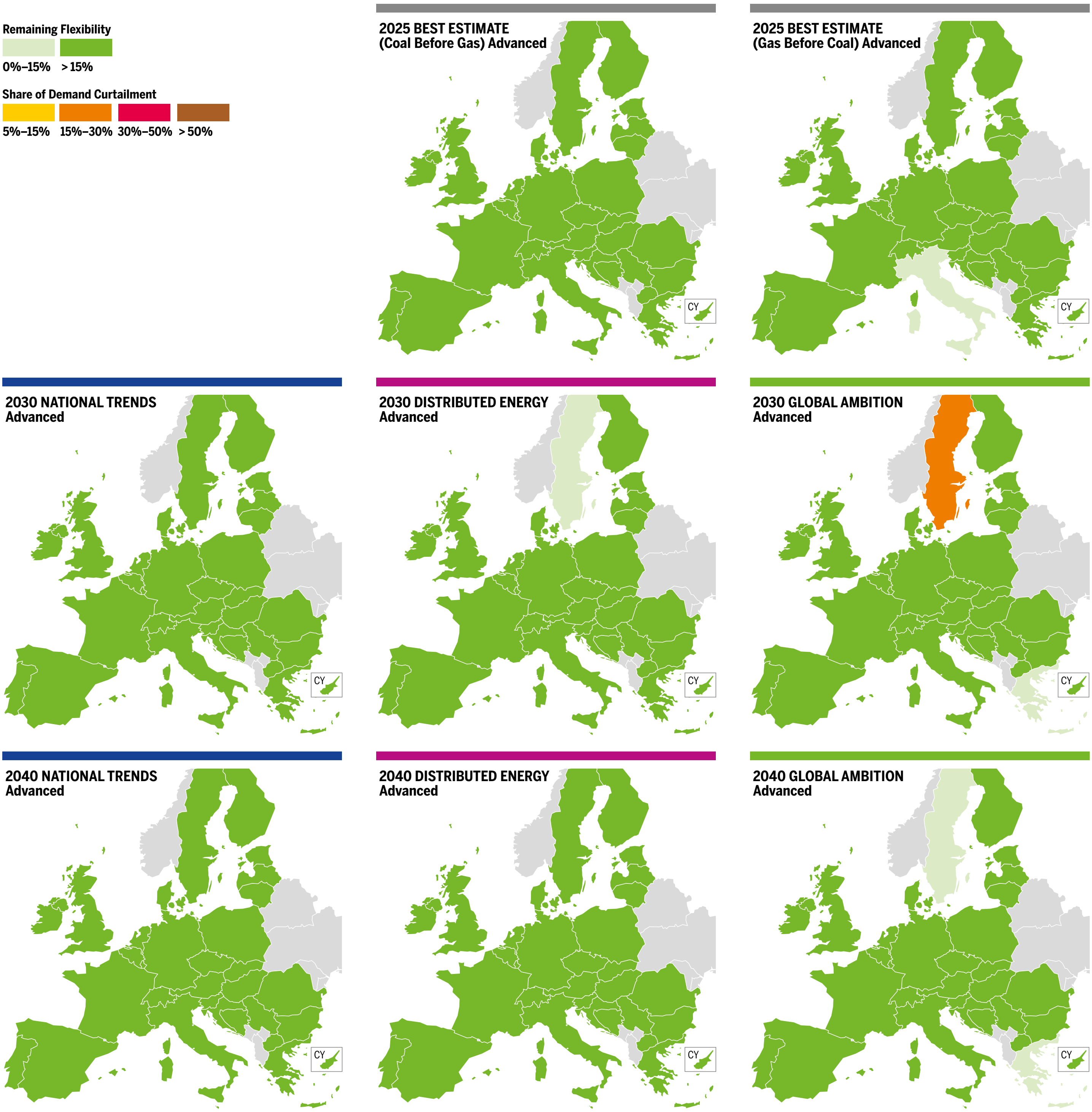

Figure 4.105 Advanced infrastructure level: Algerian pipeline import route disruption under 2-week Dunkelflaute situation.

PCI INFRASTRUCTURE LEVEL

This infrastructure level assesses the different scenarios under 2-week Dunkelflaute demand together with Algerian pipeline transit disruption against the current European gas system infrastructure complemented with FID projects (Low infrastructure level) and all projects included in the latest 4th PCI list. Simulation results are in line with climatic stress conditions (without transit disruption) assessment. The increase of the remining flexibility, thanks to the commissioning of PCI projects, is notable all-around Europe, especially in those countries with direct interconnection with Algerian supply showing the benefits from the implementation of the latest PCI list. **Figure 4.106** shows the PCI infrastructure level results.

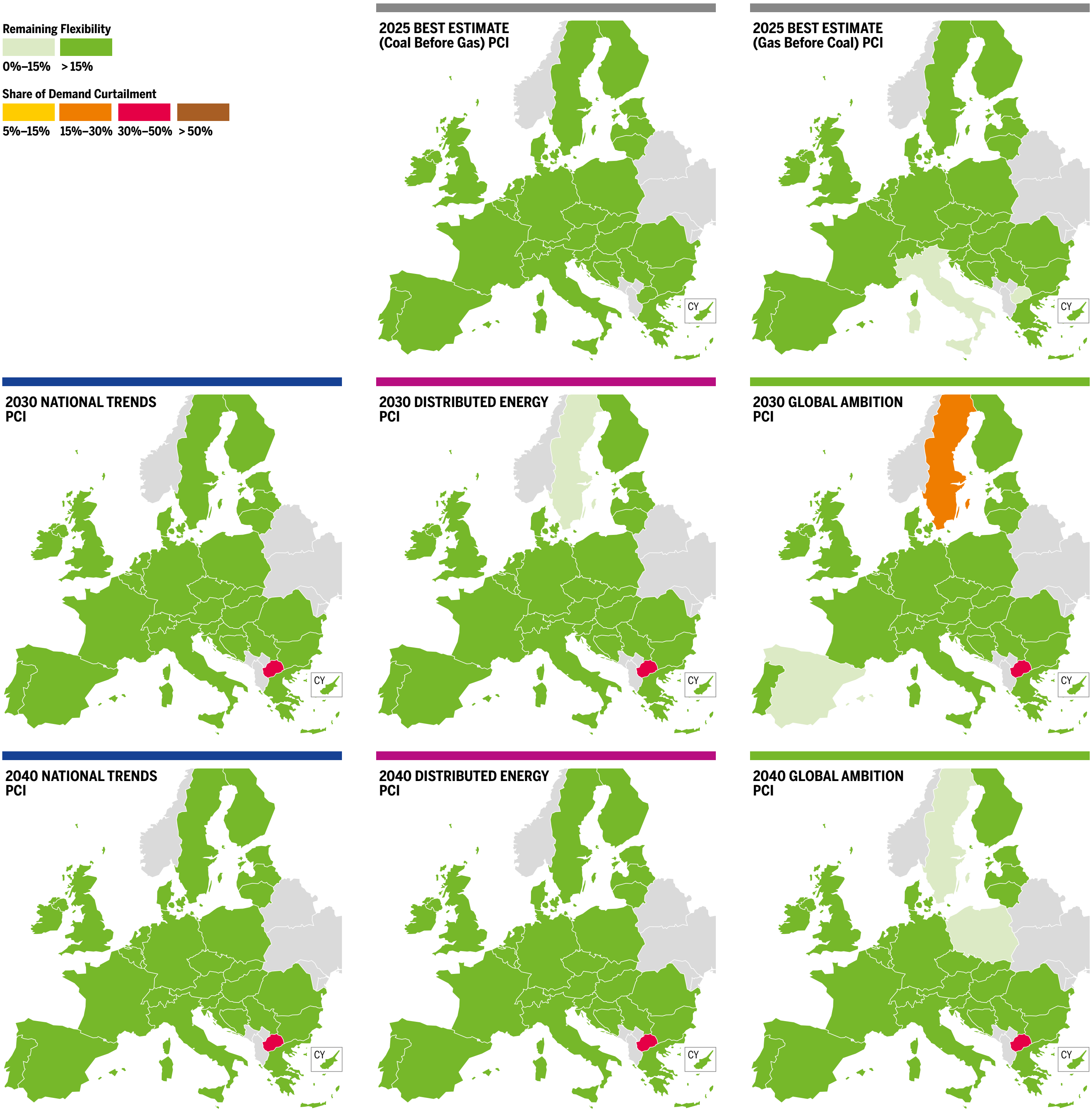

Figure 4.106 PCI infrastructure level: Algerian pipeline import route disruption under 2-week Dunkelflaute situation.

4.2.5 CONCLUSION – SUPPLY ROUTE DISRUPTIONS

The Existing gas infrastructure in Europe is resilient to most supply route disruptions (see ENTSOG SoS report: EU-wide simulation of supply and infrastructure disruption scenarios) and TYNDP 2020 further assesses the resilience of the European gas system to those supply disruptions exposing some parts of the EU to demand curtailment.

The assessment confirms that the resilience of the current gas infrastructure has improved since the previous TYNDP 2018 and the publication of the SoS simulation report in 2017.

Most of Europe is protected from a possible risk of demand curtailment in case of any major supply route disruption during high demand situations.

However, for some supply route disruptions, assessed further in this TYNDP, some infrastructure limitations keep on preventing some regions from being fully protected from a risk of demand curtailment. But projects submitted to the TYNDP can provide the necessary additional infrastructure to fully mitigate the situation.

Additionally, in some exposed areas, the assessment of the different scenarios show that the development of renewable gases efficiently contributes to security of supply and reduces the risk of demand curtailment.

Finally, the assessment shows the resilience of the gas system to a 2-week Dunkelflaute event when the gas system, including indigenous biomethane production or gas storage, can back up the intermittent power generation for a long period of time, therefore ensuring flexibility and security of supply to the electricity system.

More specifically,

- In case of **Ukraine transit route disruption**, the current gas infrastructure, along with the foreseeable reinforcements, offers alternative import routes from Russian and Caspian region supply (Nordstream 2, Turkstream and TAP) to be able to satisfy its demand and keep supporting Ukraine by maintaining gas exports.

  Apart from the countries impacted during the assessment of climatic stress conditions without transit disruption **Romania** faces a risk of demand curtailment in some scenarios in Existing, Low and PCI infrastructure levels. Advanced-status projects prove efficient in terms of improving security of supply, enabling an efficient cooperation within Europe. To a lesser extent, **Poland** is impacted by the Ukraine transit disruption as well.
- Additionally, results show the benefits of the penetration of renewables gases, especially in Distributed Energy and Global Ambition scenarios, allowing to mitigate the risk of demand curtailment and improve the resilience of the network.
- In case of **Belarus transit route disruption**, results show that the reduction in the overall import capacity from Belarus impacts **Poland** facing a higher risk of demand curtailment as a consequence of infrastructure limitations with its neighbouring countries. The commissioning of the interconnection Lithuania-Poland enables an efficient cooperation within Poland and Lithuania reducing the overall exposure of the region to demand curtailment. The use of alternative Russian supply import routes, as well as the use of the other supply sources, together with an efficient cooperation between countries, ensure security of supply in Europe with a higher level of flexibility in the Advanced and PCI infrastructure levels.
- Additionally, results confirm the benefits of the penetration of renewables gases, especially in Distributed Energy and Global Ambition scenarios.
- In case of **disruption of imports pipelines to the Baltic states and Finland**, penetration of renewables gases (biomethane and power to gas), together with infrastructures foreseeable reinforcements, in Distributed Energy and Global Ambition 2040 scenarios help decrease, or even fully mitigate, the risk of demand curtailment in Finland and Estonia during peak day and 2-week cold spell demand situation.
- Moreover, the connection of the Baltic states and Finland with the main EU gas grid in the Low infrastructure decreases their dependence to Russian gas, allowing an efficient cooperation with neighbouring countries (Latvia and Lithuania).
- The European existing infrastructure is generally resilient to a **disruption of all import pipelines from Algeria**. The results do not differ much from the results for climatic stress conditions without transit disruption route.

4.3 SEASONALITY ASSESSMENT AND SUPPLY MIXES

The gas infrastructure can integrate significant volumes of intermittent renewables

The assessment confirms that the existing gas system can support the development of renewable gases and renewable electricity by integrating all the potential biomethane and renewable hydrogen as defined in the different scenarios, the necessary adaptations of the existing gas network are undertaken. The potential of the gas system combined with significant volumes of storage is perfectly adequate to cope with the intermittent renewable generation.

The gas system and its storage capacity are key to cope with the seasonality of the energy demand

On an annual basis the gas infrastructure generally offers the necessary flexibility to balance the seasonal inadequacy between the energy supply (rather stable over the year) and the energy demand (high in winter and low in summer). The assessment confirms that the existing gas system can store more than 30 % of the current and future winter demand. This is another key element for integrating very seasonal supply such as solar energy without having to curtail other forms of renewable energy generation.

In case of high demand situations under climatic stress, the role of gas storages in the gas system prove to be necessary for security of supply, since most of the gas supply delivered in peak demand situations comes from the gas storages (8,500 GWh/d to 15,500 GWh/d). In case of Dunkelflaute event, the share of the supply coming from the storages can go up to 40 % for 2 consecutive weeks, demonstrating the role of the gas infrastructure as a necessary infrastructure to support the development of intermittent renewables while ensuring security of energy supply for the EU.

Development of renewables bring flexibility on annual level but import capacities are needed to ensure security of supply in peak situations

The assessment of the gas infrastructure under Distributed Energy show that even with a significant share of indigenous renewable production, the storages need imports to be filled up in summer and additionally, imports are a key complement to storage withdrawals in winter.

Furthermore, the analysis of the supply mixes under various price configurations confirms that the gas infrastructure allows for the market to make arbitration between cheap and expensive supply source to minimise the cost of gas supply for the EU. Additional infrastructure also proves to be giving access to alternative supply sources increasing the security of gas supply in some countries.

The assessment of Low and Advanced infrastructure levels generally bring more flexibility to the gas system. **See Figure 4.107.**

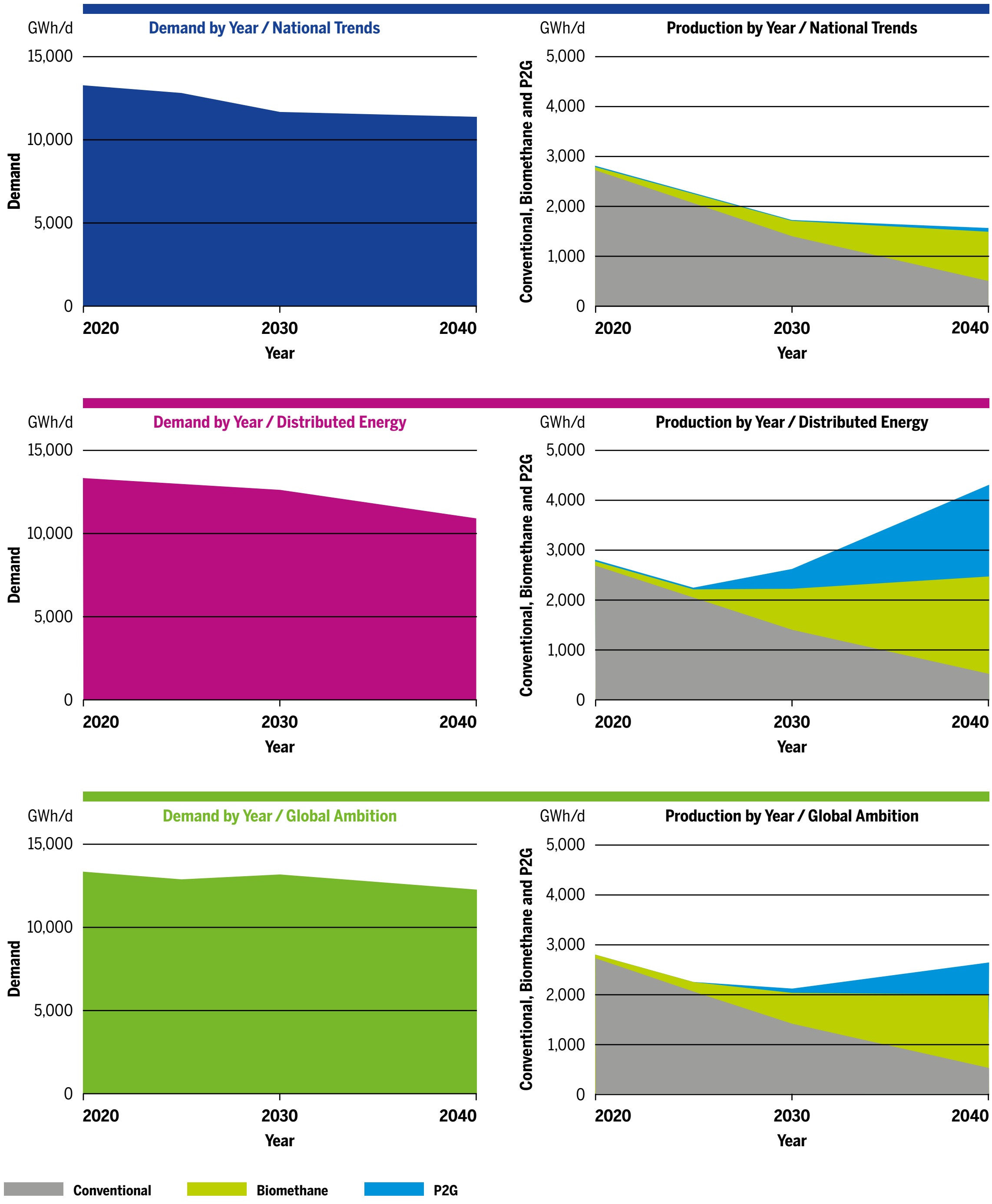

Figure 4.107 Annual demand and supply in TYNDP scenarios in the EU in GWh/d.

4.3.1 SUPPLY MIXES UNDER HIGH DEMAND SITUATIONS

Under high demand situations the supply and demand balance depend on a significant share of the underground gas storage utilisation while the share of the main supply sources remain quite stable over the years with a decrease, in absolute values, of LNG supply[18] and Norwegian gas over the years. The gas infrastructure enhances the security of gas supply in Europe in the different scenarios and years with enough import capacities and supporting the Energy Transition in very different ways, not only by enhancing the penetration of renewables gas production, but also as back up for intermittent power generation. The following charts illustrate the evolution in the different scenarios. **See Figure 4.108.**

In National Trends, the decline of the conventional natural gas production over the years is not compensated by the limited development of renewable and decarbonised gases. The supply and demand balance relies on a rather stable levels of imports shares and a significant share of storages utilisation over time, showing resilience to high demand situation in most of the EU.

In Distributed Energy, the gas system supports the integration of significant levels of renewable gas production in Europe compensating the decline of conventional natural gas. Under peak demand situations, the gas demand decreases overall. However, the increase in gas demand for power generation compensates partially for the decreasing gas demand in other sectors. The increasing share of indigenous renewable gas production, especially non-intermittent such as biomethane, allows for more flexibility imports/storage in the system to satisfy the demand. Nevertheless, the gas storages still provide 30 % (8,500 GWh/d) of the peak flexibility in 2040.

In Global Ambition, the gas European gas system can be part of a global transition where renewable and decarbonised gas can be imported. Therefore, the gas system copes with peak demand situations relying mainly on gas storages and imports while the increasing share of indigenous production bring some flexibility.

The evolution of the supply mixes share in Low and Advanced infrastructure level, follow the same trend as for existing infrastructure level.

18 In high demand situations such as peak days, the LNG supply is not limited to the possible LNG imports, but additionally includes the supply from the LNG tanks, acting like a gas storage for exceptional situations.

Figure 4.108 Evolution of the share of supply mixes under peak demand situation, Existing infrastructure level.

4.3.2 ANNUAL EU SUPPLY MIX PER CONFIGURATION

This part analyses the impact of contrasted EU supply mixes on the EU supply and demand balance and gas infrastructure. This is achieved through supply configurations intended at maximising, or respectively minimising, specific supply sources such as Russian gas and LNG.

Figures 4.109–4.112 shows the EU annual supply and demand balance for the years 2020, 2025, 2030 and 2040 for these contrasted supply mixes and the range for each supply source.

At EU-level, the Existing and Low infrastructure levels allow each source to reach its maximum potential, under the corresponding contrasted supply mix. Moreover, the gas infrastructure is well developed making use of the cheapest supply as the different price configurations show.

The infrastructure in the Low infrastructure level also provides high flexibility at EU-level. This is shown by the wide range of possible supply mixes. This can be mainly observed on the long run, where the supply flexibilities are wider.

The assessment of how marginal gas prices can further align throughout the EU is developed in the Market Integration and Competition chapter. **See Figures 4.109–4.114.**

POLICY SCENARIO

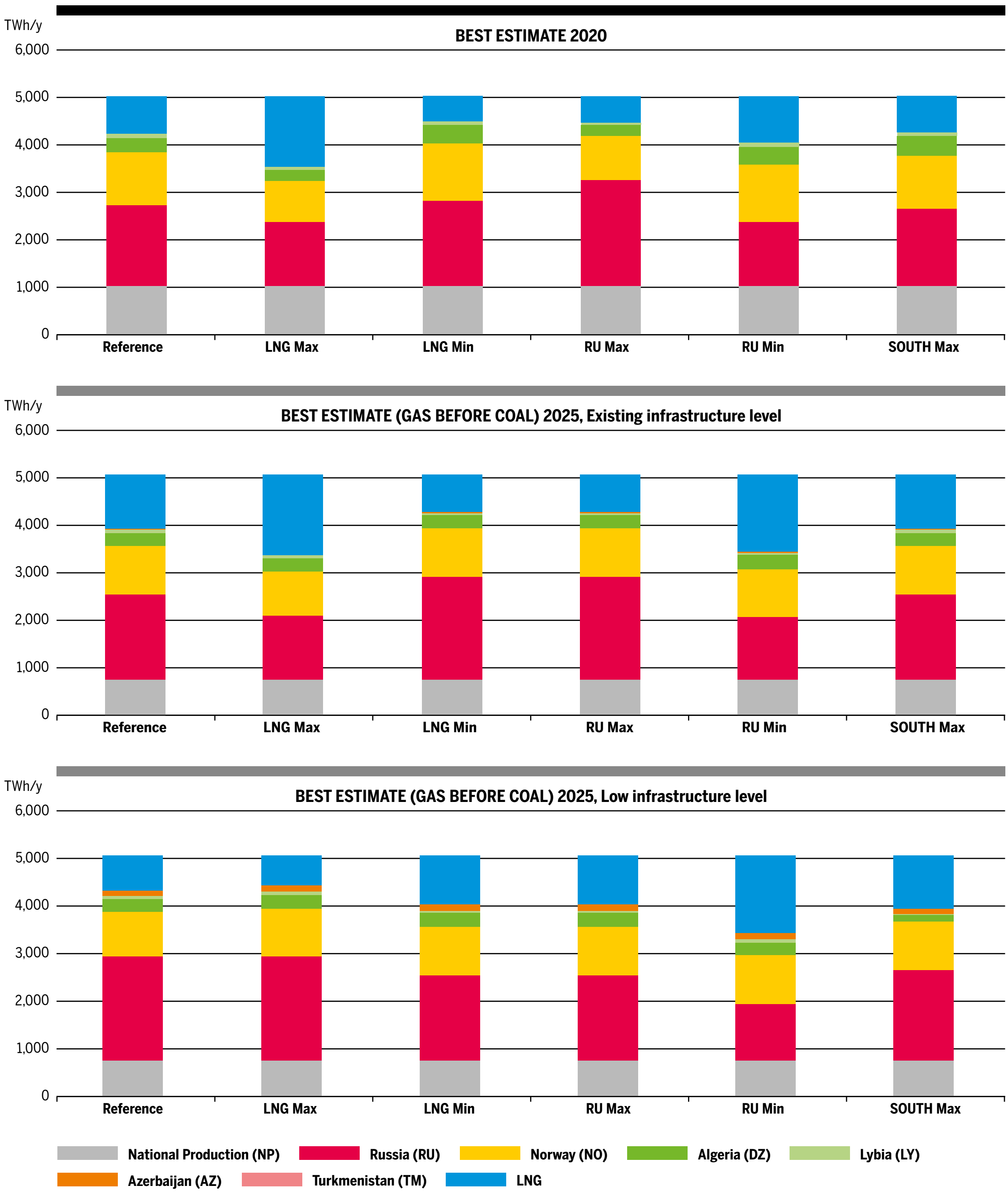

Figure 4.109 Annual EU supply mix per configuration 2020–2025.

Figure 4.110 Annual EU supply mix per configuration, National Trends 2030–2040.

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Figure 4.111 Annual EU supply mix per configuration, Distributed Energy 2030–2040.

Figure 4.112 Annual EU supply mix per configuration, Global Ambition 2030–2040.

		DZ	AZ	LNG	LY	NP	NO	RU	TM
2020	BEST ESTIMATE	5%–8%	0%–0%	11%–30%	1%–2%	20%–20%	17%–24%	27%–44%	0%–0%
2025	COAL BEFORE GAS	5%–6%	0%–0%	13%–34%	1%–1%	15%–15%	18%–21%	24%–44%	0%–0%
	GAS BEFORE COAL	6%–6%	0%–0%	15%–33%	1%–1%	14%–14%	18%–20%	26%–43%	0%–0%
2030	NATIONAL TRENDS	5%–7%	0%–0%	14%–35%	1%–1%	13%–13%	18%–22%	24%–45%	0%–0%
	DISTRIBUTED ENERGY	5%–6%	0%–0%	14%–32%	1%–1%	18%–19%	16%–21%	22%–43%	0%–0%
	GLOBAL AMBITION	6%–6%	0%–0%	15%–32%	1%–1%	14%–14%	18%–20%	27%–43%	0%–0%
2040	NATIONAL TRENDS	6%–7%	0%–0%	11%–36%	1%–1%	13%–13%	17%–21%	23%–48%	0%–0%
	DISTRIBUTED ENERGY	4%–7%	0%–0%	6%–33%	1%–1%	28%–36%	14%–22%	13%–42%	0%–0%
	GLOBAL AMBITION	5%–7%	0%–0%	10%–33%	1%–1%	20%–20%	16%–20%	21%–43%	0%–0%

Figure 4.113 Range of EU supply mix per configuration, Existing infrastructure level.

		DZ	AZ	LNG	LY	NP	NO	RU	TM
2025	COAL BEFORE GAS	5%–6%	2%–3%	13%–34%	1%–1%	15%–15%	18%–21%	23%–45%	0%–0%
	GAS BEFORE COAL	5%–6%	2%–3%	13%–33%	1%–1%	15%–15%	18%–20%	23%–43%	0%–0%
2030	NATIONAL TRENDS	4%–7%	2%–3%	14%–35%	1%–1%	13%–13%	18%–22%	22%–45%	0%–0%
	DISTRIBUTED ENERGY	5%–6%	2%–3%	13%–32%	1%–1%	19%–19%	16%–21%	20%–42%	0%–0%
	GLOBAL AMBITION	5%–6%	2%–3%	14%–32%	1%–1%	15%–15%	18%–20%	24%–43%	0%–0%
2040	NATIONAL TRENDS	5%–7%	2%–3%	8%–36%	1%–1%	13%–13%	18%–21%	21%–48%	0%–0%
	DISTRIBUTED ENERGY	3%–7%	3%–3%	6%–33%	1%–1%	28%–36%	14%–22%	13%–45%	0%–0%
	GLOBAL AMBITION	5%–7%	2%–3%	7%–33%	1%–1%	20%–21%	16%–20%	18%–44%	0%–0%

Figure 4.114 Range of EU supply mix per configuration, Low infrastructure level.

4.4 SUPPLY ADEQUACY IN NORTH-WEST EUROPE: THE CHALLENGE OF L-GAS AREAS

Historically, the main supplier of L-gas in North West Europe was the Groningen gas field in the Netherlands. Since 2012 Belgium, France, Germany and the Netherlands have been working together to phase-out L-gas. Initially, the phase-out was motivated by the natural decline of the capacity of the Groningen field. However, in March 2018 the government of the Netherlands, in order to guarantee safety in the Groningen area, announced its decision to terminate natural gas production from the Groningen field as soon as possible, and no later than 2030. After an earthquake which occurred on 22 May 2019 near Westerwijtwerd, the schedule for production phase-out was accelerated to gas year 2022/23 for average weather conditions. From the summer of 2022 onward, gas from the Groningen gas field will only be used as back-up for the nitrogen blending facilities, L-gas storages and potential disruptions in H-gas supply.

The decline of L-gas production is causing a pressing investment requirement in North-West Europe, the only region where L-gas is produced and consumed. The announced phase-out of the Groningen field production and the decline of the German L-gas production will require considerable infrastructure investments to allow L-to-H market conversion in large parts of Belgium, France and Germany. The foreseen conversion process includes the development of specific gas transmission infrastructure (or adaptation if existing) to integrate the L-gas and the H-gas networks and to bring H-gas supplies to the L-gas areas to be converted. A detailed overview is presented recently in the North West Gas Regional Investment Plan (NW-GRIP)[19].

The key conclusions in the NW-GRIP are:

- There will be sufficient L-gas supply to cover security of supply (SoS) throughout the L-to-H market conversion program, according to the Task Force Monitoring L-Gas Market Conversion.
- The measures to increase conversion capacity and reduce L-gas demand in the Netherlands are on track.
- The L to H infrastructure conversion programs in France, Belgium, Germany are on track.
- The Task Force Monitoring L-Gas Market Conversion provides a good forum for international cooperation and alignment between the four concerned countries.

The impact of COVID-19 in Europe on the L-gas supply and demand projections is assessed in the second edition of the L-gas Market Conversion Monitoring Taskforce report (September 2020), in which the participating countries conclude that until September 2020 the COVID-19 virus has not impacted the construction of the Nitrogen facility in the Netherlands, and does not delay the L-to-H market conversion programs of Belgium, France and Germany in the coming years (although some activities have been postponed by several weeks or months in 2020, with marginal impact on the overall programs).

19 https://www.entsog.eu/gas-regional-investment-plans-grips#north-west

4.5 SINGLE LARGEST INFRASTRUCTURE DISRUPTION (SLID)

This section investigates the impact of the disruption of the single largest infrastructure of a country during a Peak day. The SLID measures the curtailed demand following the disruption of the single largest interconnection infrastructure in given country (excluding storage and national production).

For each country, the Single Largest Infrastructure depends on the year and the infrastructure level.

The table of Single Largest Infrastructure Disruption and the risk group for each country considered can be found in Annex D.

The results presented below correspond to the possible curtailment demand for a country in case of disruption of its Single Largest Infrastructure and the impact on other countries. The demand curtailment in Peak Day without any disruption are not represented in this chapter (see Climatic Stress chapter).

4.5.1 EXISTING INFRASTRUCTURE LEVEL

The existing infrastructure level allows to bring an instructive light on the necessary infrastructure projects in order to mitigate the exposure of the countries to demand curtailment under disruption of the Single Largest Infrastructure.

In general, the existing infrastructure is resilient to most of the disruption of single largest infrastructures. However, some countries at the border of the EU show a potential exposure to significant levels of demand curtailment This exposure is linked to the geographical location limiting the possibility of diversification in terms of interconnection, like in Ireland, Denmark and Sweden, Finland and Greece. Furthermore, in some scenarios in some years, some other countries could be exposed to demand curtailment.


Picture courtesy of FGSZ

2020

North Eastern Europe

- **Denmark** is exposed to 40 % demand curtailment as SLID correspond to the interconnection with Germany and limited national production in 2020.
- **Sweden** is also impacted by SLID in Denmark and is exposed to demand curtailment.
- In case of Swedish SLI (interconnection with Denmark), **Sweden** is exposed to 90 % of demand curtailment without any other interconnection (low diversification).
- **Finland** is exposed to demand curtailment (88 %) due to infrastructure limitation with Estonia.
- **Estonia** is exposed to demand curtailment (18 %) due to infrastructure limitation with neighbouring countries.
- **Poland** is exposed to a low demand curtailment (4 %) due to infrastructure limitation with neighbouring countries.

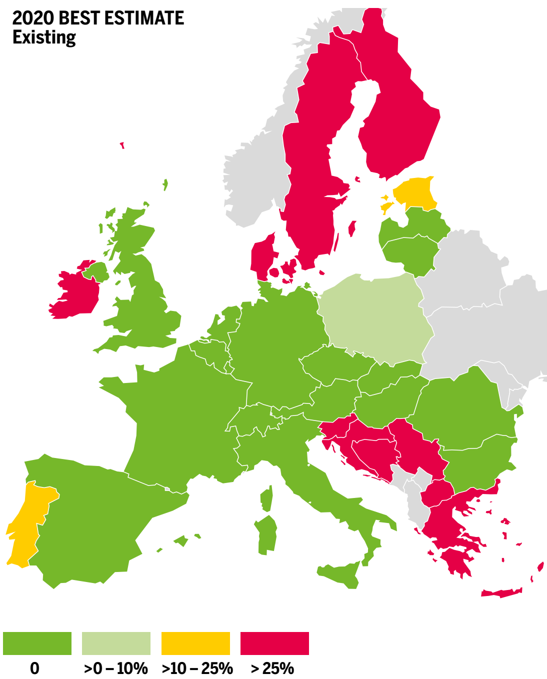


Figure 4.115 Maximum exposure to demand curtailment in case of SLID in Existing Infrastructure level in 2020.

Eastern Europe

- **Croatia** is exposed to a significant risk of demand curtailment (37 %) due to an infrastructure limitation with Slovenia.
- **Slovenia** is exposed to a significant risk of demand curtailment (37 %) due to an infrastructure limitation with Croatia and Italy.
- **Serbia** with limited access to different sources (national production and Storage in case of SLI with Hungary) is exposed to 80 % of demand curtailment. Serbia is dependent on its interconnection with Hungary.
- **Greece** is exposed to 47 % demand curtailment due to infrastructure limitation with neighbouring countries when the larger infrastructure i. e. the LNG terminal is disrupted.
- **Bosnia and Herzegovina** and **North Macedonia** have only one interconnection and are exposed to 100 % demand curtailment in case of their SLID respectively.

Western Europe

- **Ireland** is exposed to demand curtailment (71 %) due to not enough interconnections in case of Moffat disruption (connection with UK). In the same time, **Northern Ireland** which depends totally of Moffat interconnection is also exposed to 100 % demand curtailment.
- **Portugal** is exposed to a relatively low demand curtailment (12 %) due to infrastructure limitation with the Spain-Portugal interconnection (Single Largest Infrastructure disrupted in Portugal is Sines Terminal).

2025

North Eastern Europe

- In case of SLID Denmark, **Denmark** fully mitigates risk of demand curtailment with high conventional gas production and **Sweden** is no longer exposed to any risk.
- **Sweden**, in case of Swedish SLID, is exposed to 71 % of demand curtailment, thanks to the increase in national production.
- **Finland** and **Estonia** are still exposed to risks of demand curtailment.
- **Poland** with high demand scenario for power generation is more exposed to demand curtailment and show infrastructure limitation for all its interconnections (SLI-Poland is Yamal interconnection).

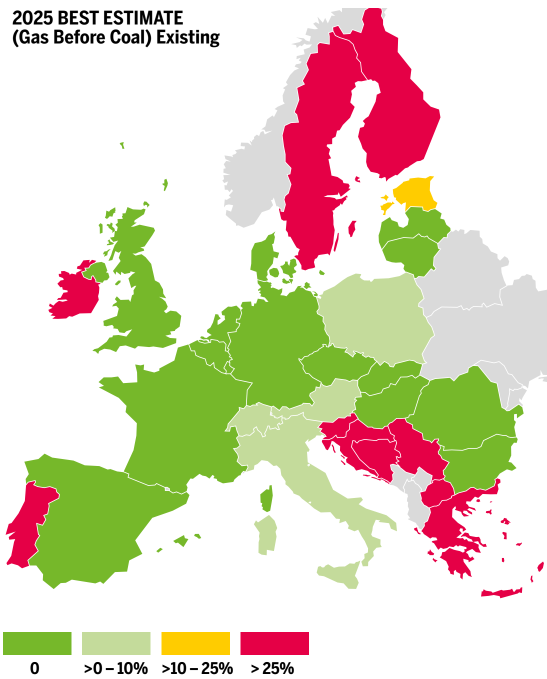


Figure 4.116 Maximum exposure to demand curtailment in case of SLID in Existing Infrastructure level in 2025 for Gas Before Coal scenario.

Eastern Europe

- **Croatia** is exposed to a significant risk of demand curtailment (37 %) due to an infrastructure limitation with Slovenia.
- **Slovenia** is exposed to a significant risk of demand curtailment (53 %) due to an infrastructure limitation with Croatia and Italy and high demand for power.
- **Serbia** with limited access to different sources (national production and storage in case of SLI with Hungary) is exposed to 67 % of demand curtailment. Serbia is dependent on its interconnection with Hungary.
- **Greece** is exposed to 46 % demand curtailment due to infrastructure limitation with neighbouring countries.
- **Bosnia and Herzegovina** and **North Macedonia** have only one interconnection and are exposed to 100 % demand curtailment in case of their SLID respectively.

Western Europe

- **Ireland** is exposed to demand curtailment (84 %) due to not enough interconnections in case of Moffat disruption (connection with UK) and low indigenous production. In the same time, **Northern Ireland** which depends totally on Moffat interconnection is also exposed to 100 % demand curtailment.
- **Portugal** is exposed to demand curtailment (35 %) due to infrastructure limitation with the Spain-Portugal interconnection and high demand scenario.
- In case of SLID in Austria, **Austria** is exposed to a slight risk of demand curtailment (2 %) and **Italy** is cooperating and is exposed to a risk of demand curtailment too.

2030

North Eastern Europe

- **Denmark** is exposed to a risk of demand curtailment (27 %) in Distributed Energy scenario and to higher risk (36 %) in Global Ambition Scenario due high demand scenario for power generation compared to National Trends scenario (risk is fully mitigated) where demand is lower because of low power generation demand and high conventional gas production. Sweden is still exposed to demand curtailment in Distributed Energy scenario only (highest demand scenario).
- **Sweden**, in case of Sweden SLID, the situation is improving in National Trends scenario due to low demand scenario (low demand for power generation) and in Distributed Energy scenario for which the increase in indigenous production is not sufficient to compensate the high demand for power.
- **Finland** is exposed to high demand curtailment with a slight improvement compared to 2025 in National Trends scenario due to low demand for power. For the other scenarios, the high indigenous production is not enough to compensate the high demand for power and the demand curtailment is still high (70 %).
- **Estonia** is exposed to a risk of demand curtailment in National Trends scenario due to high demand for power compared to other scenarios.
- **Poland** is in a similar position with higher demand curtailment in Global Ambition and National Trends scenarios (15 %) and demand curtailment comparable with 2025 (11 %).
- In case of SLID in Slovakia, **Slovakia** is exposed to a significant risk of demand curtailment (24 %) and in the same time, neighbouring countries as **Austria** and **Czech Republic** are also exposed to the same risk (24 %) due to cooperation mode between neighbouring countries.

Eastern Europe

- **Croatia** is exposed to a significant risk of demand curtailment (35 %) due to an infrastructure limitation with Slovenia in National Trends scenario. The risk still exists (16 %) in Global Ambition scenario where the indigenous production is not enough to compensate high demand for power generation. The risk is mitigated (8 %) in Distributed Energy due to low demand specially for power and high indigenous production.
- **Slovenia** is exposed to a significant risk of demand curtailment (53 %) due to an infrastructure limitation with Croatia and Italy and high demand for power in Global Ambition and National Trends scenarios. The situation is mitigated (40 %) in Distributed Energy where indigenous production is compensating partially high demand for power.
- **Serbia** with limited access to different sources (national production and storage in case of SLI with Hungary) is exposed to 88 % of demand curtailment. Serbia is dependent on its interconnection with Hungary.
- **Greece** is exposed to 42 % demand curtailment due to infrastructure limitation with neighbouring countries in Global Ambition scenario. The situation is mitigated (43 and 47 %) in Distributed Energy scenario where indigenous production is compensating partially high demand for power and in National Trends scenario with the lowest demand value.
- **Bosnia and Herzegovina** and **North Macedonia** have only one interconnection and are exposed to 100 % demand curtailment in case of their SLID respectively.
- **Romania** is exposed to a slight risk of demand curtailment (5 %) in National Trends scenario due to high demand for power and the lowest national production scenario.

Western Europe

- **Ireland** is exposed to Demand curtailment (90 %) due to not enough interconnections in case of Moffat disruption (connection with UK) and an indigenous production which does not compensate demand and specially demand for power. In the same time, **Northern Ireland** which depends totally of Moffat interconnection is also exposed to 100 % demand curtailment.
- **Portugal** is exposed to demand curtailment (25 %) due to infrastructure limitation with the Spain-Portugal interconnection and high demand scenario in Global Ambition scenario. In National Trends scenario, the demand curtailment reaches 34 % due to high demand for power and 16 % in Distributed Energy with high indigenous production.
- In case of SLID in Austria, **Austria** is exposed to a slight risk of demand curtailment (2 %) in Global Ambition scenario and **Italy** is cooperating and might be exposed to a marginal risk of demand curtailment too.

See Figure 4.117.

2040

North Eastern Europe

- In case of SLID Denmark, **Denmark** and **Sweden** fully mitigate risk of demand curtailment in Distributed Energy scenario with high indigenous production which compensates high demand for power. In Global Ambition scenario the situation is mitigated but still persist with demand curtailment around 24 % in Denmark, 53 % in Sweden (High demand for power but low indigenous production). In National Trends scenario, Denmark mitigates risk of demand curtailment with Indigenous production compare to Sweden which is still exposed to risk of demand curtailment (54 % in Sweden).
- Indigenous production in Distributed Energy scenario mitigates risk of demand curtailment in **Finland**. In Global Ambition and National Trends scenarios, the risk of demand curtailment is still high (51 and 81 %) due to an infrastructure limitation with Estonia not compensated with indigenous production.
- **Poland** is exposed to demand curtailment in all scenarios. Indigenous production is not enough to compensate the high demand for power in National Trends (17 %) compared to the other scenario (12 % in Distributed Energy and in Global Ambition).

Eastern Europe

- **Croatia** is exposed to a significant risk of demand curtailment (35 %) due to an infrastructure limitation with Slovenia in National Trends scenario. The risk is higher compared to 2030 due to low indigenous production. The risk still exists but slightly (7 %) in Global Ambition scenario where the indigenous production is not enough to compensate high demand for power generation. The risk is fully mitigated in Distributed Energy due to low demand specially for power and high indigenous production.
- **Slovenia** is exposed to a significant risk of demand curtailment (50 %) due to an infrastructure limitation with Croatia and Italy and high demand for power in Global Ambition and National Trends scenarios. The situation is mitigated (32 %) in Distributed Energy where indigenous production is compensating partially high demand for power.
- **Serbia** with limited access to different sources (national production and storage in case of SLI with Hungary) is exposed to 90 % of demand curtailment. Serbia is dependent on its interconnection with Hungary.
- **Greece** is exposed to a risk of 46 % demand curtailment due to infrastructure limitation with neighbouring countries in Global Ambition and National Trends scenarios. The situation is mitigated (13 %) in Distributed Energy where demand is compensated partially by indigenous production.
- **Bosnia and Herzegovina** and **North Macedonia** have only one interconnection and are exposed to 100 % demand curtailment in case of their SLID.

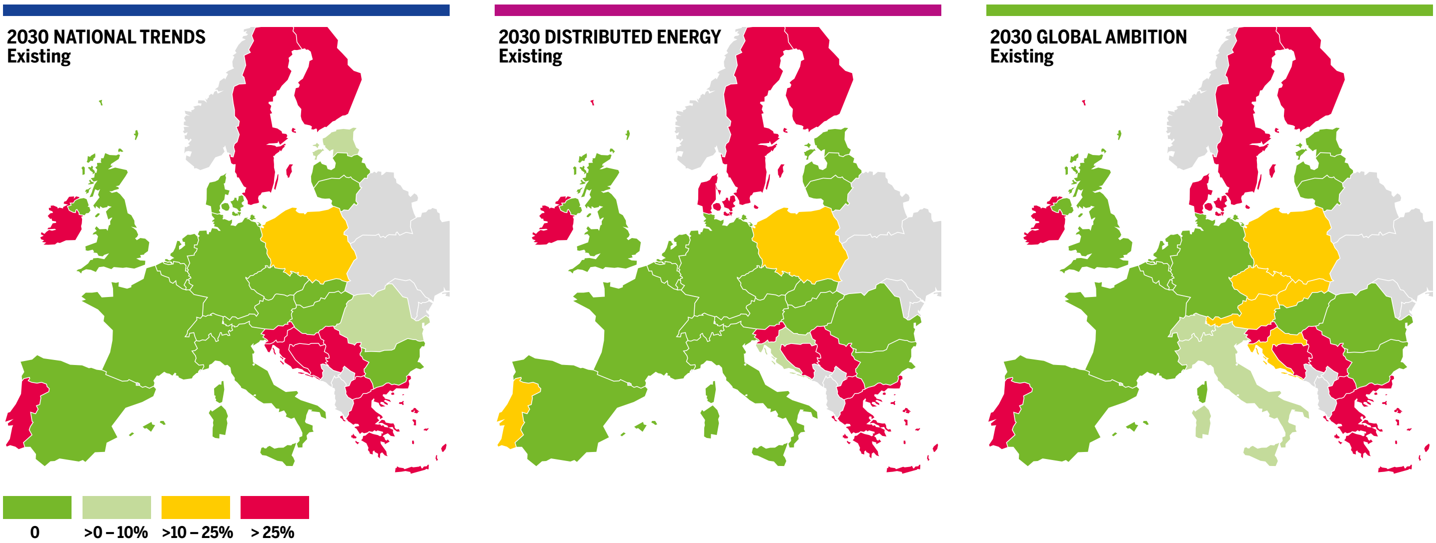


Figure 4.117 Maximum exposure to demand curtailment in case of SLID in Existing Infrastructure level in 2030 for all scenarios.

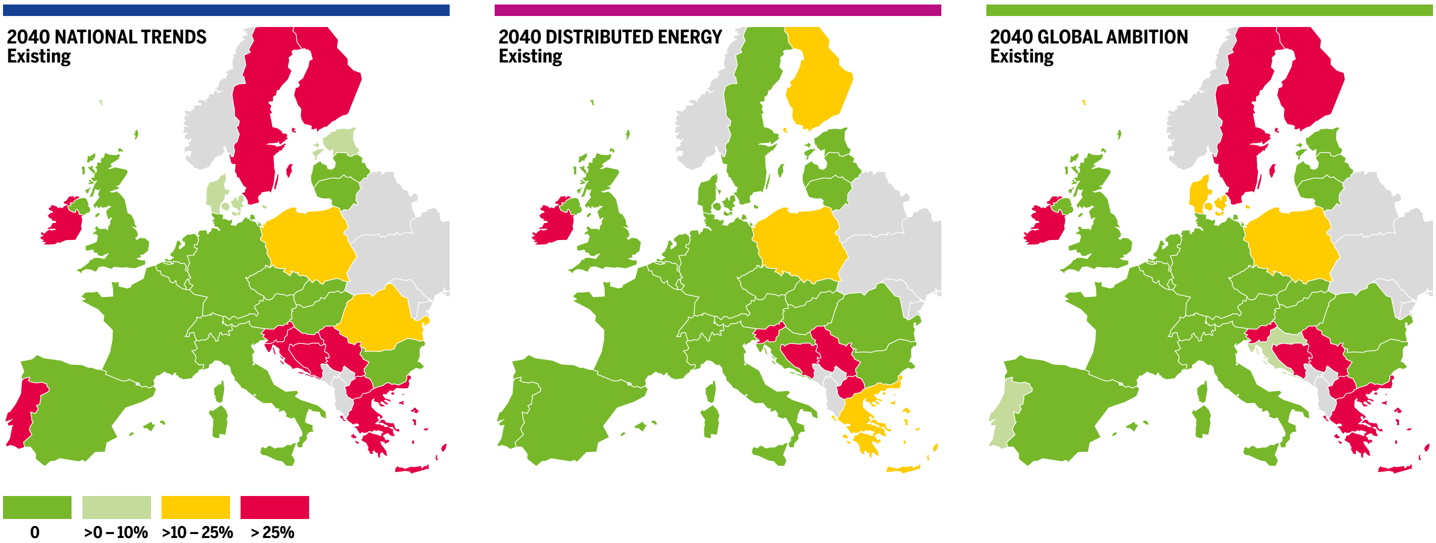


Figure 4.118 Maximum exposure to demand curtailment in case of SLID in Existing Infrastructure level in 2040 for all scenarios.

Western Europe

- **Ireland** is exposed to Demand curtailment (80 %) due to not enough interconnections in case of Moffat disruption (connection with UK) and an indigenous production which does not compensate demand and specially demand for power. In the same time, **Northern Ireland** which depends totally of Moffat interconnection is also exposed to 100 % demand curtailment.
- **Portugal** is exposed to demand curtailment (29 %) due to infrastructure limitation with the Spain-Portugal interconnection, high demand scenario and low indigenous production in National Trends scenario. Demand curtailment is mitigated in Global Ambition scenario with 8 % and fully mitigated in Distributed Energy with demand scenarios compensated partially by high indigenous production.

See Figure 4.118.

4.5.2 LOW INFRASTRUCTURE LEVEL

The results of the indicator in Low infrastructure level allows to bring an instructive light on the impact of FID projects and the necessary infrastructure projects still needed in order to reduce or even eliminate all risks of demand curtailment under disruption of the Single Largest Infrastructure. FID projects generally improve the resilience of the gas infrastructure but do not fully mitigate the exposure to demand curtailment in case of disruption of some Single Largest Infrastructures.

2025

North Eastern Europe

- **Finland** mitigates risk of demand curtailment (65 %) thanks Baltic Connector increase capacity from Estonia. In this case, **Estonia** cooperates more with Finland and is now exposed to high demand curtailment (45 %).
- **Poland** fully mitigated risk of demand curtailment thanks to Slovakia and Lithuania new interconnections.
- **Sweden** situation is unchanged without any project improving its source of supply.

Eastern Europe

- FID project in Croatia (LNG terminal KRK) is new Single Largest Infrastructure. **Croatia** fully mitigates risk of demand curtailment in particular with the existing interconnection from Hungary.
- **Greece** mitigates its risk of demand curtailment thanks to the Trans Adriatic Pipeline interconnection. Nevertheless, all the interconnections with neighbouring countries are showing infrastructure limitations which do not allow Greece to have access to more gas.
- **Slovenia** situation is unchanged without any project improving its diversification.
- **Bosnia and Herzegovina** and **North Macedonia** situations are unchanged with 100 % risk of demand curtailment.
- **Serbia** mitigates risk of demand curtailment (8 %) with new interconnections with Bulgaria and Trans Balkan Pipeline.

Western Europe

- The situation is unchanged for **Portugal**, **Ireland,** and **Northern Ireland**.

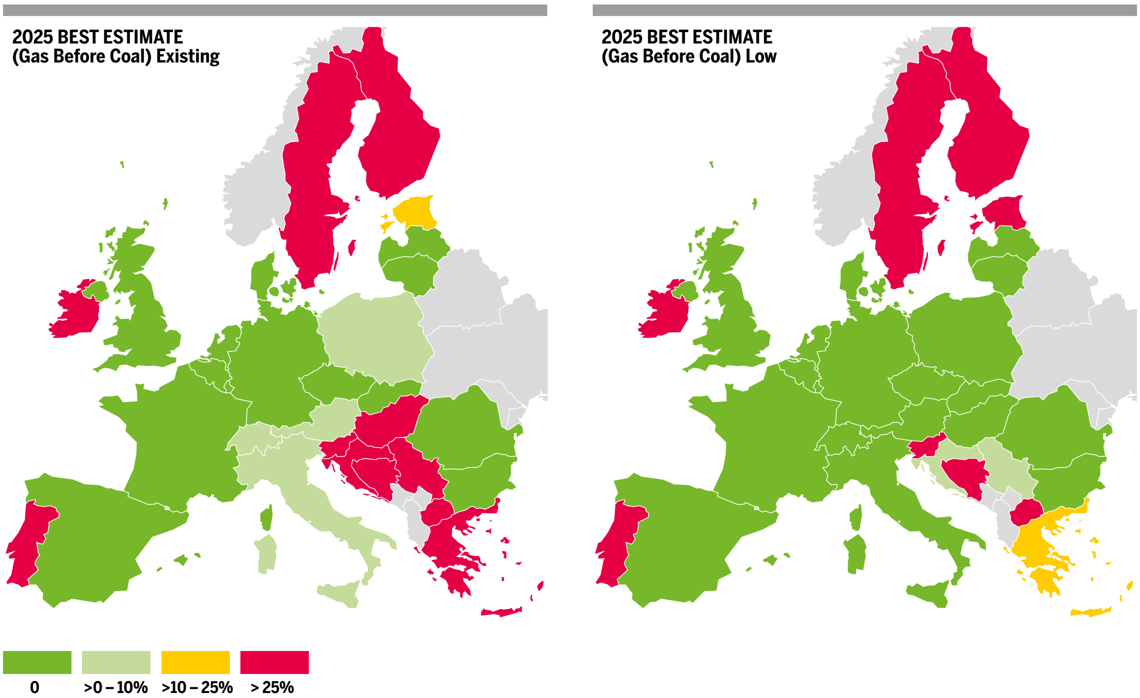


Figure 4.119 Maximum exposure to demand curtailment in case of SLID in Existing and Low infrastructure levels in 2025 for Gas Before Coal scenario.

2030

North Eastern Europe

- The situation is unchanged for **Denmark** and **Sweden**.
- **Finland** mitigates risk of demand curtailment thanks to Baltic Connector increased capacity from Estonia. In this case, **Estonia** cooperates more with Finland and is more exposed to demand curtailment in National trend and Global Ambition scenarios only. In Distributed Energy scenario, indigenous production is enough to satisfy demand and increase flow to Finland.
- **Poland** fully mitigates risk of demand curtailment in National Trends scenario and mitigates risk of demand curtailment in Distributed Energy and Global Ambition scenarios (14 and 15 % respectively) thanks to Slovakia and Lithuania new interconnections.

Eastern Europe

- **Greece** mitigates its risk of demand curtailment thanks to the Trans Adriatic Pipeline interconnection. Nevertheless, all the interconnections with neighbouring countries are showing infrastructure limitations which do not allow Greece to have access to more gas.
- **Slovenia** situation is unchanged without any project improving its diversification.
- **Bosnia and Herzegovina** and **North Macedonia** situations are unchanged with 100 % risk of demand curtailment.
- **Serbia** mitigates risk of demand curtailment (90 % to 27 %) with new interconnections with Bulgaria and Trans Balkan Pipeline.

Western Europe

- The situation is unchanged for **Portugal**, **Ireland** and **Northern Ireland**.

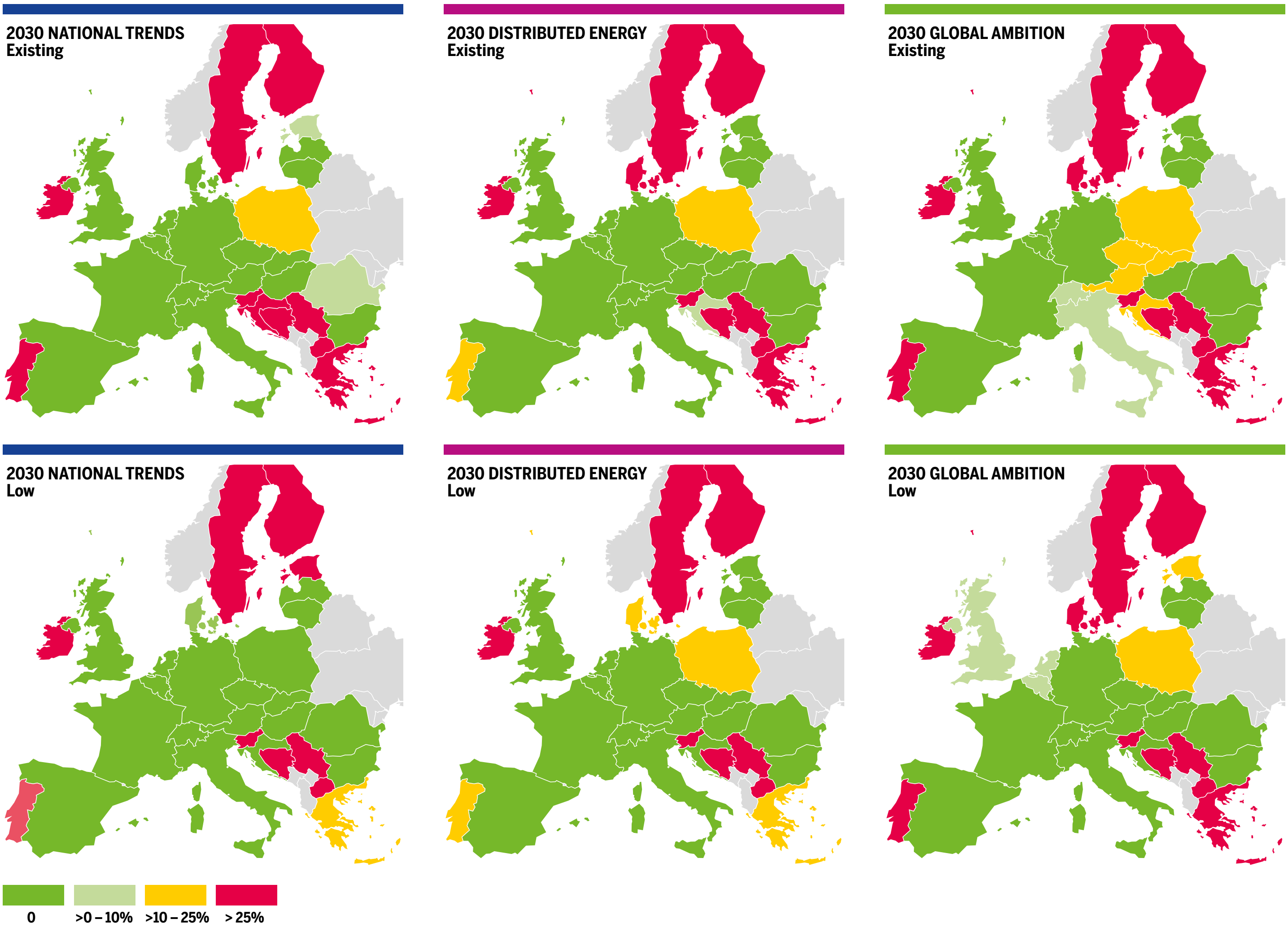


Figure 4.120 Maximum exposure to demand curtailment in case of SLID in Existing and Low infrastructure levels in 2030 for all scenarios.

2040

North Eastern Europe

- The situation is unchanged for **Denmark** and **Sweden**.
- **Finland** fully mitigates risk of demand curtailment in Distributed Energy scenario, thanks to Baltic Connector increase capacity. Risk of demand curtailment is mitigated in National Trend and Global Ambition scenarios due to high demand in these scenarios not compensated by the increase capacity between Estonia and Finland.
- **Poland** mitigates risk of demand curtailment in National Trend scenario thanks to Slovakia and Lithuania new interconnections. The situation is unchanged for the other scenarios.
- **Romania** mitigates risk of demand curtailment in National Trends scenario (12 %) thanks to increase storage capacity project.
- **Lithuania** is now exposed to demand curtailment in Global Ambition scenario (9 %) due to high demand value for this scenario and its co-operation with Poland thanks to new interconnection with Poland (GIPL).

Eastern Europe

- **Greece** fully mitigates risk of demand curtailment in Distributed Energy scenario thanks to indigenous production and Trans Adriatic Pipeline interconnection. Risk of demand curtailment is mitigated in National Trend and Global Ambition scenarios (16 % and 26 %). All the interconnections with neighbouring countries are showing infrastructure limitations and do not allow Greece to have access to more gas.
- **Slovenia** situation is unchanged without any project improving its diversification.
- **Bosnia and Herzegovina** and **North Macedonia** situations are unchanged with 100 % risk of demand curtailment.
- **Serbia** mitigates risk of demand curtailment (53 % to 28 %) with new interconnections with Bulgaria and Trans Balkan Pipeline.

Western Europe

The situation is unchanged for **Portugal**, **Ireland** and **Northern Ireland**.

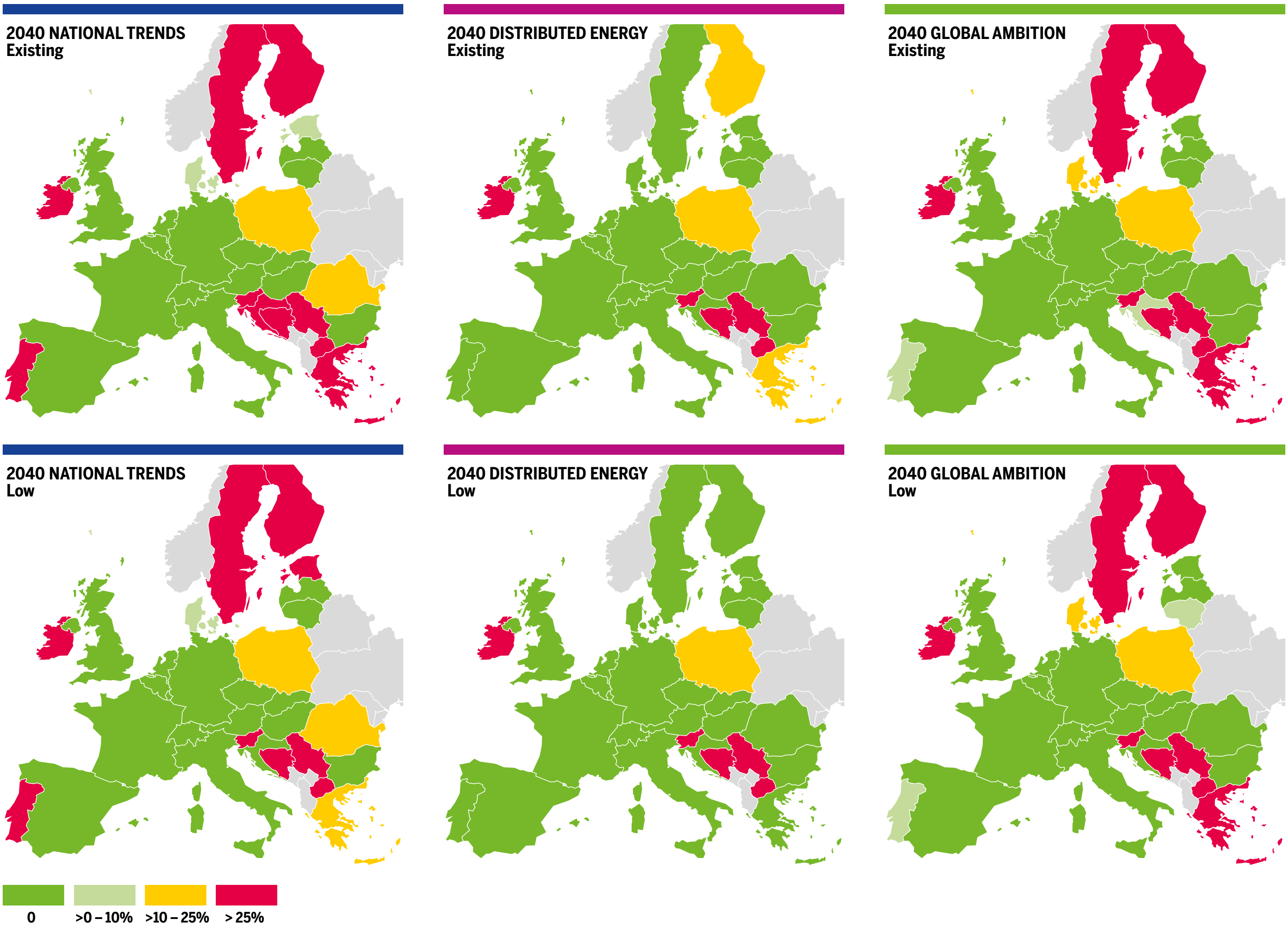


Figure 4.121 Maximum exposure to demand curtailment in case of SLID in Existing and Low infrastructure levels in 2040 for all scenarios.

4.5.3 ADVANCED INFRASTRUCTURE LEVEL

The results of the indicator in Advanced infrastructure level allows to bring an instructive light on the impact of Advanced projects and the necessary infrastructure projects still needed in order to reduce or even eliminate all risks of demand curtailment under disruption of the Single Largest Infrastructure. Advanced projects further improve the resilience of the gas infrastructure and significantly mitigate the exposure of many countries to the disruption of their Single Largest Infrastructure.

2025

North Eastern Europe

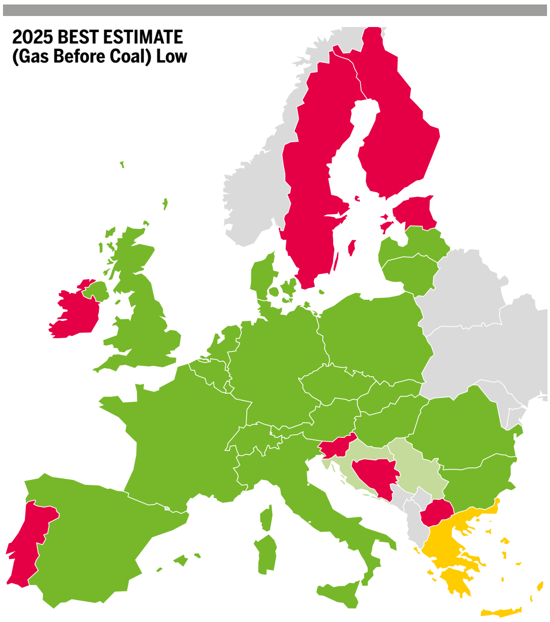
- The situation is unchanged in **Sweden** and **Finland** without any project in these countries.
- **Estonia** is no more exposed to demand curtailment thanks to LNG terminal project. Baltic connector is showing infrastructure limitation and **Estonia** can't cooperate more with **Finland**.

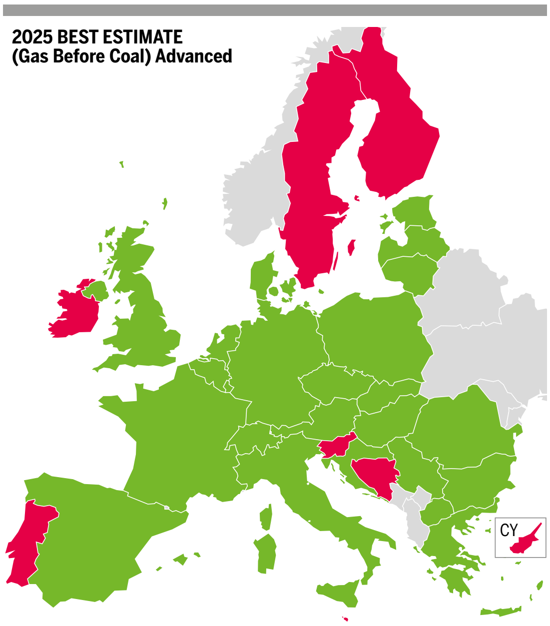
Eastern Europe

- **Greece** fully mitigates risk of demand curtailment thanks to projects Poseidon Pipeline.
- **Serbia** fully mitigates risk of demand curtailment thanks to new interconnections with Croatia and Romania.
- **North Macedonia** is no more exposed to demand curtailment thanks to the new interconnection with Greece.
- **Slovenia**, **Bosnia and Herzegovina** situations are unchanged.
- **Malta** and **Cyprus** are exposed to risk of demand curtailment (100 %).

Western Europe

- The situation is unchanged for **Portugal** and **Ireland.**
- **Northern Ireland** mitigates risk of demand curtailment (100 % to 23 %) thanks to the UGS project Islandmagee Gas Storage Facility.





0 | >0 – 10% | >10 – 25% | > 25%

Figure 4.122 Maximum exposure to demand curtailment in case of SLID in Low and Advanced infrastructure levels in 2025 for Gas Before Coal scenario.

2030

North Eastern Europe

- **Denmark** fully mitigates risk of demand curtailment due to new interconnection with Poland and increase capacity from Norway.
- Situation in **Sweden** and in **Finland** is unchanged.
- **Estonia** is no more exposed to demand curtailment thanks to LNG terminal project. Baltic connector is showing infrastructure limitation and **Estonia** can't cooperate more with **Finland**.
- **Poland** fully mitigates risk of demand curtailment thanks to new interconnections with Denmark and increase capacity with Czech Republic, Slovakia and Ukraine.

Eastern Europe

- **Greece** fully mitigates risk of demand curtailment in National Trend and Distributed Energy scenarios thanks to projects South Kavala (storage) and EastMed pipeline. Risk of demand curtailment is mitigated in Global Ambition scenario (9 %) due to high demand for power generation.
- **Serbia** fully mitigates risk of demand curtailment thanks to new interconnections with Croatia and Romania.
- **North Macedonia** mitigates risk of demand curtailment (42 %) with new interconnection with Greece which is now the SLI.
- **Slovenia**, **Bosnia and Herzegovina** situations are unchanged.
- **Malta** and **Cyprus** are exposed to risk of demand curtailment (100 % and 46 %).

Western Europe

- The situation is unchanged for **Portugal** and **Ireland**.
- **Northern Ireland** mitigates risk of demand curtailment (100 % to 20 %) thanks to the UGS project Islandmagee Gas Storage Facility.

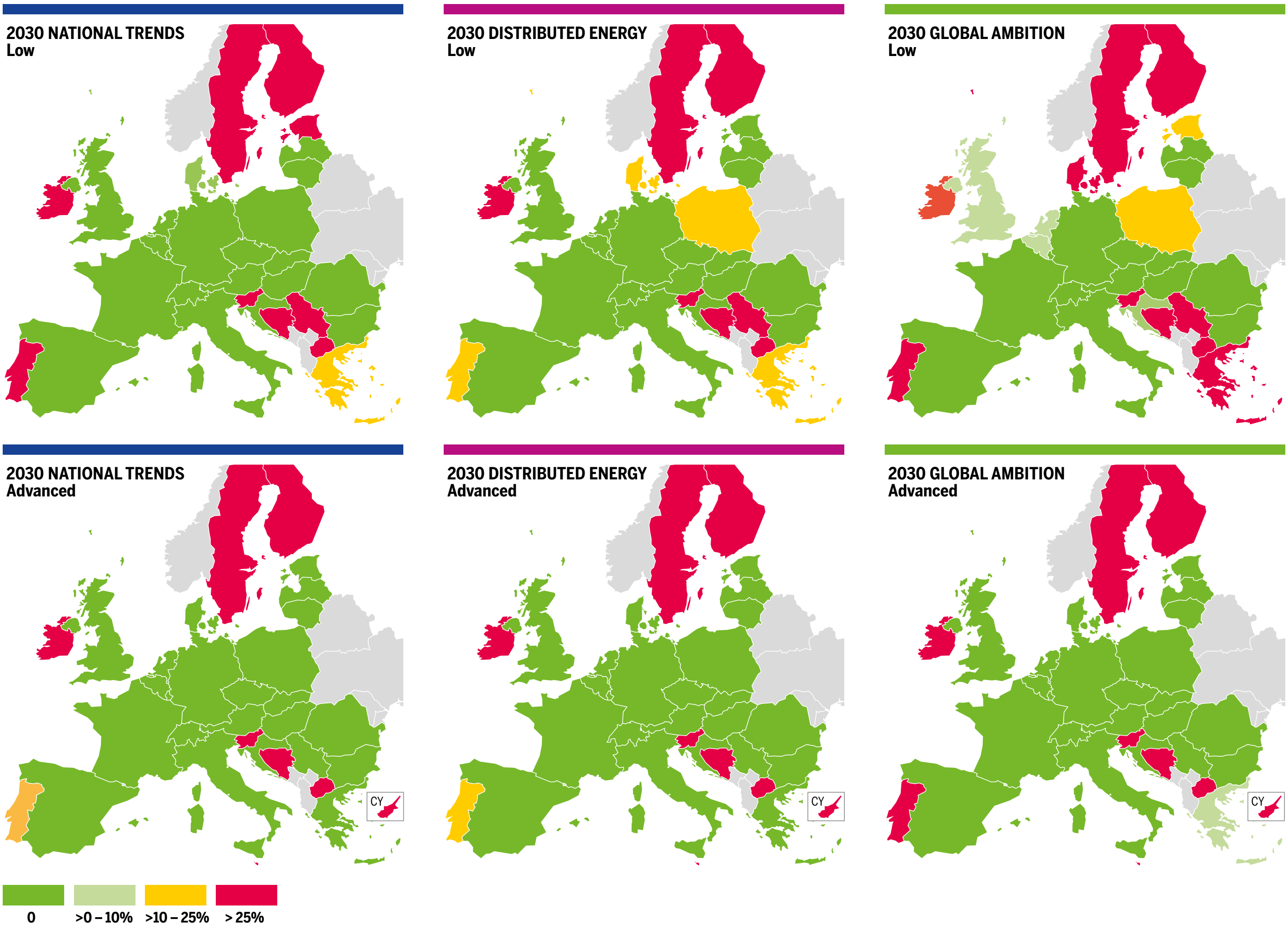


Figure 4.123 Maximum exposure to demand curtailment in case of SLID in Low and Advanced infrastructure levels in 2030 for all scenarios.

2040

North Eastern Europe

- **Denmark** fully mitigates risk of demand curtailment due to new interconnection with Poland and increase capacity from Norway in Global Ambition scenario.
- Situation in **Sweden** and in **Finland** is unchanged.
- **Poland** fully mitigates risk of demand curtailment in National Trends scenario and mitigates it in Global Ambition and Distributed Energy scenarios (4 % and 2 % respectively), thanks to new interconnections with Denmark and increase capacity with Czech Republic Slovakia and Ukraine.
- **Lithuania** is no more exposed to demand curtailment thanks to the interconnection projects with Poland.
- **Estonia** is no more exposed to demand curtailment thanks to LNG terminal project. Baltic connector is showing infrastructure limitation and **Estonia** can't cooperate more with **Finland**.

See Figure 4.124.

Eastern Europe

- **Romania** fully mitigates risk of demand curtailment in National Trends scenarios thanks to new interconnections with Serbia, Eastream and increase capacity from Hungary**.**
- **Greece** fully mitigates risk of demand curtailment in National Trend thanks to projects Poseidon pipeline. Risk of demand curtailment is mitigated in Global Ambition scenario (4 %) due to high demand for power generation.
- **Serbia** fully mitigates risk of demand curtailment thanks to new interconnections with Croatia and Romania.
- **North Macedonia** mitigates risk of demand curtailment with new interconnection with Greece which is now the SLI.
- **Slovenia**, **Bosnia and Herzegovina** situations are unchanged.
- **Malta** and **Cyprus** are exposed to risk of demand curtailment (100 % and 47 %).

Western Europe

- The situation is unchanged for **Portugal** and **Ireland**
- **Northern Ireland** fully mitigates risk of demand curtailment in National Trends scenario and mitigates risk of demand curtailment (32 %) in Global Ambition and Distributed Energy scenarios thanks to the UGS project Islandmagee Gas Storage Facility.

Picture courtesy of DESFA

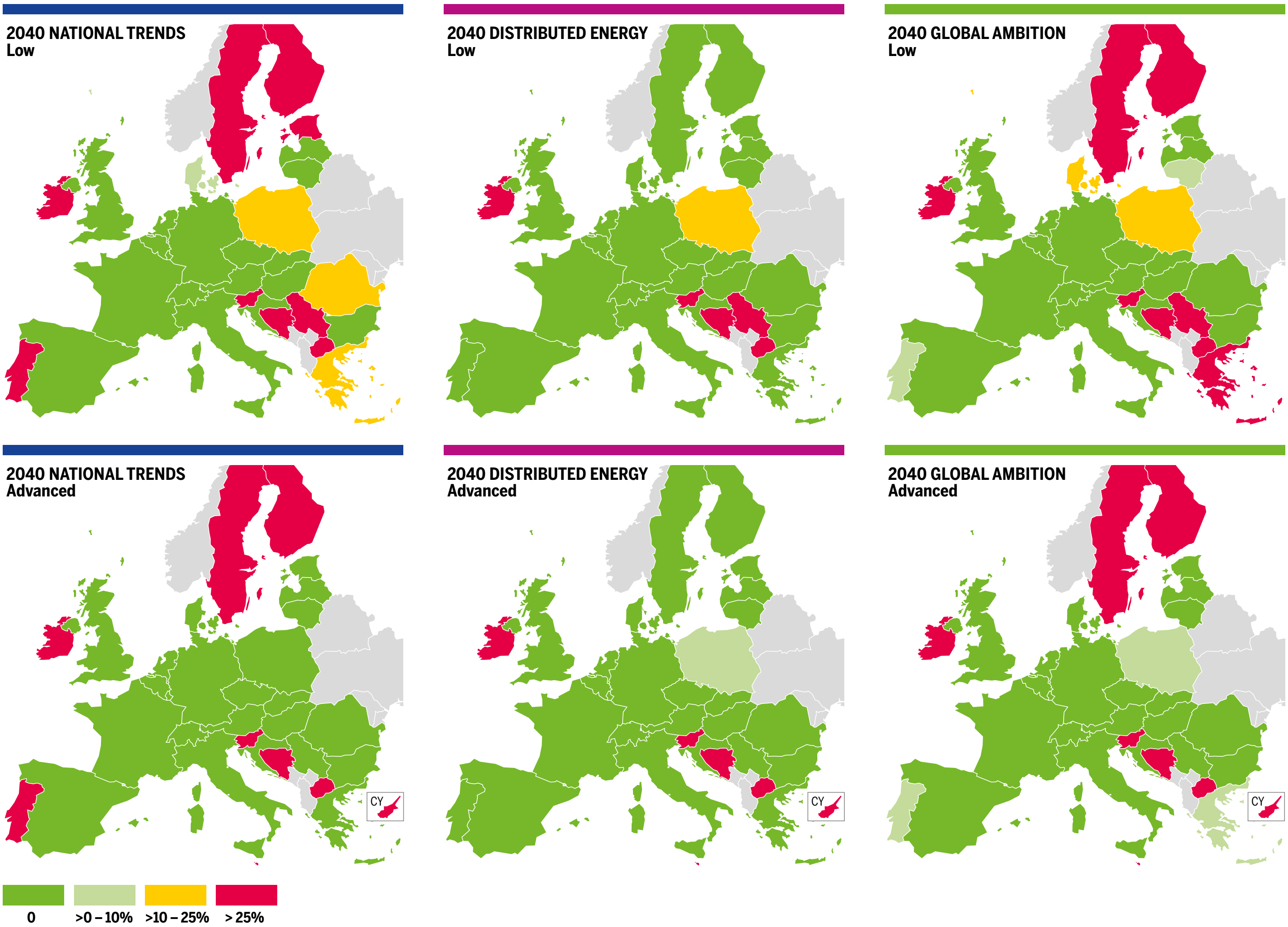


Figure 4.124 Maximum exposure to demand curtailment in case of SLID in Low and Advanced infrastructure levels in 2040 for all scenarios.

4.5.4 PCI INFRASTRUCTURE LEVEL

The results of the indicator in PCI infrastructure level allows to bring an instructive light on the impact of PCI projects and the necessary infrastructure projects still needed in order to reduce or even eliminate all risks of demand curtailment under disruption of the Single Largest Infrastructure. PCI projects, like Advanced projects, improve the resilience of the gas infrastructure and significantly mitigate the exposure of many countries to the disruption of their Single Largest Infrastructure. However, the situation is different from country to country.

2025

North Eastern Europe

- The situation is unchanged for **Sweden**, **Finland** and **Estonia**.

Eastern Europe

- **Greece** fully mitigates risk of demand curtailment thanks to new connection with Cyprus and increase capacity with Compressor Station Kipi project which mitigates bottleneck in Greece.
- **Slovenia** mitigates risk of demand curtailment (4 %) thanks to new interconnection with Hungary increase capacity with Croatia. **Croatia** is now exposed to demand curtailment (3 %) due to cooperation Slovenia.

Western Europe

- The situation is unchanged for **Portugal** and in **Northern Ireland**.
- **Ireland** mitigates risk of demand curtailment (57 %) thanks to terminal project (Shannon).

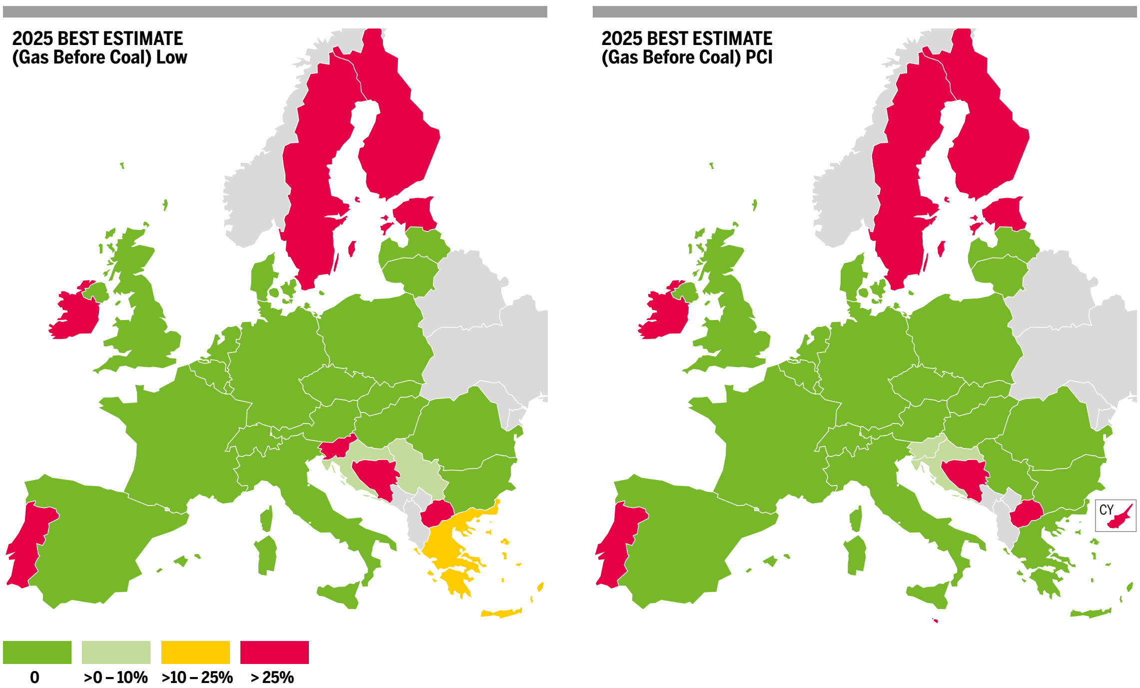


Figure 4.125 Maximum exposure to demand curtailment in case of SLID in Low and PCI infrastructure levels in 2025 for Gas Before Coal scenario.

2030

North Eastern Europe

- **Denmark** mitigates risk of demand curtailment in Distributed Energy and Global Ambition (10 % and 13 % respectively) thanks to the new interconnection with Poland and increase capacity from Norway. **Sweden** is still exposed to risk of demand curtailment in Global Ambition scenario due to infrastructure limitation with Denmark.
- In case of Swedish SLID, **Sweden** situation is unchanged.
- Situation in **Finland** and in **Estonia** remains unchanged.
- **Poland** fully mitigates risk of demand curtailment thanks to LNG terminal increase capacity and new interconnections with Denmark.

Eastern Europe

- **Greece** fully mitigates risk of demand curtailment thanks to new connection with Cyprus (EastMed) and increase capacity with Compressor Station Kipi project which mitigates bottleneck.
- **Serbia** mitigates risk of demand curtailment (2 %) thanks to new interconnection with Bulgaria in all scenarios.
- **Slovenia** fully mitigates risk of demand curtailment thanks to increase capacity with Hungary and increase interconnection with Croatia.
- **North Macedonia** and **Bosnia and Herzegovina** situations are unchanged.
- **Malta** and **Cyprus** are exposed to risk of demand curtailment (100 % and 46 %).

Western Europe

- **Ireland** mitigates risk of demand curtailment (from 85 % to 7 % in National Trends scenario and from 90 % to 20 % in Global Ambition and Distributed Energy scenarios) thanks to increase capacity from terminal (Shannon).
- The situation is unchanged for **Portugal** and in **Northern Ireland.**

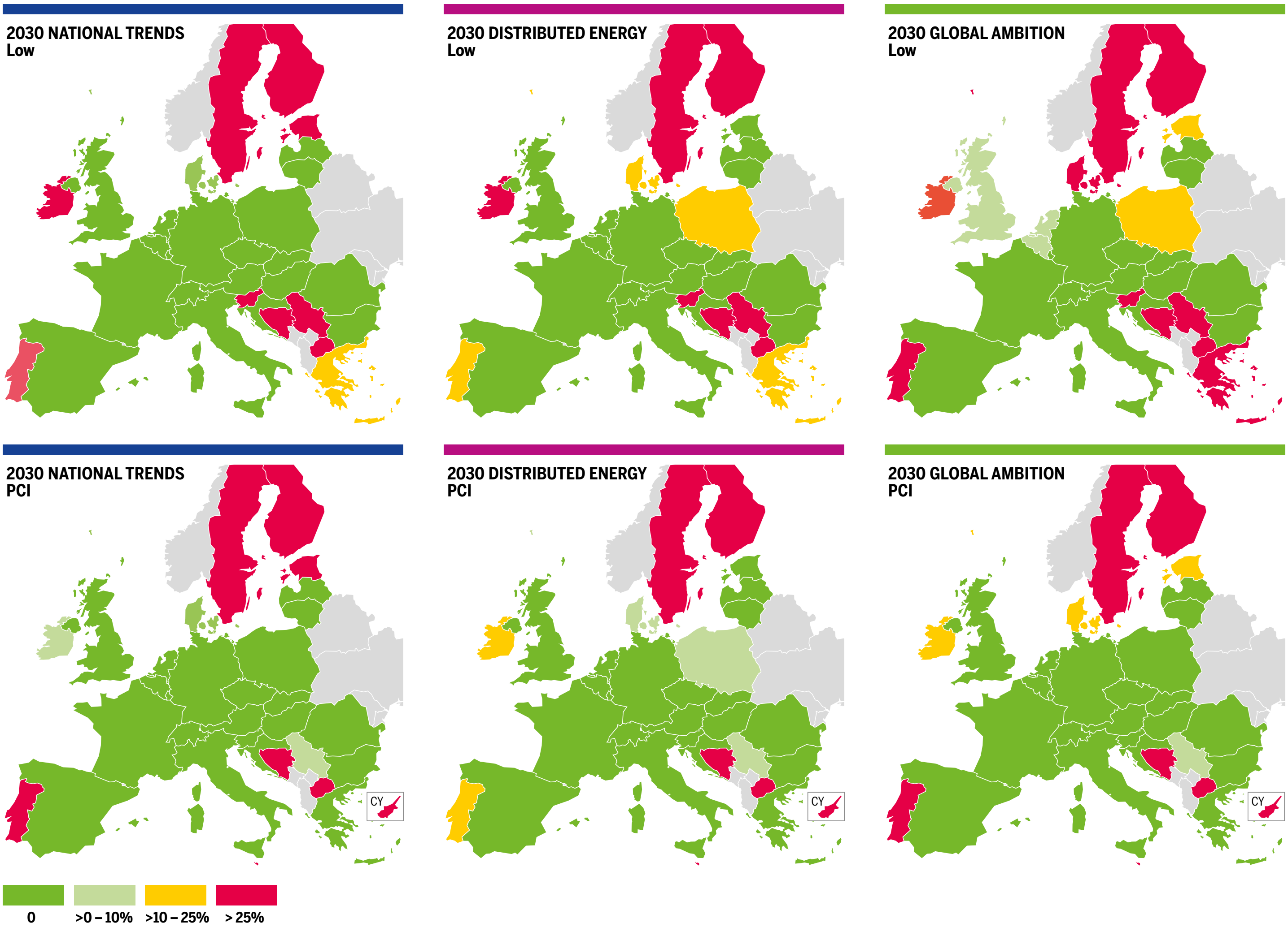


Figure 4.126 Maximum exposure to demand curtailment in case of SLID in Low and PCI infrastructure levels in 2030 for all scenarios.

2040

North Eastern Europe

- **Denmark** fully mitigates risk of demand curtailment in National Trends scenario and mitigates it in Global Ambition scenario. In Distributed Energy scenario, Denmark is now exposed to a slight demand curtailment due to the cooperation with Poland, thanks to the new interconnection with Poland and increase capacity from Norway. The impact is fully mitigated in Sweden in Distributed Energy scenario and mitigated in Global Ambition scenario.
- In Global Ambition and Distributed Energy scenarios, **Poland** mitigates risk of demand curtailment (12 % and 7 % respectively) and fully mitigates it in National Trends scenario. Poland improved its situation thanks to LNG terminal increase capacity and new interconnections with Denmark.
- The satiation is unchanged in **Sweden**, in **Finland** and in **Estonia**.

See Figure 4.127.

Eastern Europe

- **Romania** fully mitigates risk of demand curtailment in National Trends scenario thanks to new interconnections with Serbia, Eastream and increase capacity from Hungary**.**
- **Greece** fully mitigates risk of demand curtailment thanks to new interconnection with Cyprus (EastMed) and increase capacity with Compressor Station Kipi project which mitigates bottleneck.
- **Serbia** mitigates risk of demand curtailment (3 %) thanks to new interconnection with Bulgaria in all scenarios.
- **Slovenia** fully mitigates risk of demand curtailment thanks to increase capacity with Hungary and increase interconnection with Croatia.
- **North Macedonia** and **Bosnia and Herzegovina** situations are unchanged.
- **Malta** and **Cyprus** are exposed to risk of demand curtailment (100 % and 47 %).

Western Europe

- **Ireland** mitigates risk of demand curtailment thanks to increase capacity from terminal (Shannon) in National Trends scenario from 80 % to 3 %, in Distributed Energy scenario from 70 % to 2 % and in Global Ambition scenario from 86 % to 19 %.
- The situation is unchanged in **Portugal** and **Northern Ireland.**

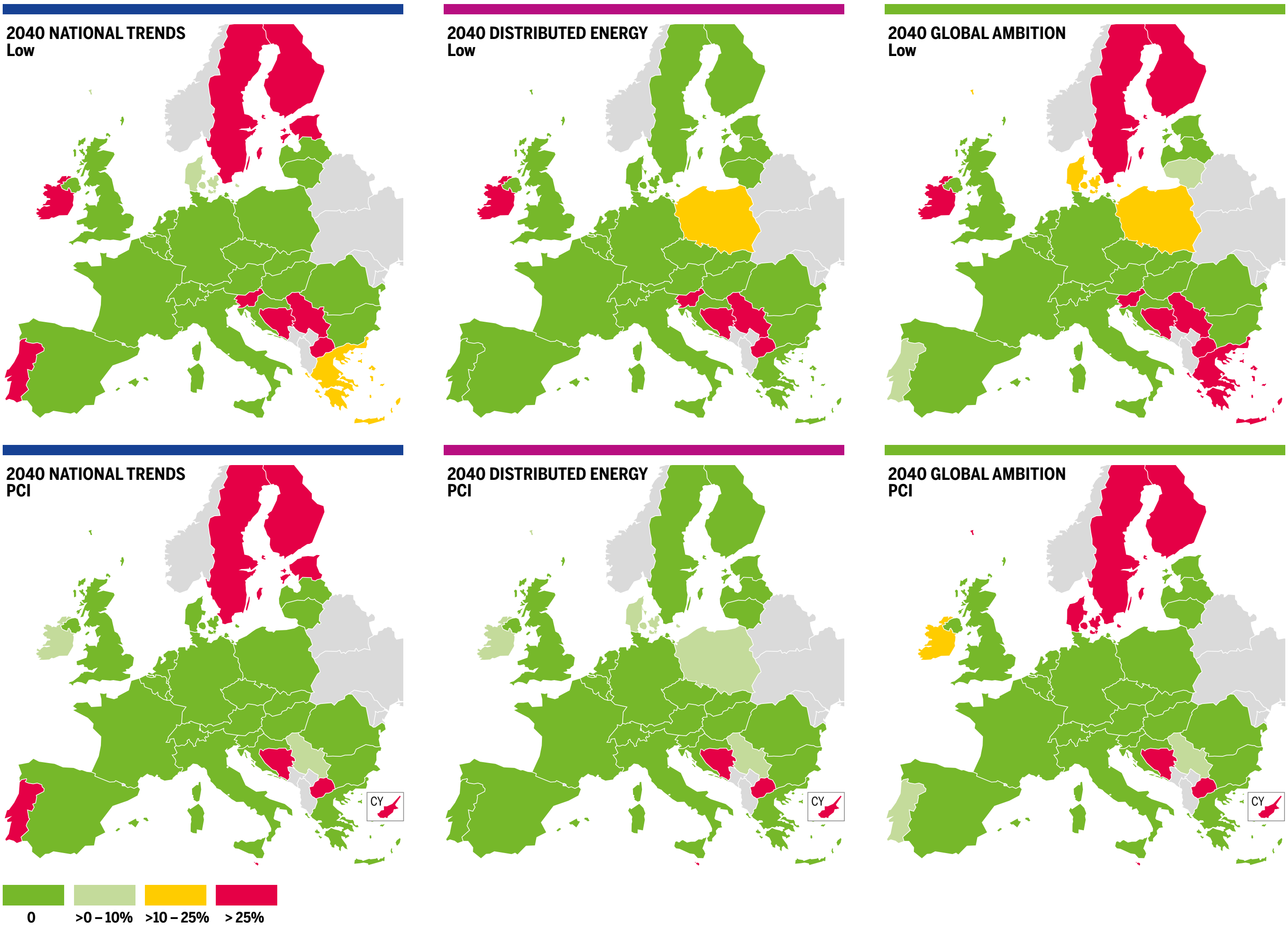


Figure 4.127 Maximum exposure to demand curtailment in case of SLID in Low and PCI infrastructure levels in 2040 for all scenarios.

5 COMPETITION AND MARKET INTEGRATION NEEDS

5.1 EUROPEAN ENERGY SUPPLY DEPENDENCE

The evolution of the European gas supply dependence generally reflects the evolution of 3 different elements:

- with the decline of its indigenous conventional production, the EU relies more and more on gas imports to satisfy its demand, especially for the next 10 years.
- the development of indigenous production of renewable gases have an important growth potential like shown in the COP 21 scenarios. This development can fully compensate for the decline of the conventional natural gas production as of 2030 in Distributed Energy scenario.
- between 2030 and 2040, in Distributed Energy and Global Ambition scenarios, the share of gas demand is increasing in transport and industrial sectors as gas is becoming less carbon intensive and therefore replaces more carbon intensive alternatives.

Whilst the EU conventional natural gas production is decreasing, the combined effect of the development of renewable gases and energy efficiency improvement, the overall dependence of the EU on energy imports, and more specifically, gas imports is on a decreasing trend in both COP 21 scenarios. In National Trends, there is limited shift to gas in other sectors and imports remain at a stable level. **See Figure 5.2.**

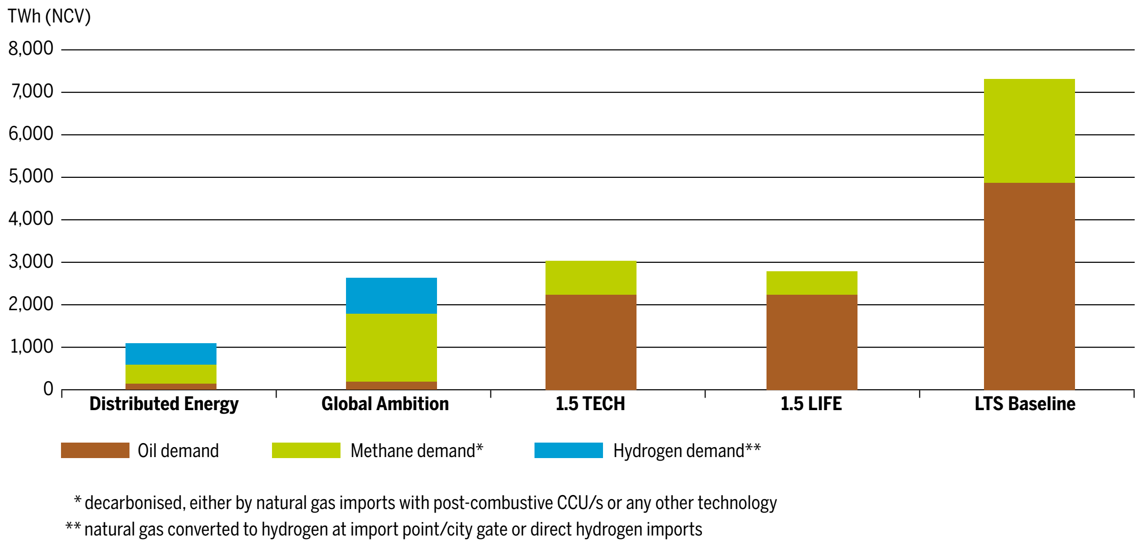


Figure 5.1 European energy imports in COP 21 scenarios in 2050.

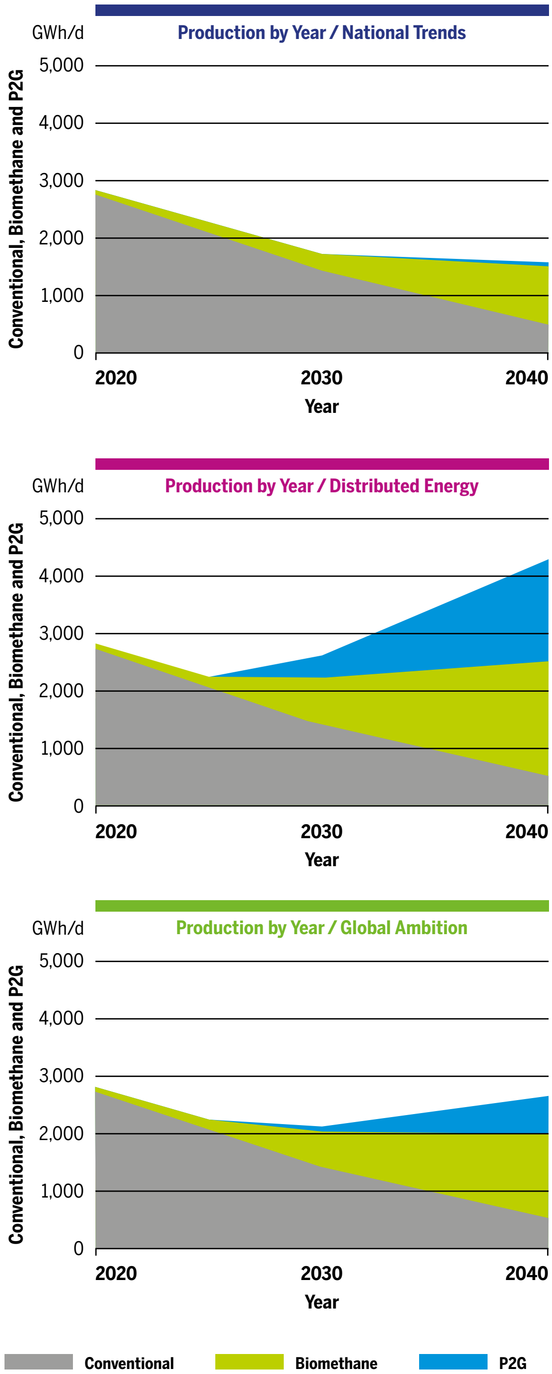


Figure 5.2 EU indigenous production by scenario.

5.2 MINIMUM ANNUAL SUPPLY DEPENDENCE (MASD)

The Minimum Annual Source Dependence (MASD) should be understood as the minimum share of a given source in the supply mix, being the source share which cannot be substituted by the other supply sources. The analysis is done over the whole year. It has both a European and a country-level dimension. On a European level, it relates to the overall demand and supply volumes that are available. The European level situation therefore reflects a supply gap and not an infrastructure gap. For more details about the demand and supply scenarios, please read the TYNDP 2020 Scenario Report.

The MASD is assessed independently for each extra-EU supply under the assumption that countries interact in a cooperative way.

As a consequence of such cooperative behaviour, different levels of dependence between neighbouring countries indicate an infrastructure limitation that can be only mitigated by infrastructure reinforcement.

5.2.1 MASD NORWAY

The results for the MASD indicator for Norwegian supply show no dependence for all European countries on Norwegian gas. The other suppliers can satisfy the European demand and the infrastructure is sufficient to provide gas. The maximum supply potential without considering Norwegian supply can cover the evolution of demand in all scenarios. Results show that Europe is generally not dependent on Norwegian gas and, at country level, the infrastructure network is well developed for all countries to access alternative sources.
See Figure 5.3.

5.2.2 MASD-LNG

The results of the MASD indicator for LNG supply show dependence for most of Europe on LNG.

At EU-level, the assessment shows that gas infrastructure allows to make use of the maximum supply potential of all the other gas sources. However, this is not enough to cover the overall EU gas demand. This indicates that Europe relies on LNG to achieve its balance between supply and demand.

This evolution of the LNG dependence generally reflects that the LNG supply has a high potential and therefore can offer a significant level of flexibility to compensate with the decline of the indigenous conventional production.

The assessment shows that between 2030 and 2040, in Distributed Energy and Global Ambition scenarios, whilst the share of gas demand is increasing in transport and industrial sectors as gas keeps on decreasing its carbon intensity and therefore replaces more carbon intensive alternatives, the combined effect of the development of renewable gases and energy efficiency improvement puts the overall dependence of the EU on imports on a decreasing trend, including LNG imports.

Yet, some country-level limitations exist and are detailed hereafter. **See Figure 5.4.**

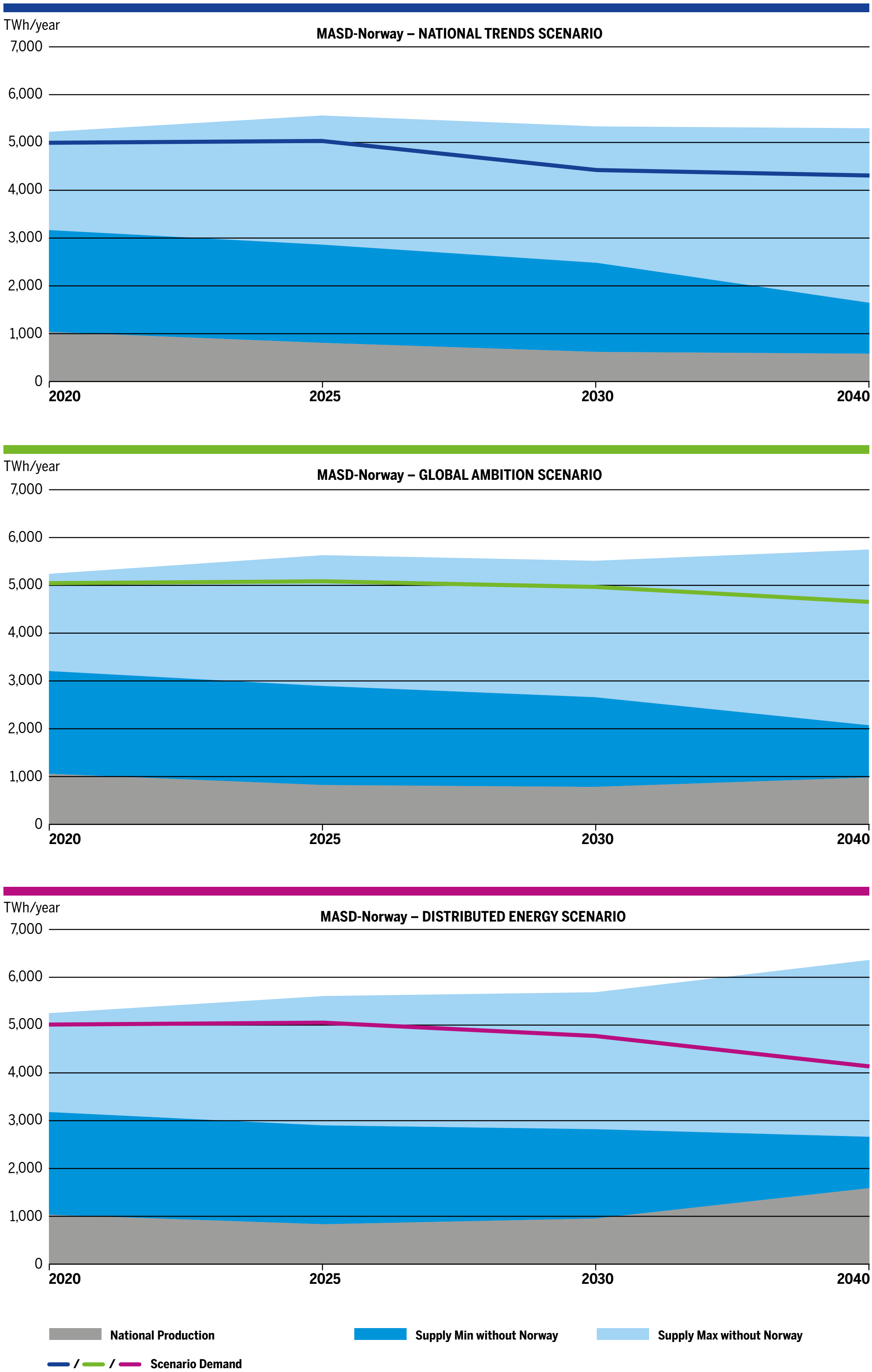


Figure 5.3 European Level Supply and Demand Adequacy with no supply from Norway.

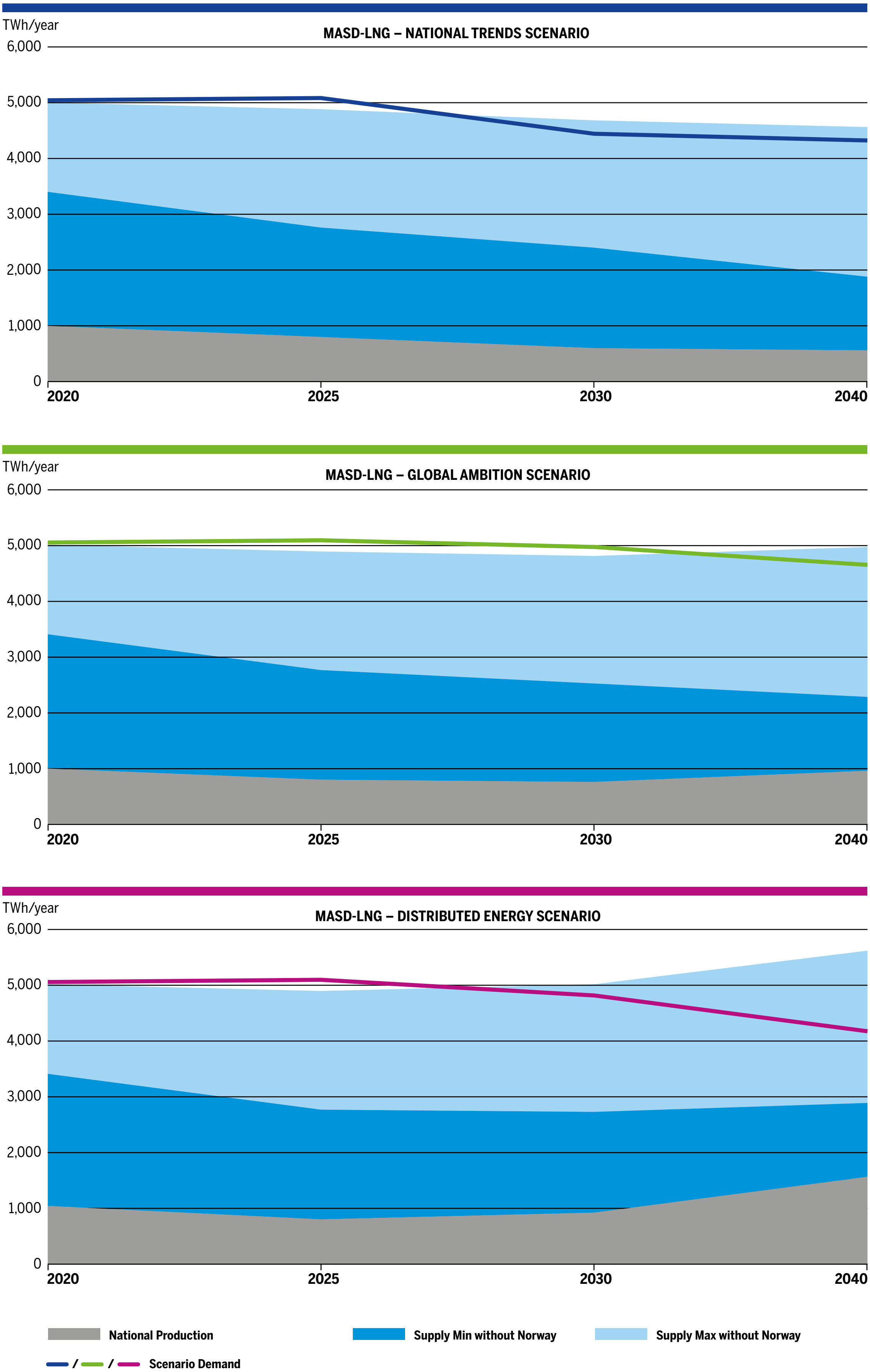


Figure 5.4 European Level Supply and Demand Adequacy with no supply from LNG.

5.2.2.1 EXISTING INFRASTRUCTURE LEVEL

At European level, the existing infrastructure enables the different countries to benefit from the overall reduction of dependence on the LNG supply. However, the dependence on LNG is fully mitigated in the Distributed Energy scenario in 2040 only. In all the other years and scenarios, Europe remains dependent on LNG for around 10 % of its supply. However, at country level, the situation is more contrasted:

2020

Only Greece and Iberian Peninsula (Portugal, Spain) are showing dependence due to bottlenecks (import from Turkey for Greece, import from Algeria and interconnection with France for Iberian Peninsula) with 13 %, 22 % respectively.

2025

All European countries show a dependence on LNG from 12 % (Coal Before Gas scenario) to 15 % (Gas Before Coal scenario). The existing infrastructure level makes it possible to distribute this dependency evenly across all European countries. Only Portugal faces a higher dependence of +10 % compared to the rest of the EU due to infrastructure limitation between Portugal and Spain.

2030

For all scenarios, the dependence is mitigated (from 7 % to 15 %) with a homogenous dependence reflecting the general trend at European level and showing that the existing gas infrastructure level allows for an efficient cooperation between European countries. In 2030, the evolution of the Portuguese demand due to energy efficiency combined with the evolution of renewable gases production mitigates the situation compared to 2025 and the existing infrastructure is not limiting the cooperation between Portugal and Spain any longer.

2040

NATIONAL TRENDS

Europe is dependent on LNG to a limited extent since 6 % of the gas demand fully relies on LNG imports. The homogenous dependence in all countries reflect the efficiency of the gas system to distribute the gas supply to all EU countries.

COP 21 SCENARIOS

Distributed Energy

Almost all of the EU does not depend on the LNG supply to satisfy its gas demand, increasing arbitrage possibilities and therefore enhancing competition within the EU market. Only Poland remains dependent on LNG to a very limited extent for 4 % of its average annual demand. This dependence reflects some infrastructure limitation reducing the ability of Poland to align its dependence with the neighbouring countries.

Global Ambition

The existing infrastructure allows for an efficient cooperation between Member States so that they all show the same level of dependence that reflects the overall EU dependence. See Figure 5.6.

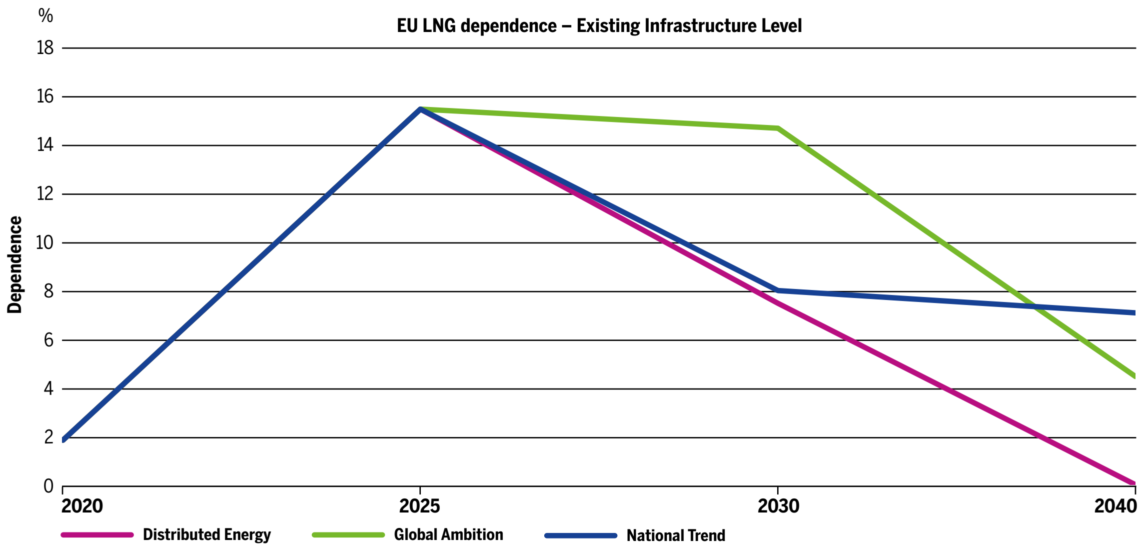


Figure 5.5 Overall EU dependence on LNG supply in Existing infrastructure level.

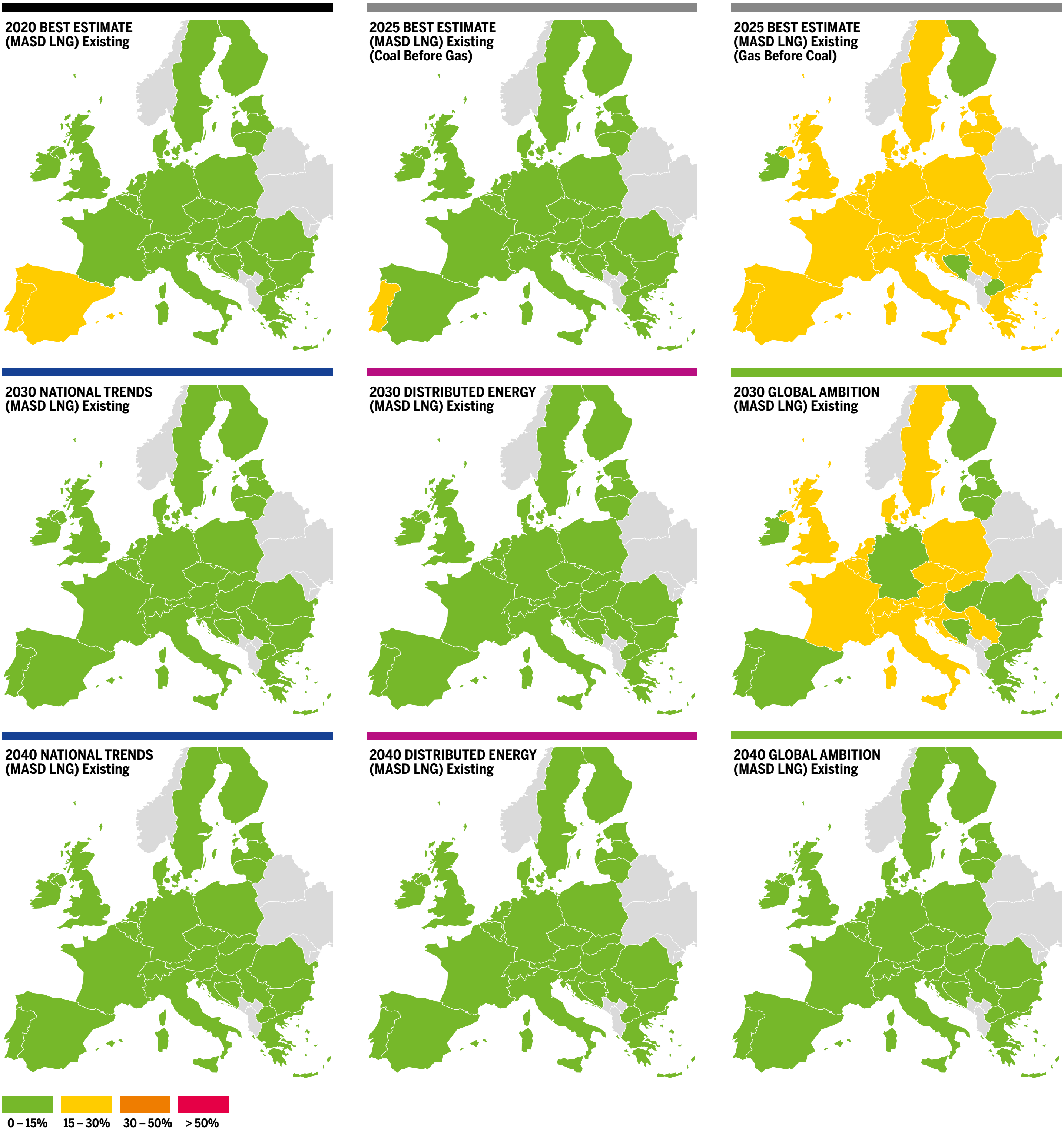


Figure 5.6 MASD LNG – Scenario and Years – Existing Infrastructure level.

5.2.2.2 LOW INFRASTRUCTURE LEVEL

At European level, the Low infrastructure including all the FID projects shows further reduction in the overall dependence on LNG compared to the existing infrastructure (circa 5 % in average). The FID projects allow Europe to be less than 5 % dependent on LNG as of 2030 in National Trends and Distributed Energy scenarios. Furthermore, in Global Ambition in 2040, Europe is only dependent on LNG for 2 % of its supply. However, at Country level, the situation is more contrasted:

2025

The FID projects allow all the European countries to reduce their dependence on the LNG supply by 3 % in Coal Before Gas and Gas Before Coal scenarios thanks to the increase indigenous production and Trans Adriatic Pipeline which increases the access to Azeri gas. The infrastructure limitation between Portugal and Spain identified in the existing infrastructure level is not alleviated in 2025 by the FID projects.

Furthermore, FID projects allow Denmark and Sweden to fully mitigate their dependence on the LNG supply. However, the Low infrastructure level shows some infrastructure limitations preventing Denmark and Sweden to share those benefits with their neighbouring countries and therefore the rest of the EU. See Figure 5.8.

2030

FID projects improve the access to alternative sources to the LNG supply and therefore reduce the dependence of all EU countries by 3 %.
See Figure 5.9.

2040

NATIONAL TRENDS

FID projects improve the access to alternative sources to the LNG supply and therefore reduce the dependence of all EU countries by 3 %.

COP 21 SCENARIOS

FID projects improve the access to alternative sources to the LNG supply and therefore reduce the dependence of all EU countries by 3 %.

Furthermore, in Distributed Energy scenario, FID projects fully mitigate the remaining infrastructure limitations between Poland and its neighbouring countries. See Figure 5.10.

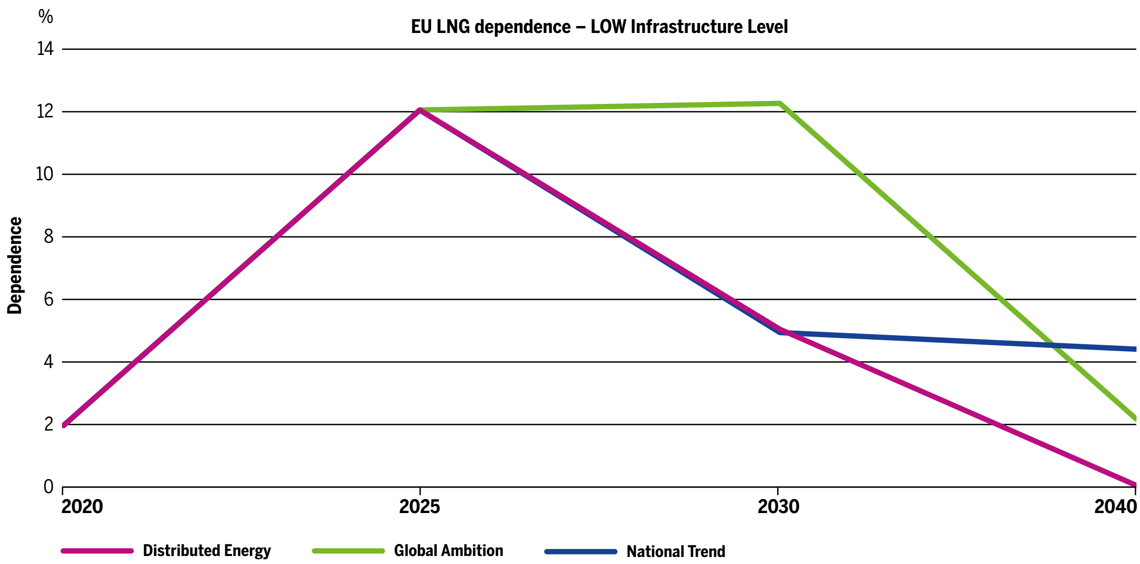


Figure 5.7 Overall EU dependence on LNG supply in the Low infrastructure level.

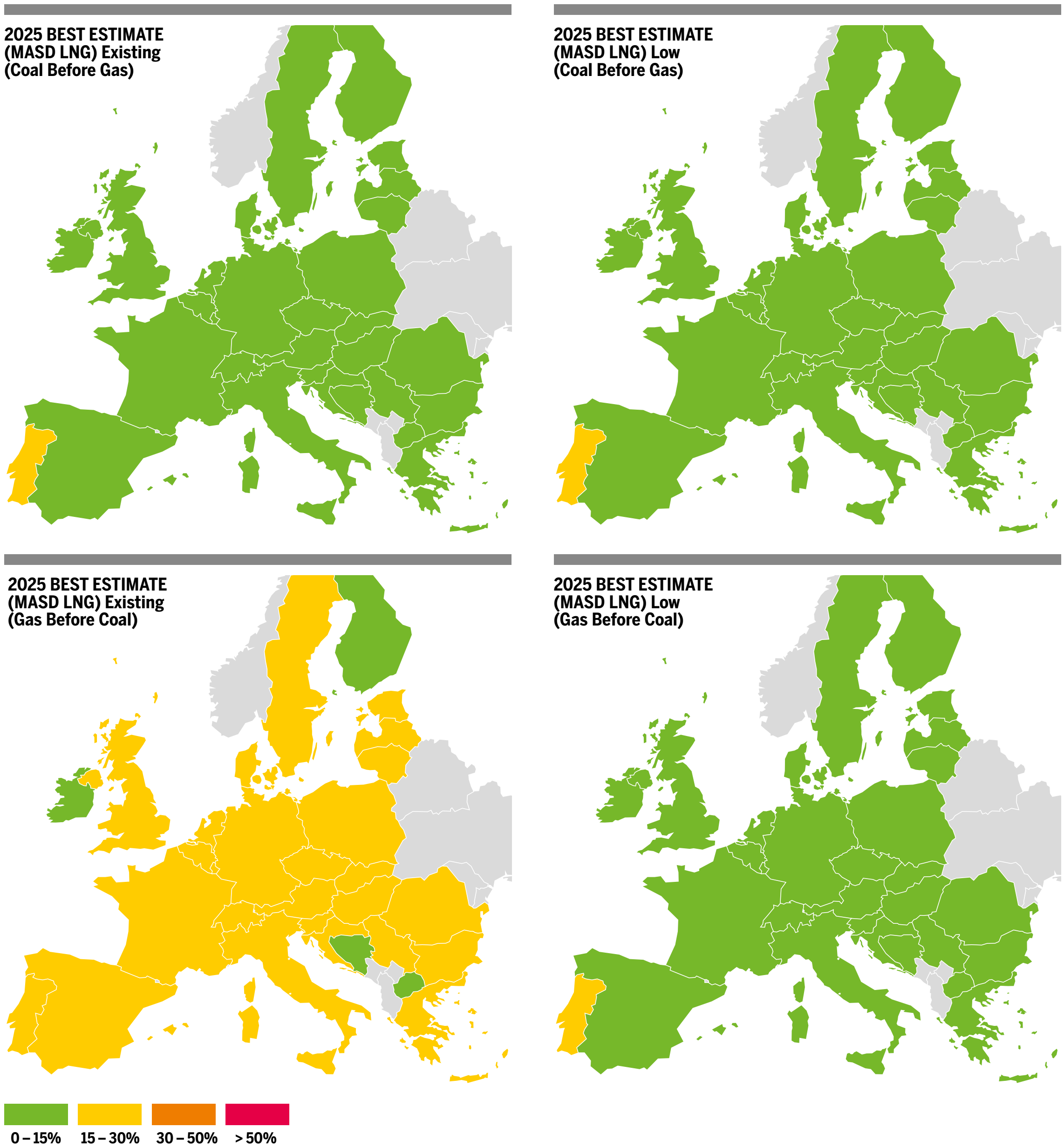


Figure 5.8 MASD LNG – Gas Before Coal and Coal Before Gas – 2025 – Existing and Low Infrastructure levels

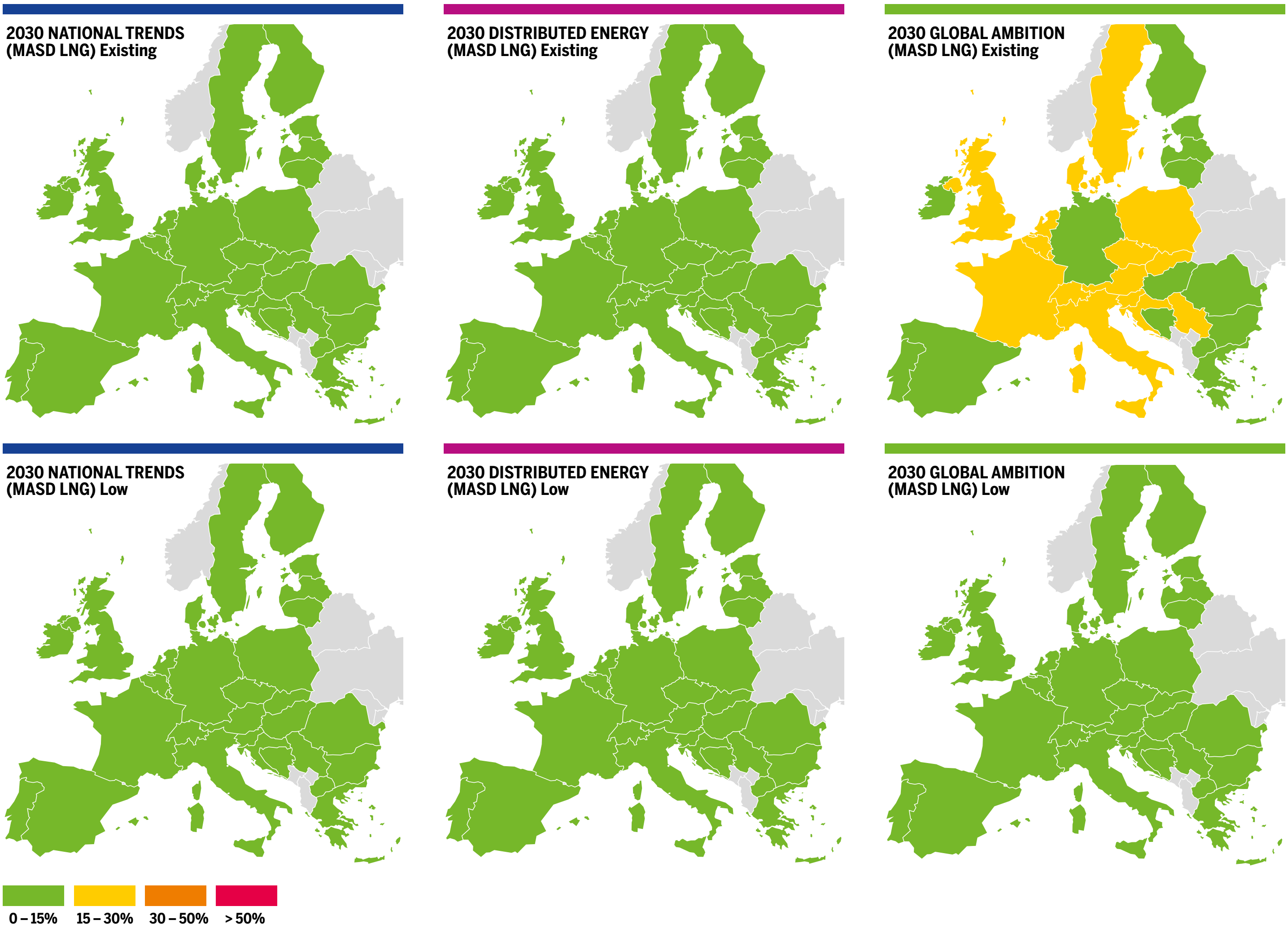


Figure 5.9 MASD LNG – All scenarios – 2030 – Existing and Low infrastructure levels.

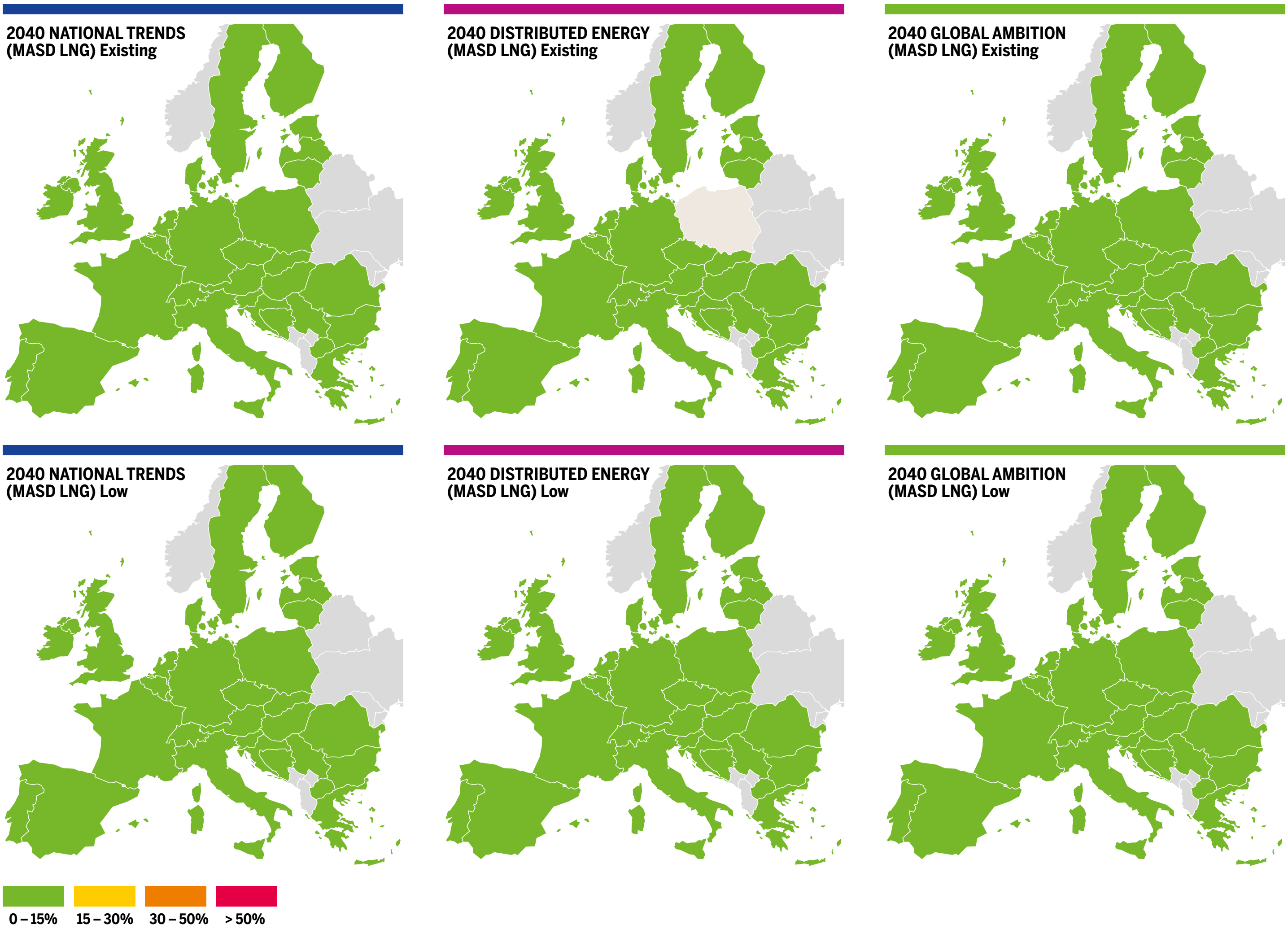


Figure 5.10 MASD LNG – All scenarios – 2040 – Existing and Low infrastructure levels.

5.2.2.3 ADVANCED INFRASTRUCTURE LEVEL

At European level, the advanced infrastructure level (FID + advanced projects) almost achieve to mitigate the dependence of the EU on the LNG supply. By 2030 in National Trends and Distributed Energy LNG depends on LNG for 1 % of its supply. Furthermore, in 2040 both COP 21 scenarios, the advanced infrastructure level achieves to fully mitigate EU's dependence on LNG. At country level:

2025

Advanced projects further decrease the overall dependence of EU countries on the LNG supply by 2 % compared to the Low infrastructure level (from 12 % to 10 % in GBC and from 10 % to 8 % in CBG). In particular, the Advanced projects alleviate the infrastructure limitation that was preventing Denmark and Sweden to cooperate with the rest of the EU. However, the Advanced projects do not mitigate the infrastructure limitation preventing Portugal to align its dependence to Spain and thus, to the rest of the EU. In addition, Cyprus shows a 100 % dependence on LNG supply driven by the commissioning of the new LNG terminal and no connection to other EU countries. **See Figure 5.12.**

2030

NATIONAL TRENDS

Advanced projects almost mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level. However, the Advanced projects do not fully mitigate the dependence of Spain (3 %) and Portugal (7 %) reflecting some infrastructure limitations for Spain to fully cooperate with France and Portugal.

Nevertheless, Cyprus mitigates its dependence on LNG supply driven by the commissioning of the EastMed allowing Cyprus to connect with the rest of Europe.

COP 21 SCENARIOS

Distributed Energy

Advanced projects almost fully mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level (from 5 % to 1 %).

Global Ambition

Advanced projects almost fully mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level (from 12 % to 8 %). **See Figure 5.13.**

2040

NATIONAL TRENDS

Advanced projects almost mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level (from 4 % to 1 %).

COP 21 SCENARIOS

Distributed Energy

FID projects already fully mitigate the overall dependence of EU countries on the LNG supply.

Global Ambition

Advanced projects fully mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level (2 %).

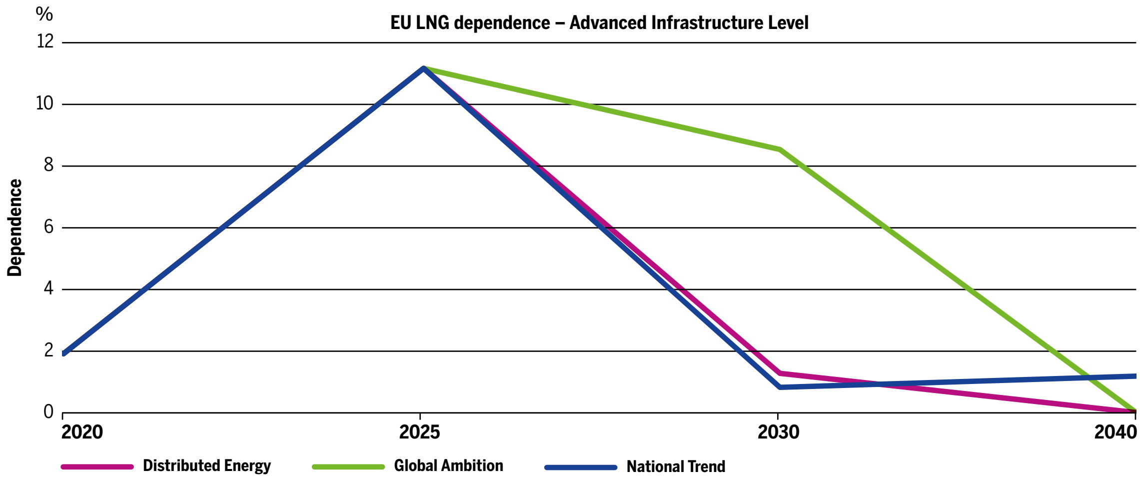


Figure 5.11 Overall EU dependence on LNG supply in the Advanced infrastructure level.

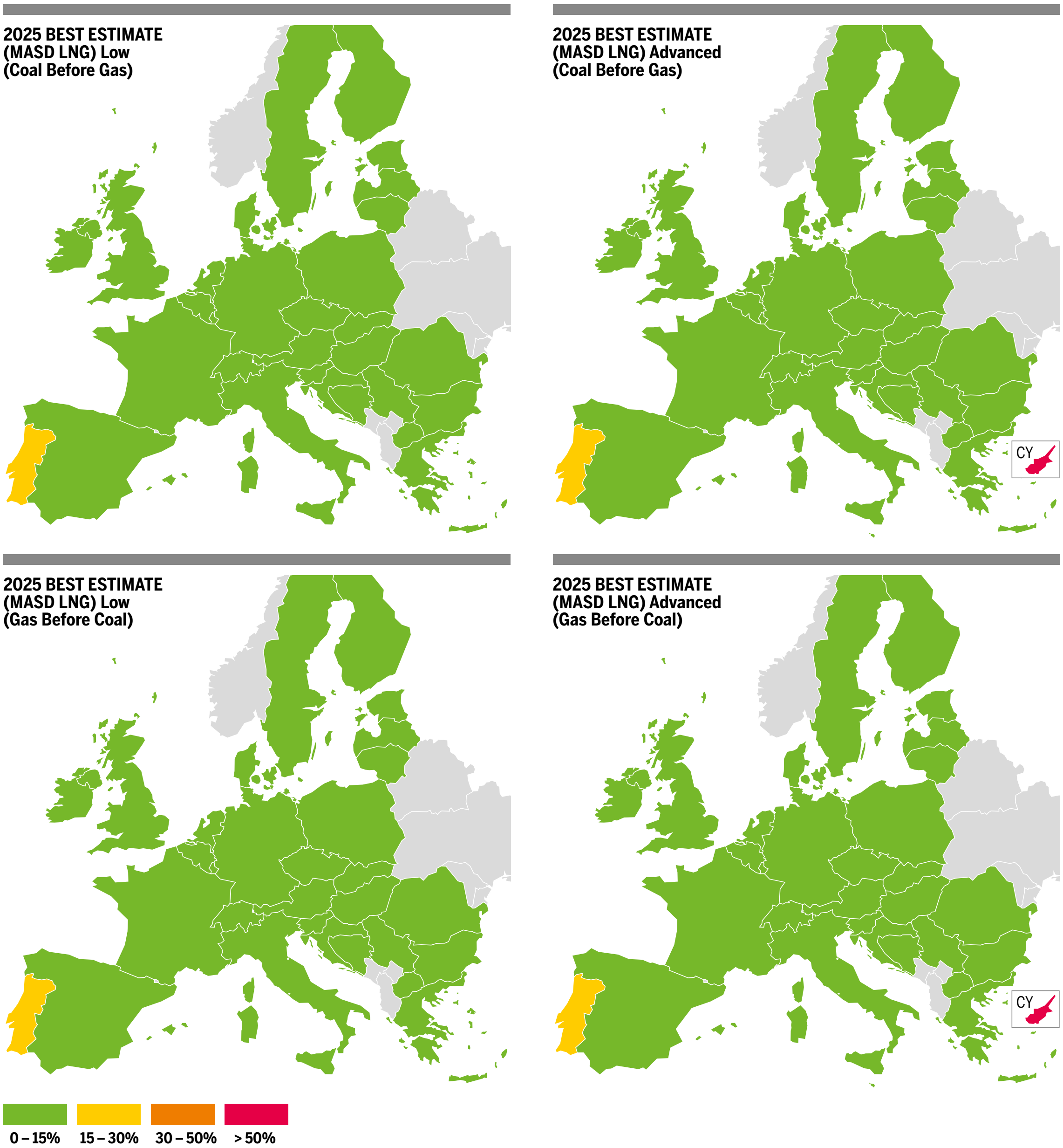


Figure 5.12 MASD LNG – Gas Before Coal and Coal Before Gas – 2025 – Low and Advanced infrastructure levels.

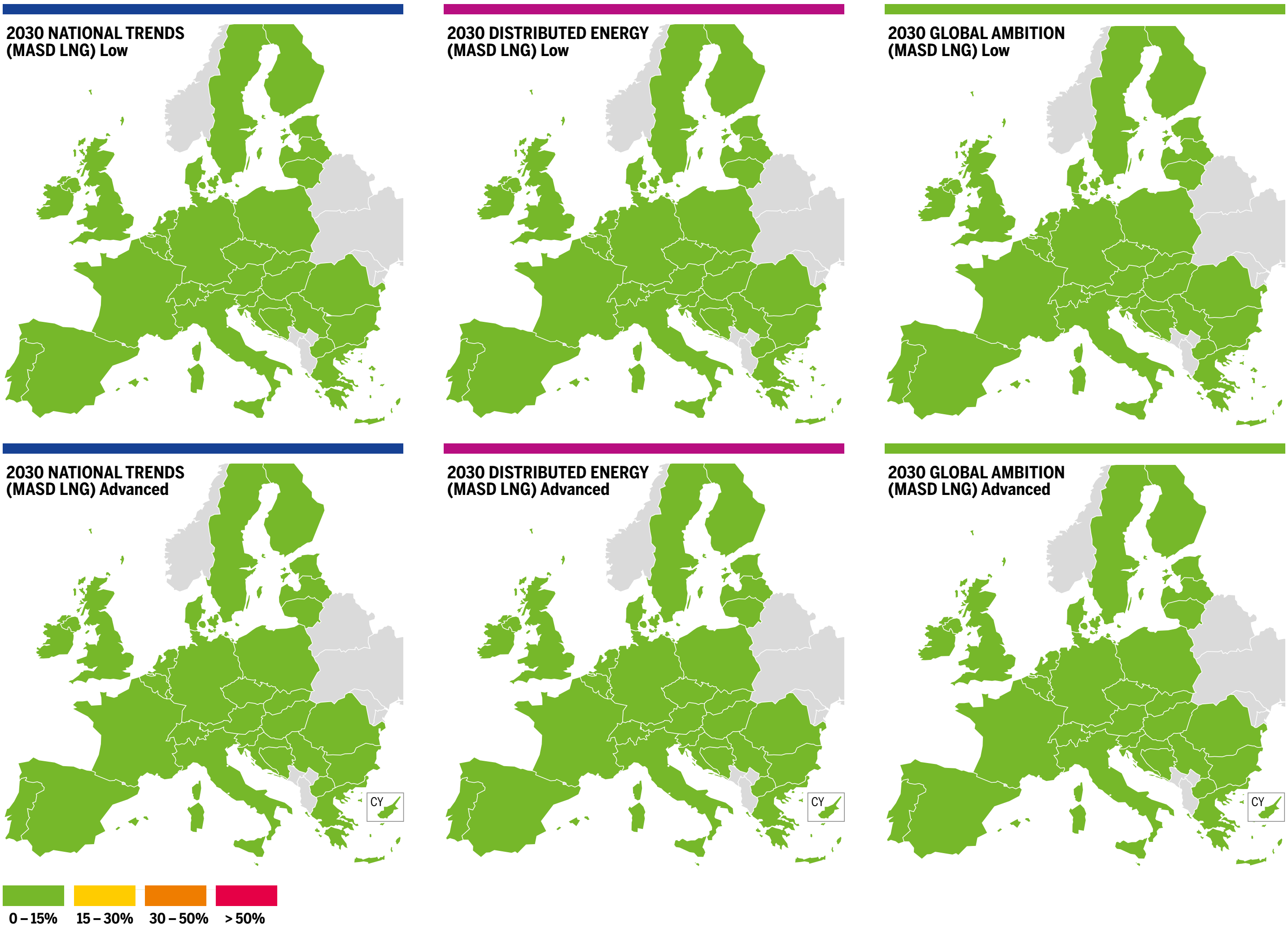


Figure 5.13 MASD LNG – All scenarios – 2030 – Low and Advanced infrastructure levels.

5.2.2.4 PCI INFRASTRUCTURE LEVEL

At European level, the PCI infrastructure level (FID + PCI projects), like the Advanced infrastructure level, almost achieve to mitigate the dependence of the EU on the LNG supply. By 2030 in National Trends and Distributed Energy LNG depends on LNG for 1 % of its supply. Furthermore, in 2040 both COP 21 scenarios, the advanced infrastructure level achieves to fully mitigate EU's dependence on LNG.

2025

PCI projects allow all the European countries to reduce their dependence on the LNG supply by 5 % in Coal Before Gas and Gas Before Coal scenarios. Compared to the FID projects, PCI projects both reduce the overall dependence on LNG, but also prevent infrastructure limitations between Denmark and Sweden and the rest of the EU. Therefore, all the EU benefits from the decreasing dependence of Denmark and Sweden on LNG.

However, the infrastructure limitation between Portugal and Spain identified in the existing infrastructure level is not alleviated in 2025 by the PCI projects. In addition, Cyprus shows a 100 % dependence on LNG supply driven by the commissioning of the new LNG terminal and no connection to other EU countries. **See Figure 5.15.**

2030

NATIONAL TRENDS

PCI projects show similar impact as the Advanced infrastructure level and almost mitigate the overall dependence of EU countries on the LNG supply, compared to the Low infrastructure level. However, the Advanced projects do not fully mitigate the dependence of Spain (3 %) and Portugal (7 %) reflecting some infrastructure limitations for Spain to fully cooperate with France and Portugal respectively with Spain.

Nevertheless, Cyprus mitigates its dependence on LNG supply driven by the commissioning of the EastMed allowing Cyprus to connect with the rest of Europe.

COP 21 SCENARIOS

Distributed Energy

PCI infrastructure level projects show similar impact as the Advanced infrastructure level and almost fully mitigate the overall dependence of EU countries on the LNG supply, compared to the Existing infrastructure level (from 7 % to 1 %).

Global Ambition

PCI infrastructure level projects show similar impact as the Advanced infrastructure level and almost fully mitigate the overall dependence of EU countries on the LNG supply, compared to the Existing infrastructure level (from 14 % to 8 %).
See Figure 5.16.

2040

NATIONAL TRENDS

PCI projects fully mitigate the overall dependence of EU countries on the LNG supply.

COP 21 SCENARIOS

PCI projects fully mitigate the overall dependence of EU countries on the LNG supply.

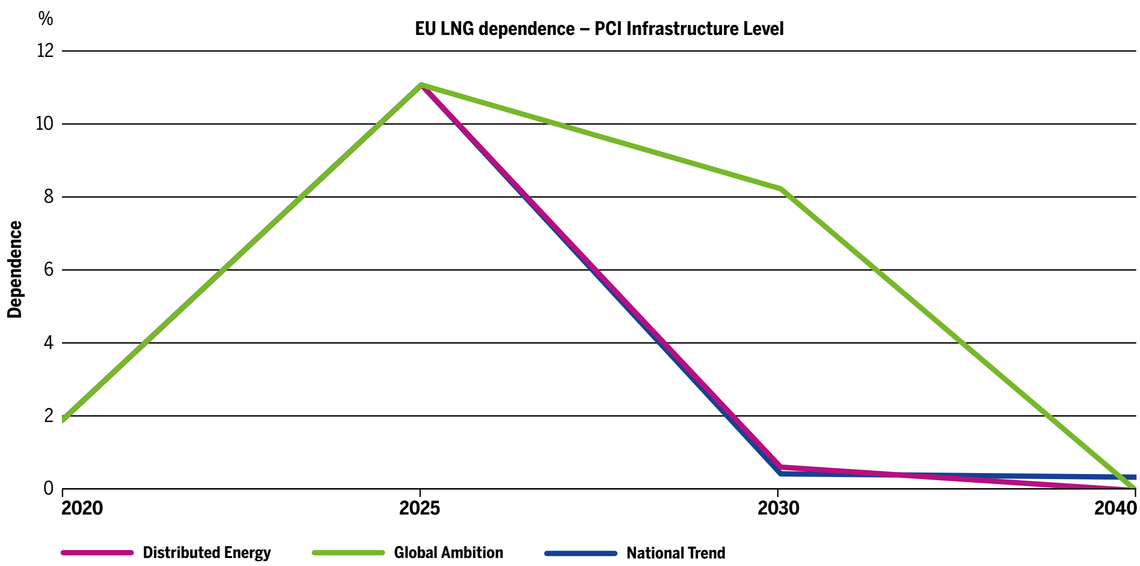


Figure 5.14 Overall EU dependence on LNG supply in the PCI infrastructure level.

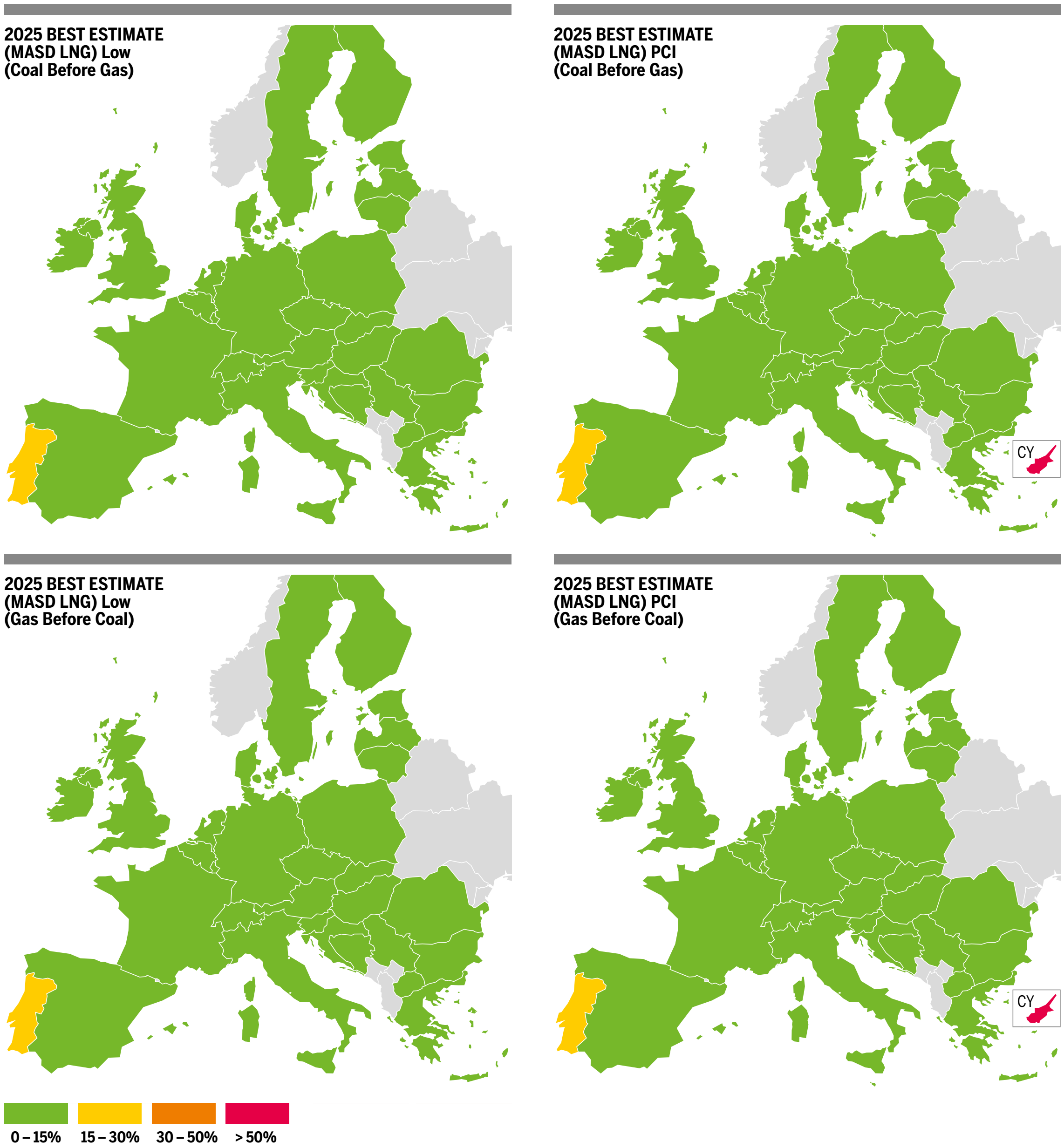


Figure 5.15 MASD LNG – Gas Before Coal and Coal Before Gas – 2025 – Low and PCI infrastructure levels.

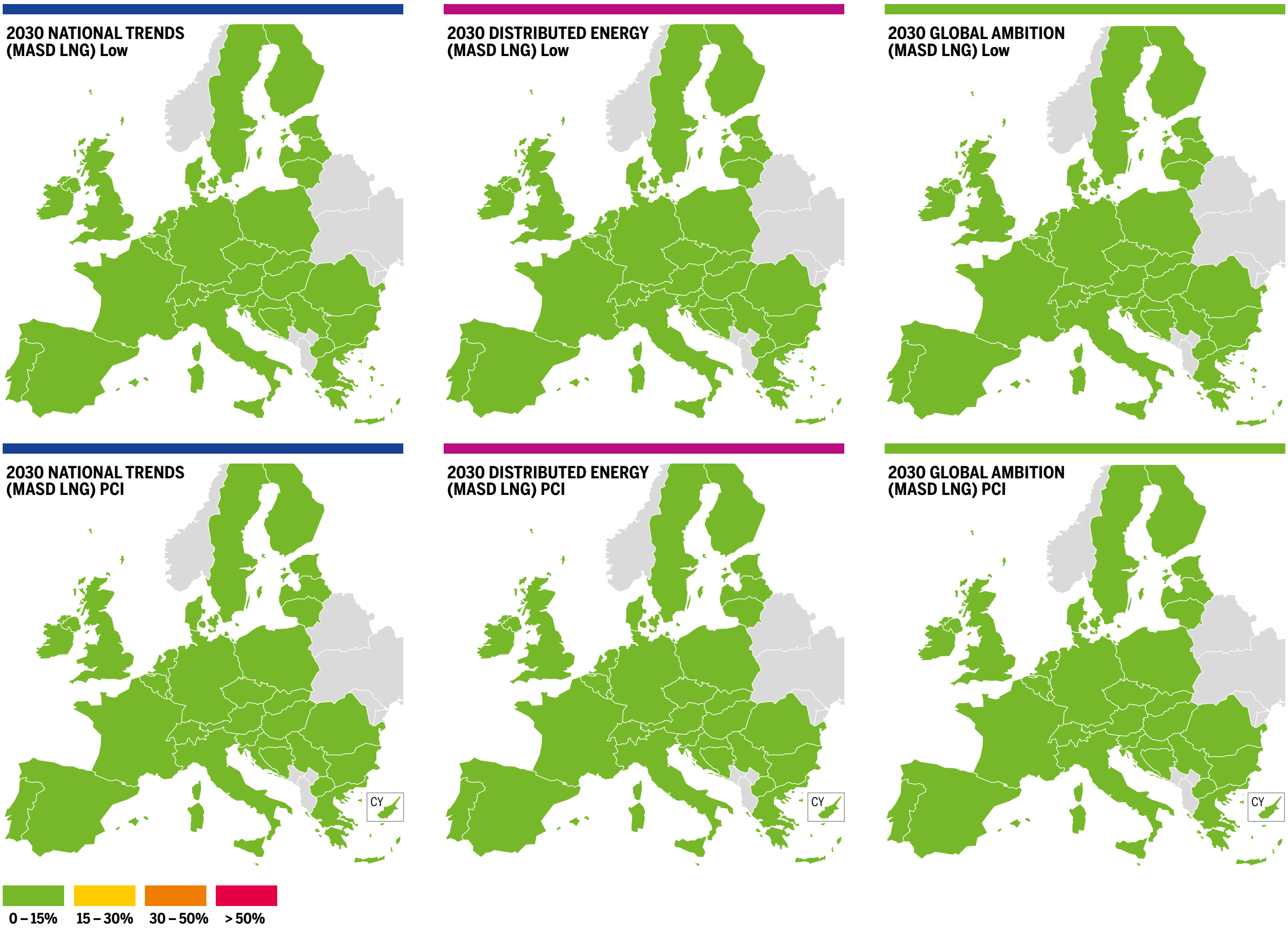


Figure 5.16 MASD LNG – All scenarios – 2030 – Low and PCI infrastructure levels.

5.2.2.5 DEPENDENCE TO THE LARGEST LNG BASIN

The LNG market is a global and very diversified market. The assessment of the dependence of Europe on the largest LNG basin (Middle-East LNG supply) with the existing infrastructure confirms that Europe is not dependent on a single LNG basin and can always find alternative LNG supplies.

Figure 5.17 LNG dependence on the single largest LNG basin

5.2.3 MASD RUSSIA

In all scenarios, Europe depends on Russian gas to satisfy its demand in 2020, 2025 and 2030 and to a lesser extent in 2040. At EU-level, the assessment shows that gas infrastructure allows to make use of the maximum supply potential of all the other gas sources. However, this is not enough to cover the overall EU gas demand. This indicates that Europe relies on Russian gas supply to achieve its balance between supply and demand.

The evolution of the Russian supply dependence generally reflects that the Russian supply has a high potential and therefore can offer a significant level of flexibility to compensate with decline of indigenous conventional production.

The assessment shows that between 2030 and 2040, in Distributed Energy and Global Ambition scenarios, whilst the share of gas demand is increasing in transport and industrial sectors as gas keeps on decreasing its carbon intensity and replaces more carbon intensive alternatives, the combined effect of the development of renewable gases and energy efficiency improvement puts the overall dependence of the EU on imports on a decreasing trend, including Russian imports.

Yet, some country-level limitations exist and are detailed hereafter (**see Figure 5.18)**.


Picture courtesy of Gascade

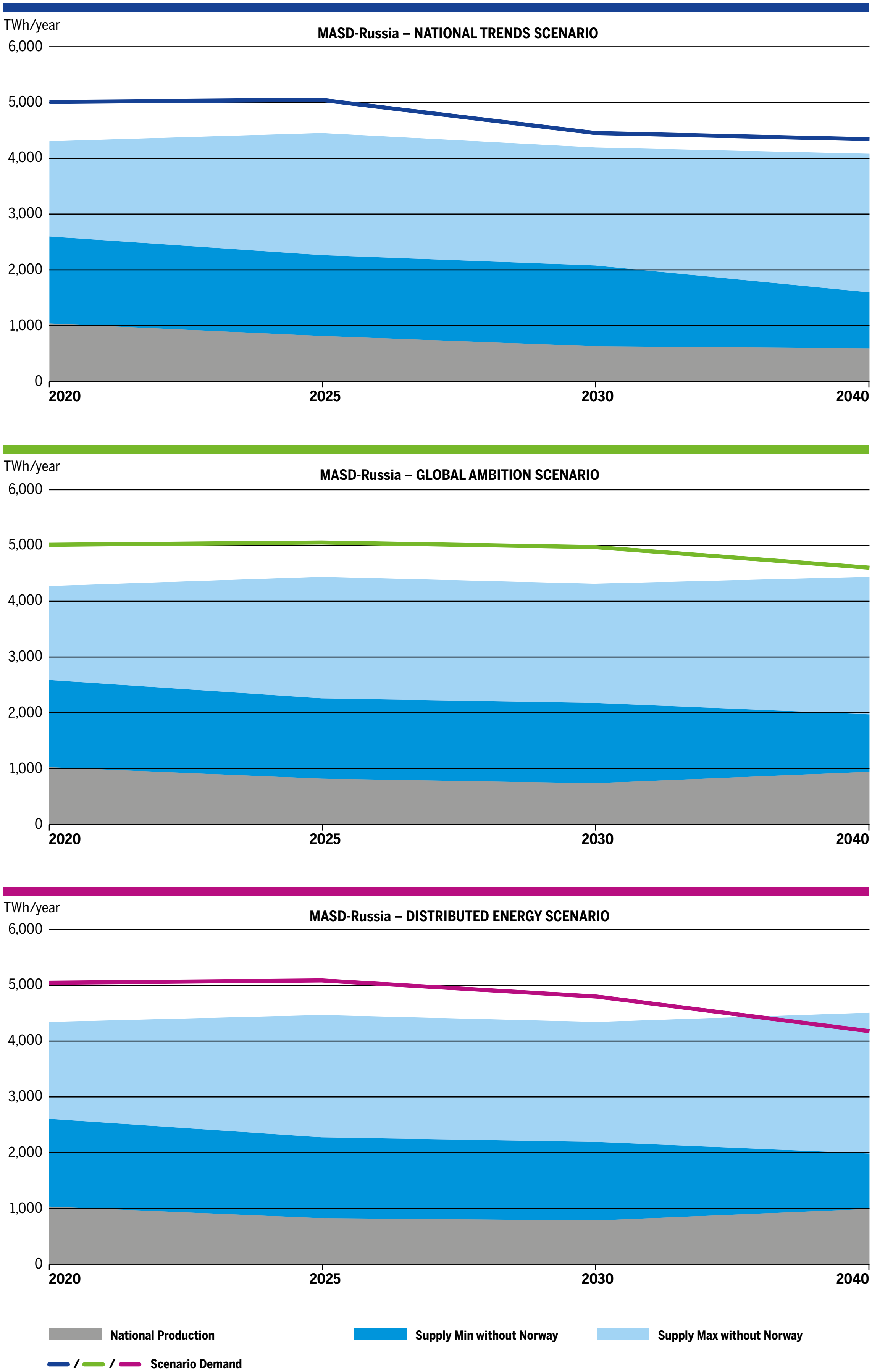


Figure 5.18 European Level Supply and Demand Adequacy with no supply from Russia.

5.2.3.1 EXISTING INFRASTRUCTURE LEVEL

At European level, the existing infrastructure allows the different countries to benefit from the overall reduction of dependence on the Russian supply. However, if the dependence on Russia can be reduced to 10 % in the Distributed Energy scenario in 2040, in the other scenarios, Europe remains dependent on Russia for around 20 % of its gas supply. The situation is very different from country to country where some infrastructure limitations persist in Central and Eastern Europe. **See Figure 5.20.**

2020–2025

For the next 5 years, Europe is expected to be dependent on Russia for 15 to 20 % of its annual gas supply. However, the current infrastructure does not allow for a sharing this dependence in a uniform way among all the European countries. Generally, the simulations show contrasted dependence between Eastern European countries (dependence higher than 40 %) and Western Europe (less than 10 % dependence), indicating some infrastructure limitations between Western and Eastern countries.

Specifically, in South-Eastern Europe, the assessment shows different levels of dependence between Central East European countries[20] (more than 40 %) and Romania (less than 30 %), Bulgaria (less than 30 %) and Greece (less than 10 %), indicating further infrastructure limitations between South Eastern countries and Central Eastern countries.

Lithuania has alternative supply access than Russia and shows a lower dependence than its neighbouring countries. However, the assessment shows some infrastructure limitations preventing Lithuania to further cooperate with the other Baltic states and Poland to reduce the overall dependence of the region.

Over time, Italy shows an increasing dependence on Russian gas from 10 % in 2020 to 30 % in 2025 in the Gas before coal scenario.

20 Central East European Countries: Germany, Poland, Czech Republic, Slovakia, Austria, Hungary, Croatia, Serbia, Bosia and Herzegovina and Slovenia

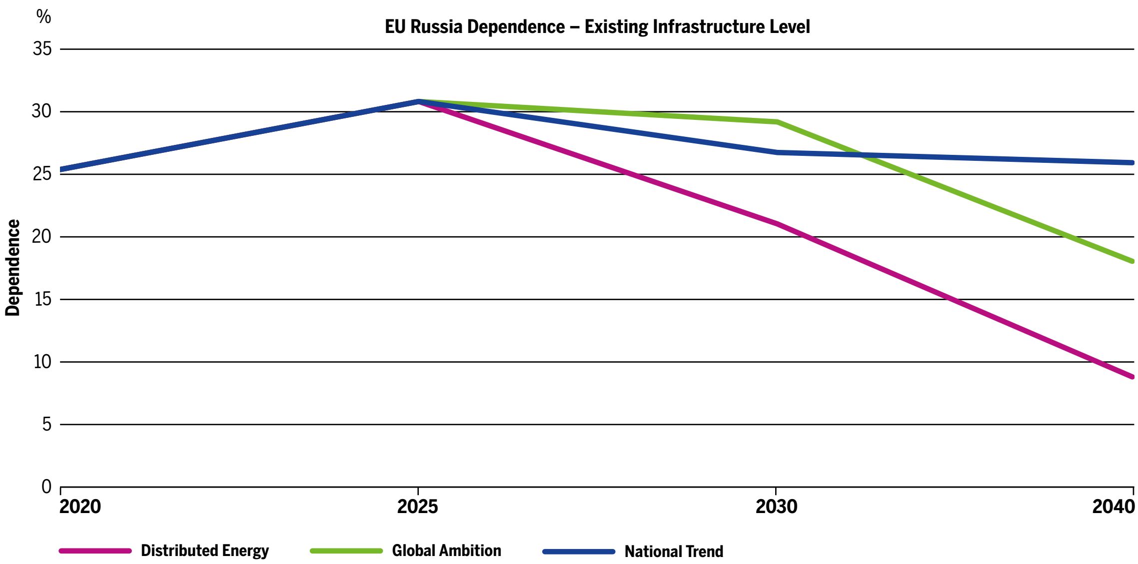


Figure 5.19 European dependence on Russian supply – Existing infrastructure level.

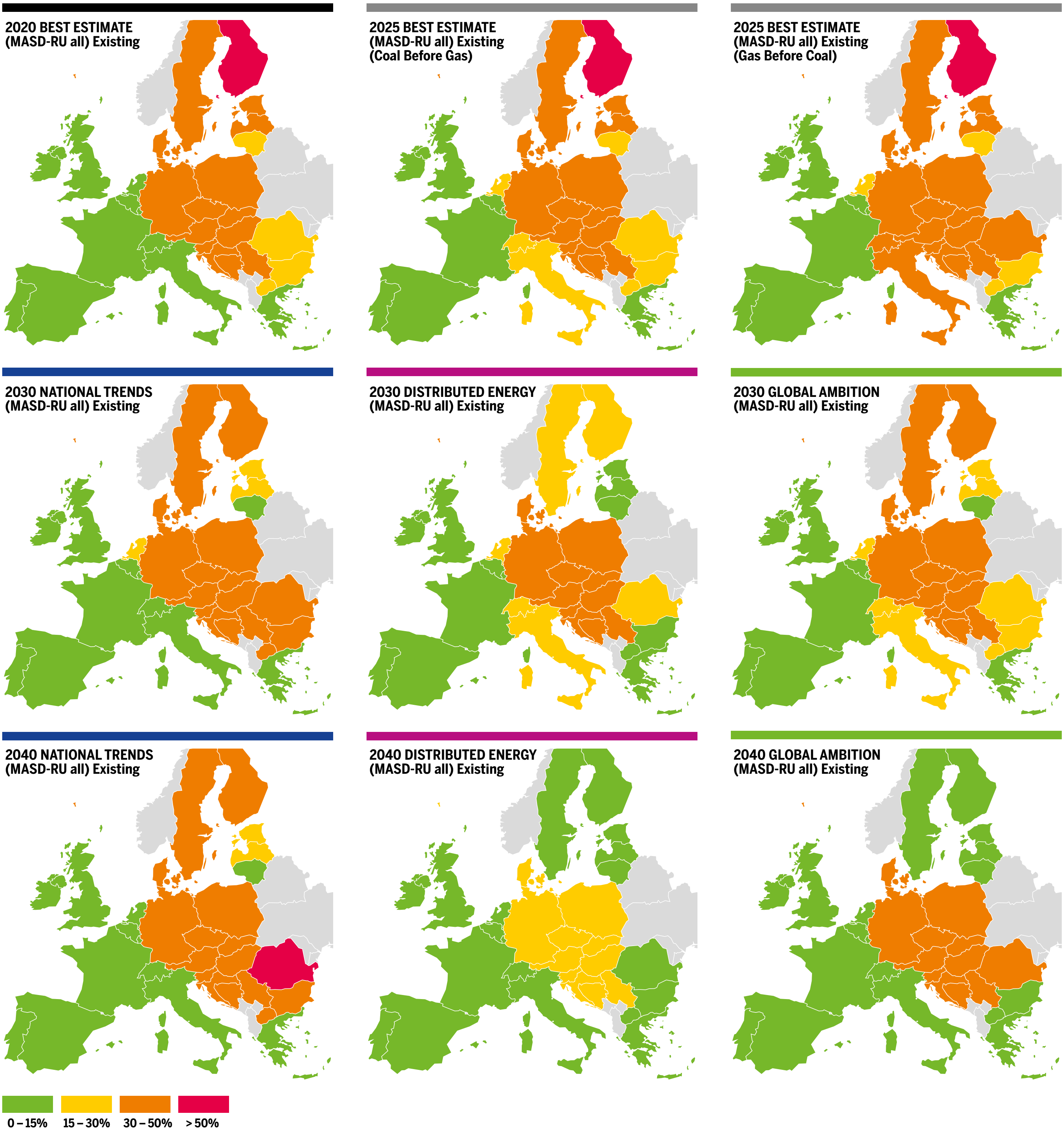


Figure 5.20 MASD RUSSIA – Scenario and Years – Existing Infrastructure level.

2030

NATIONAL TRENDS

The assessment shows some infrastructure limitations preventing:

- Western (MASD < 15 %) and Eastern Europe, including Germany (MASD > 30 %) to cooperate and reduce the overall EU dependence.
- The Baltic states to share their lower dependence (15 % to 25 %) with Poland (43 %) and Finland (49 %).
- Lithuania to share its lower dependence (15 %) with Poland and the other Baltic states (25 %).
- Greece to share its lower dependence (5 %) with Bulgaria (30 %) and the other Balkan countries (45 %).

COP 21 SCENARIOS

Distributed Energy

The uptake of indigenous renewable gases production generally reduces the overall dependence of the EU on imports. Additionally, those renewables further reduce the carbon intensity of the gas mix and demand in industry and transport enabling the shift from carbon intensive fuels to gas. However, the combination of those two elements still shows some improvement in the reduction of the EU dependence towards the Russian supply compared to National Trends. In particular:

- Development of biomethane and Power-to-Gas in Sweden and Finland significantly reduces in their dependence on Russian supply (–20 %).
- Following the further penetration of biomethane and the development of Power-to-Gas capacities, the Baltic states show a significant decrease in their dependence (–10 %) and are further aligned with Lithuania.
- Greece shows no dependence on Russia and Bulgaria is dependent to a very limited extent (3 %).
- Romania shows a significant decrease in its dependence on Russia (from 43 % to 17 %).

However, those improvements also reveal some remaining infrastructure limitations:

- between Western Europe (0 % dependence) and Germany (41 %),
- between the Baltic states, Finland and Poland,
- between Lithuania and Latvia,
- in the Balkan region between Romania and its neighbouring countries and between Bulgaria and Serbia,
- in Italy where the development of renewable gases (compared to National Trends) sustains the gas demand with additional fuel switch from other sectors.

Global Ambition

The uptake of indigenous renewable gases production generally limits the overall increasing dependence of the EU on imports caused by the decline of the conventional indigenous production. Equally, the global approach towards tackling climate change enhances the production of renewable and decarbonised gases outside the EU and sustains a global and decarbonised gas market. Consequently, the production and imports of renewable and decarbonised gases reduce the carbon intensity of the gas mix and demand in industry and transport further shifts from carbon intensive fuels to gas compared to National Trends.

However, the combination of those two elements shows comparable EU dependence towards the Russian supply compared to National Trends except for Romania and Bulgaria showing a significant decrease in their dependence (–25 %).

Those improvements also reveal some remaining infrastructure limitations:

- Between the UK and Ireland (0 %) and continental Europe.
- Between the Iberian Peninsula (0 %) and the rest of Europe.
- Between Western Europe (0 % dependence) and Germany (41 %).
- Between Western (MASD < 15 %) and Eastern Europe, including Germany (MASD > 40 %).
- The Baltic states cannot share their lower dependence (15 % to 25 %) with Poland (48 %) and Finland (47 %).
- Lithuania cannot share its lower dependence (15 %) with Poland and the other Baltic states (25 %).
- In the Balkan region between Romania and its neighbouring countries and between Bulgaria and Serbia.

2040

NATIONAL TRENDS

With the further decline of the conventional indigenous production and the very limited development of renewable gases, the EU is increasingly dependent on imports and more specifically on the Russian supply.

The assessment shows some infrastructure limitations preventing:

- Western (MASD < 11 %) and Eastern Europe, including Germany (MASD > 40 %) to cooperate and reduce the overall EU dependence.
- The Baltic states to share their lower dependence (10 % to 15 %) with Poland (45 %) and Finland (45 %).
- Lithuania to share its lower dependence (10 %) with Poland and the other Baltic states (15 %).
- Greece (not dependent) to help Bulgaria (30 %) and the other Balkan countries (45 %).
- Romania (55 %) to cooperate with Bulgaria (31 %) or Hungary (45 %).

COP 21 SCENARIOS

Distributed Energy

The overall improvement in energy efficiency and the significant development of renewable gases (biomethane and power-to-gas) compensate the decline of the conventional natural gas production and the increasing gas demand for power generation due to increasing electrification.

Europe in general could satisfy its demand with alternative supply sources of gas and show no dependence on Russian gas supply. However, Central-Eastern Europe (DK, DE, PL, CZ, SK, AT, HU, HR, SI, BA and RS) shows a dependence close to 25 % revealing some infrastructure limitation between this group of countries and their neighbours:

- In the West between Germany with the Netherlands, Belgium, France, Switzerland and Italy.
- In the North-East between Poland and Lithuania.
- In the East between Hungary and Romania; and between Bulgaria and Serbia.
- In the South between Austria and Slovenia with Italy.

Picture courtesy of GASUM

Global Ambition

The further development of indigenous renewable gases production participates to decreasing the overall dependence of the EU on imports and fully compensate the decline of the conventional indigenous production. Equally, the global approach towards climate change enhances the production of renewable and decarbonised gases outside the EU and sustains a global and decarbonised gas market. Consequently, the production and imports of renewable and decarbonised gases reduces the carbon intensity of the gas mix and demand in industry and transport further shifting from carbon intensive fuels to gas compared to National Trends.

In 2040, as in the Distributed Energy scenario, Europe in general could satisfy its demand with alternative supply sources of gas and show close to no dependence on Russian gas supply.

However, if most of the EU countries show no dependence at all on Russian supply, Central-Eastern Europe (Denmark, Germany, Poland, Slovakia, Austria, Czech Republic, Croatia, Slovenia, Bosnia and Herzegovina and Serbia) shows a dependence close to 40 % revealing some infrastructure limitation between this group of countries and their neighbours:

- In the West between Germany with the Netherlands, Belgium, France, Switzerland and Italy.
- In the North-East between Poland and Lithuania.
- In the East between Hungary and Romania, between Romania and Bulgaria, and between Bulgaria and Serbia.
- In the South Between Austria and Slovenia with Italy.

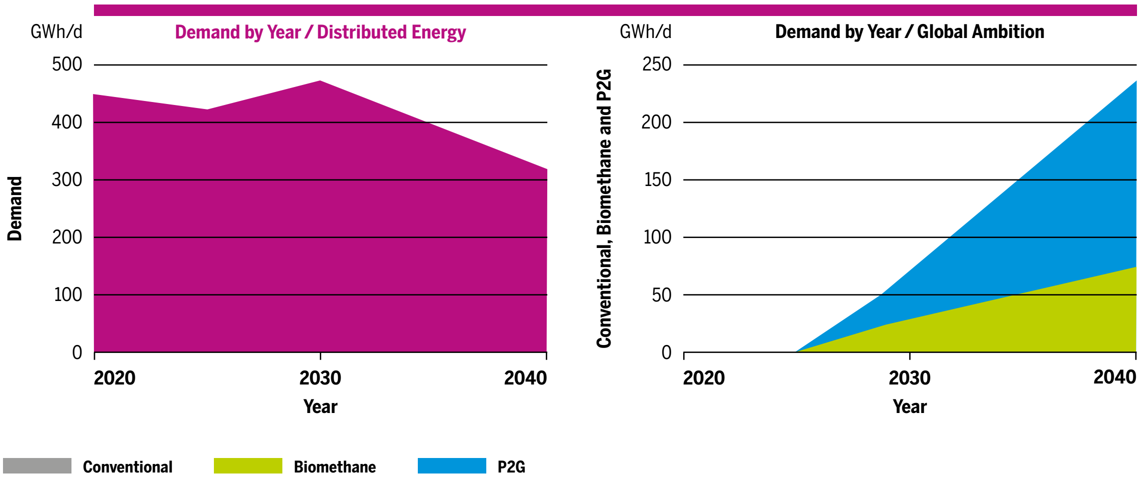


Figure 5.21 Demand and production evolution in the Baltic states and Finland in Distributed Energy scenario.

5.2.3.2 LOW INFRASTRUCTURE LEVEL

At European level, the Low infrastructure including all the FID projects shows further reduction in the overall dependence on Russia compared to the existing infrastructure. FID projects allow Europe to reduce the dependence on Russian gas by 5 % as of 2030 in all scenarios. Furthermore, in Distributed Energy in 2040, the FID projects almost fully mitigate the dependence of Europe on Russian supply (3 % dependence). However, the situation can be different from country to country.

2025

FID projects partially mitigate the situation in Central-Eastern Europe with a general decrease of the Russian dependence by 10 %, and a total mitigation for Denmark and Sweden. FID projects additionally enhance the cooperation between the Baltic states and Finland: they all show the same level of dependence on Russian supply (40 % in Coal Before Gas scenario).

However, some infrastructure limitations remain:

- The improvement in Denmark and Sweden cannot be fully shared with the other Member States due to limited interconnections,
- Germany and the Netherlands cannot benefit from the limited dependence of their western neighbours (UK, Belgium and France),
- Lithuania interconnections with Poland and Latvia are limited and prevent from spreading and decreasing the lower dependence of CEE further North.
- In the Balkan region, Romania and Bulgaria remain isolated since their dependence cannot either benefit to Central-Eastern Europe (because of infrastructure limitations between Romania and Hungary, Serbia and Croatia-Hungary) or take advantage of the low dependence of Greece on Russian supply due to the limited interconnection with Bulgaria.

See Figure 5.23.

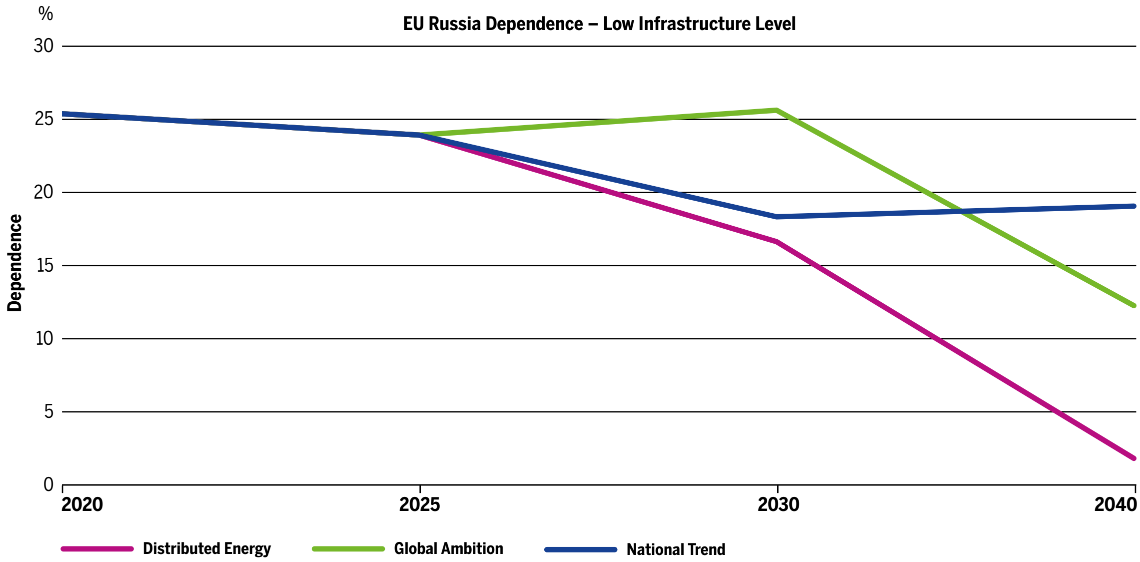


Figure 5.22 European dependence on Russian supply in the Low infrastructure level.

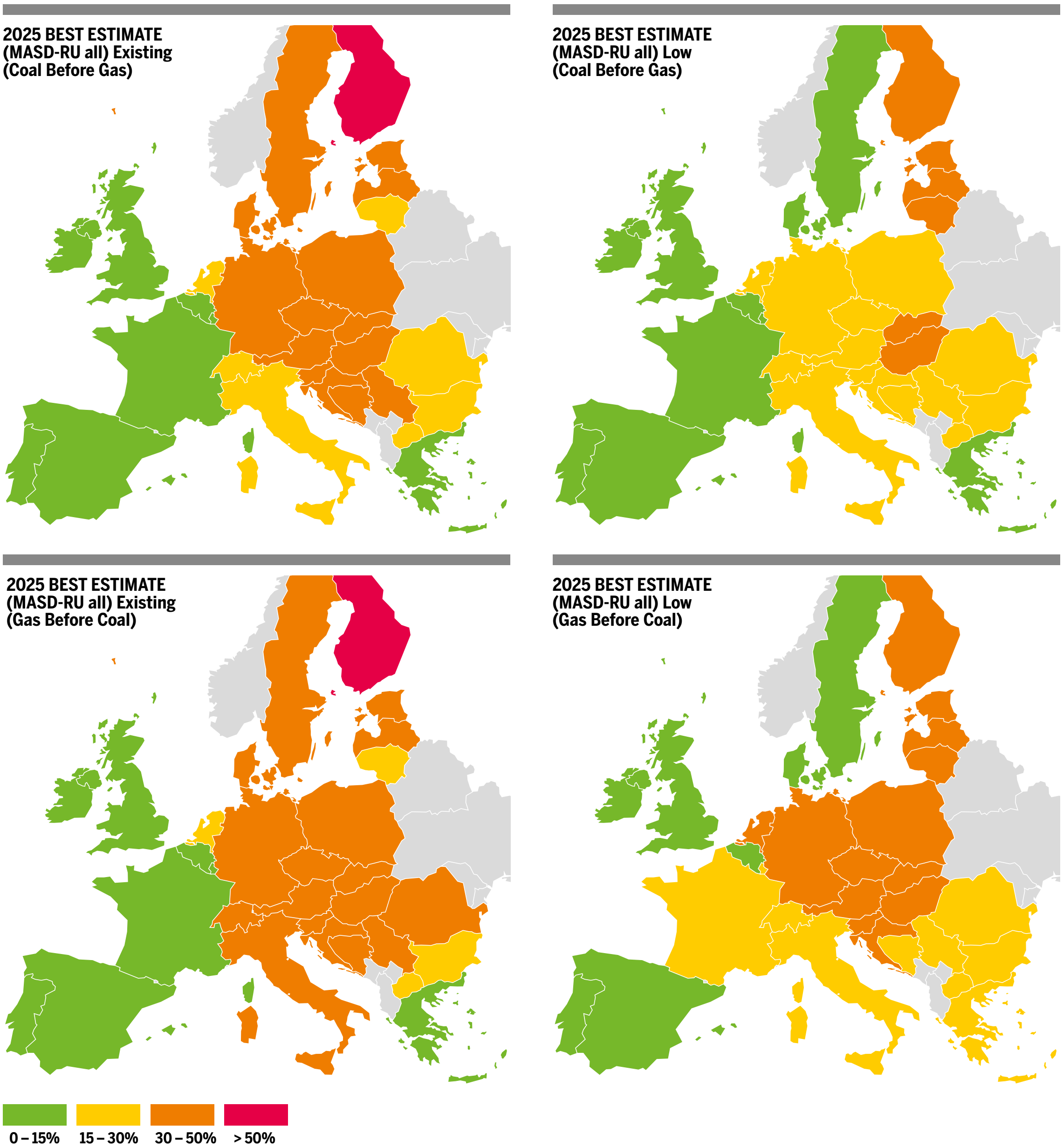


Figure 5.23 MASD RUSSIA – Gas Before Coal and Coal Before Gas – 2025 – Existing and Low infrastructure levels.

2030

NATIONAL TRENDS

FID projects improve significantly the dependence of Central and Eastern Europe on Russian supply (−10 % to −15 %). In some areas, the impact of the FID projects is even more visible:

- In Denmark and Sweden the dependence on Russia decreases from 42 % to 13 %.
- In the Balkans, Bulgaria, Serbia and Bosnia reduce their dependence by 15 % to 20 %.

However, some infrastructure limitations still prevent all EU countries to fully cooperate to mitigate further their dependence:

- Denmark and Sweden cannot make their neighbouring countries benefiting from their lower dependence,
- Eastern European countries cannot benefit from the lower dependence of Western Europe due to some limitations between the Netherlands and Belgium-UK, Germany and Belgium-France, Austria and Italy,
- Central-Eastern countries cannot entirely benefit from the lower dependence of the Balkan region due to infrastructure limitations between Bulgaria and Romania, and between Serbia-Bosnia and Croatia-Hungary

COP 21 SCENARIOS

Distributed Energy

FID projects significantly reduce the dependence of Central-Eastern Europe on Russian supply from 42 % down to 28 %. Furthermore, FID projects improve the cooperation in the Balkan region that reduces its dependence with all countries aligned on a 16 % dependence on Russian supply compared to a range between 3 % to 42 % in the Existing infrastructure level.

However, some infrastructure limitations remain:

- Between the UK-Belgium-France and their Eastern neighbouring countries (The Netherlands, Germany, Switzerland and Italy) with a 18 % dependence on the Russian supply.
- Between Greece (7 %) and Bulgaria (15 %) where infrastructure bottlenecks prevent the region to benefit from Greece's low dependence.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria and Hungary (28 %) to further align their dependence with the South of Europe (16 %).
- Between Denmark-Sweden (7 %) and their neighbouring countries where FID projects do not allow for further cooperation and alignment of the dependence on Russian supply in the region.

Global Ambition

FID projects, improve the cooperation of European countries so that:

- Central and North Eastern Europe show a homogenous dependence of 33 % (−14 % compared to the Existing infrastructure level).
- The Balkan region, from Bulgaria to Italy shows a homogenous dependence of 28 % compared to a range of dependence from 16 % to 47 % in the Existing infrastructure level.

However, some infrastructure limitations remain:

- Between the UK and Ireland (0 %) and continental Europe.
- Between the Iberian Peninsula (0 %) and the rest of Europe.
- Between the UK-Belgium-France and their Eastern neighbouring countries (Germany, Switzerland and Italy), with a gap of 15 % in their dependence on the Russian supply.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria and Hungary (33 %) to further align their dependence with the South of Europe (28 %).

See Figure 5.24.

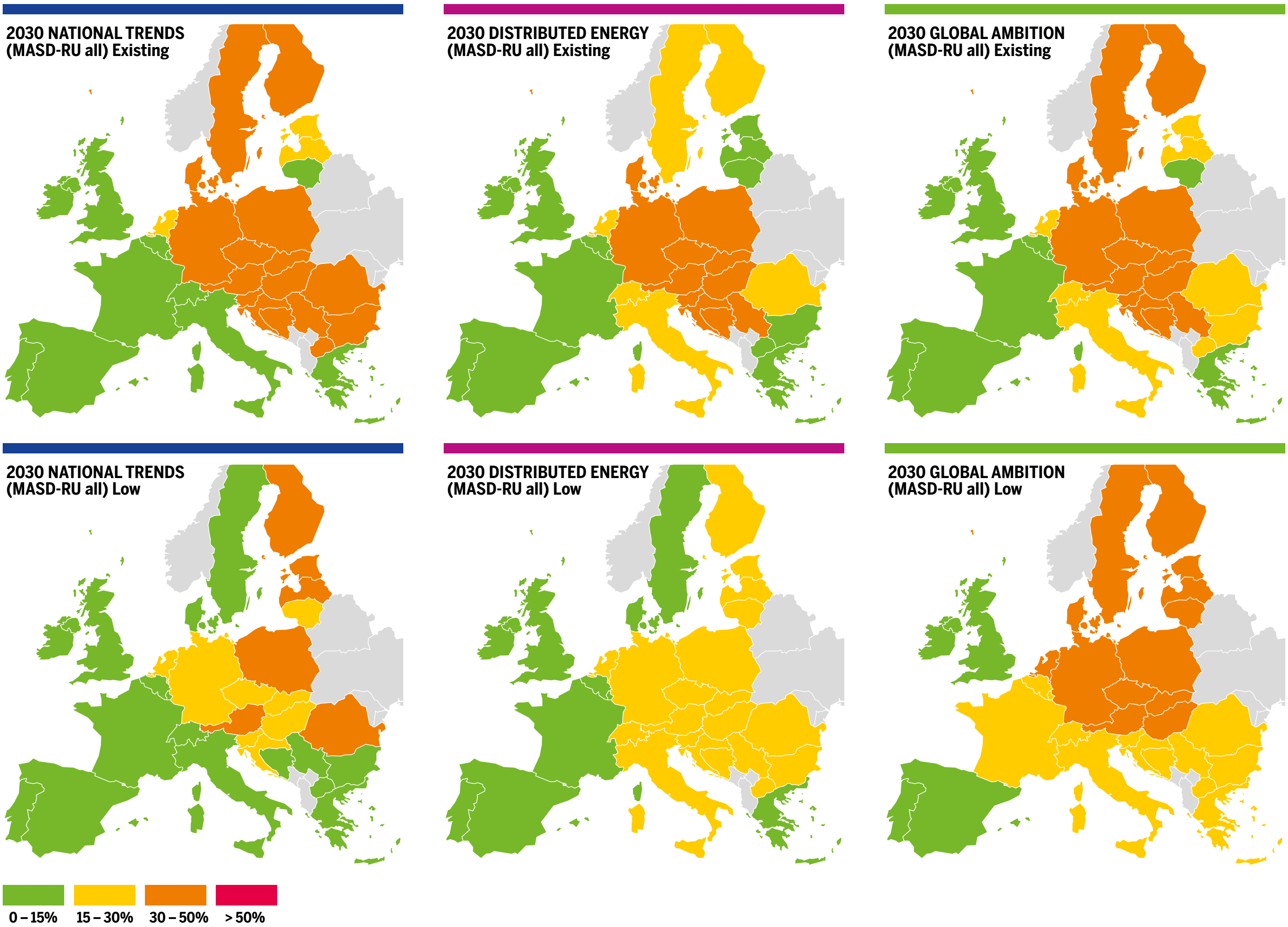


Figure 5.24 MASD RUSSIA – All scenarios – 2030 – Existing and Low infrastructure levels.

2040

NATIONAL TRENDS

FID projects improve significantly the dependence of Central and Eastern Europe on Russian supply (−15 %). In some areas, the impact of the FID projects is even more visible:

- The Baltic states and Finland can fully cooperate with the rest of the EU and share the same dependence (30 %), contributing to the overall reduction.
- Italy and Switzerland can fully align their dependence with France and Belgium (5 %).
- In the Balkans, Bulgaria, Serbia and Bosnia reduce their dependence to 13 %.

However, some infrastructure limitations still prevent all EU countries to fully cooperate to mitigate further their dependence:

- Eastern European countries cannot benefit from the lower dependence of Western Europe due to some limitations between the Netherlands and Belgium-UK, Germany and Belgium-France, Austria and Italy.
- Central-Eastern countries cannot entirely benefit from the lower dependence of the Balkan region due to infrastructure limitations between Bulgaria and Romania, and between Serbia-Bosnia and Croatia-Hungary.

COP 21 SCENARIOS

Distributed Energy

FID projects almost fully alleviate the dependence of the EU on Russian gas supply.

However, some infrastructure limitations prevent from a total independence:

- Between the UK-Belgium-France (0 %) and their Eastern neighbouring countries (The Netherlands, Germany, Switzerland and Italy) with a 7 % dependence on the Russian supply.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria and Hungary (7 %) to further align their dependence with the South of Europe (0 %).
- Between Denmark-Sweden (0 %) and their neighbouring countries (7 %) where FID projects do not allow for further cooperation and alignment of the dependence on Russian supply in the region.
- In the Baltic region between Lithuania (0 %) and Poland (7 %).

Global Ambition

FID projects, improve the cooperation of European countries so that:

- Western and Eastern European countries align further their dependence by halving gap between those countries (from 42 % difference to 21 %), benefiting the whole EU to reduce its dependence on Russian supply from 20 % to 14 %.
- Central-Eastern Europe shows a homogenous dependence of 26 % (–16 % compared to the Existing infrastructure level).
- In the Balkan region, Bulgaria Serbia and Bosnia show a homogenous dependence of 7 % similar to Western Europe and reduced compared to the Existing infrastructure level (range from 1 % to 42 %).

However, some infrastructure limitations remain:

- Between the UK and Ireland (0 %) and continental Europe.
- Between the Iberian Peninsula (0 %) and the rest of Europe.
- In the Baltics between Lithuania (6 %) and Poland (26 %).
- Between the UK-Belgium-France and their Eastern neighbouring countries (Germany, Switzerland and Italy), with a gap of more than 20 % in their dependence on the Russian supply.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria, Slovenia, Croatia, Hungary and Romania (26 %) to further align their dependence with the South of Europe (6 %).

See Figure 5.25.

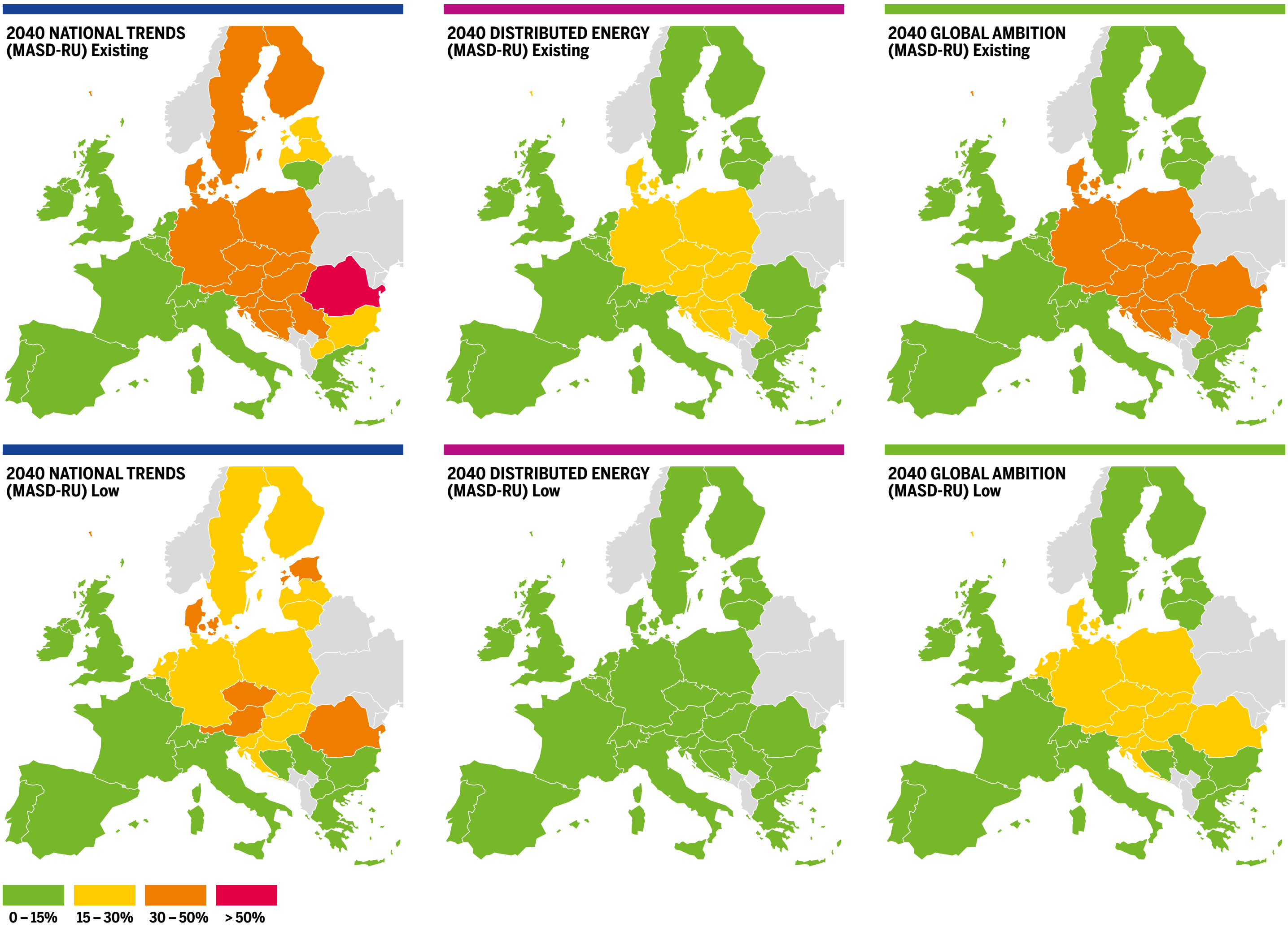


Figure 5.25 MASD RUSSIA – All scenarios – 2040 – Existing and Low infrastructure levels.

5.2.3.3 ADVANCED INFRASTRUCTURE LEVEL

At European level, the advanced infrastructure level (FID + advanced projects) achieve to mitigate the dependence of the EU on the Russian supply by 2040 in Distributed Energy scenario. Furthermore, in National Trends and Global Ambition Advanced infrastructure projects further reduce the dependence of Europe on Russian supply by 3 %, with a dependence of 10 % in 2040 in Global Ambition.

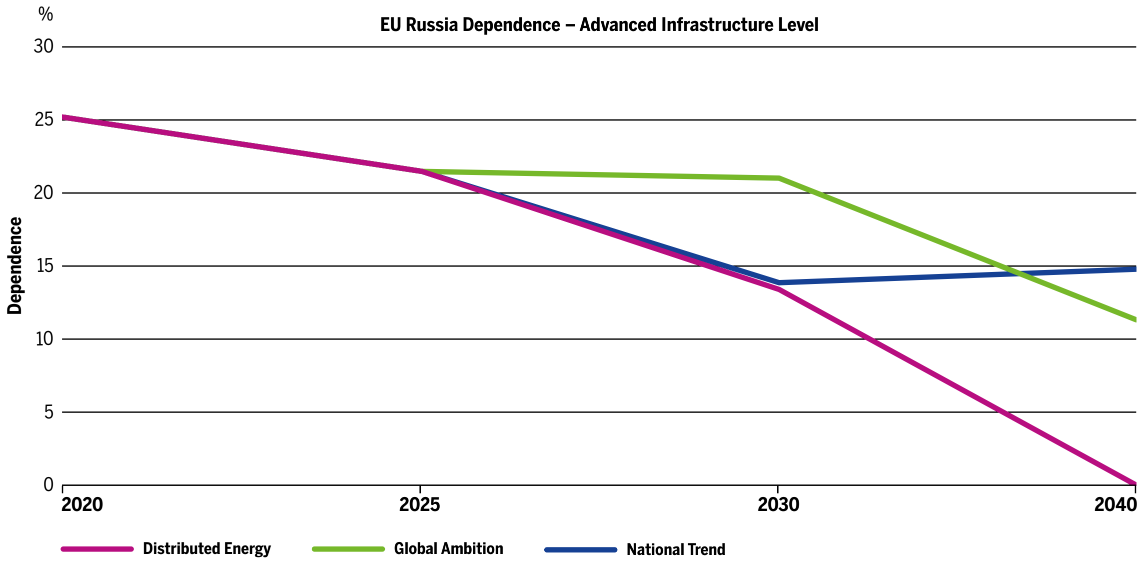


Figure 5.26 European dependence on Russian supply in the Advanced infrastructure level.

2025

COAL BEFORE GAS AND GAS BEFORE COAL SCENARIOS

Advanced projects achieve to enable a full and efficient cooperation of EU countries which can reduce to the minimum the dependence of the EU on Russian supply (20 %).

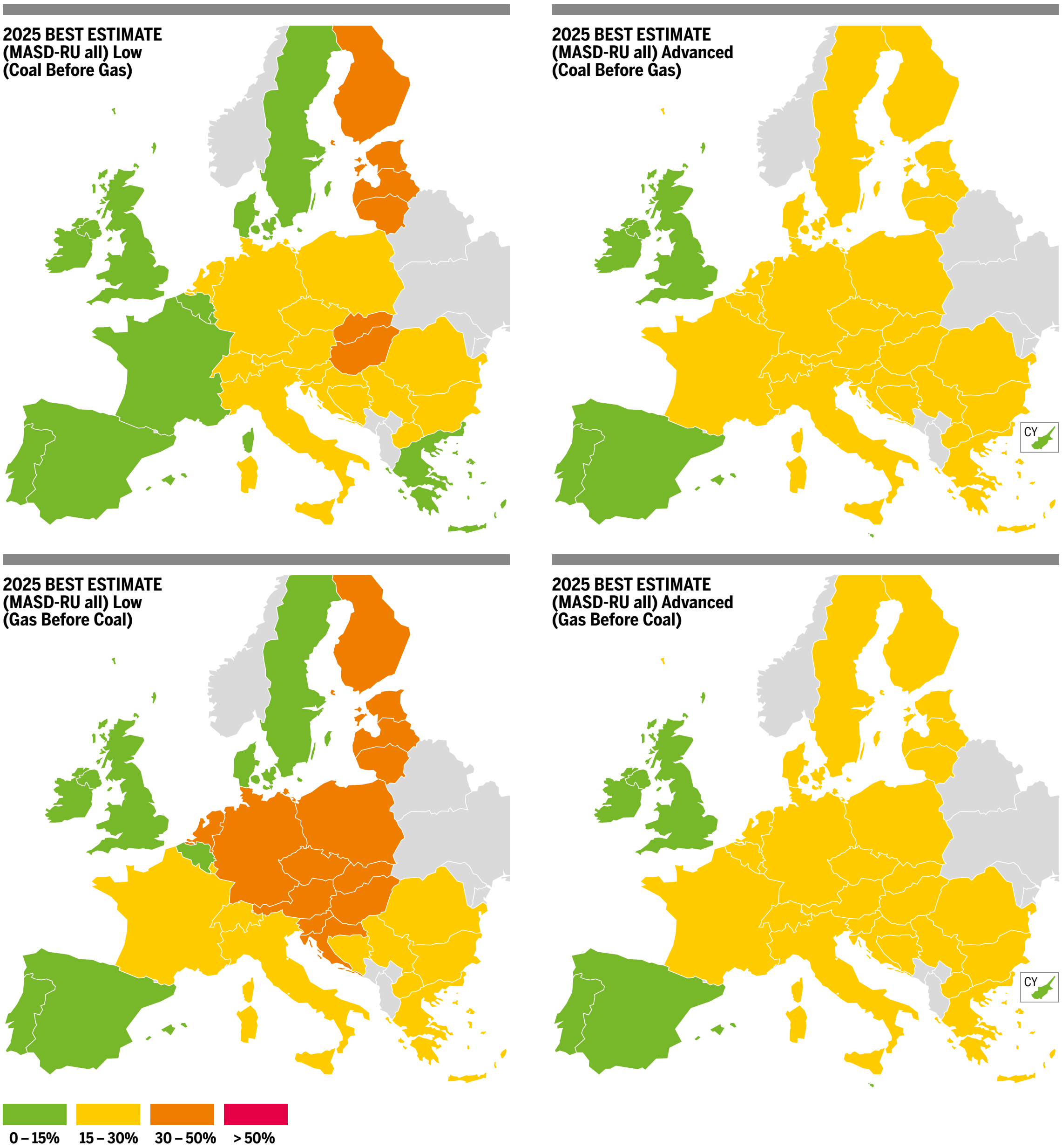


Figure 5.27 MASD RUSSIA – Gas Before Coal and Coal Before Gas – 2025 – Low and Advanced infrastructure levels.

2030

Advanced projects achieve to enable a full and efficient cooperation of EU countries which can reduce to the minimum the dependence of the EU on Russian supply in all scenarios (16 % in National Trends, 16 % in Distributed Energy and 25 % in Global Ambition).

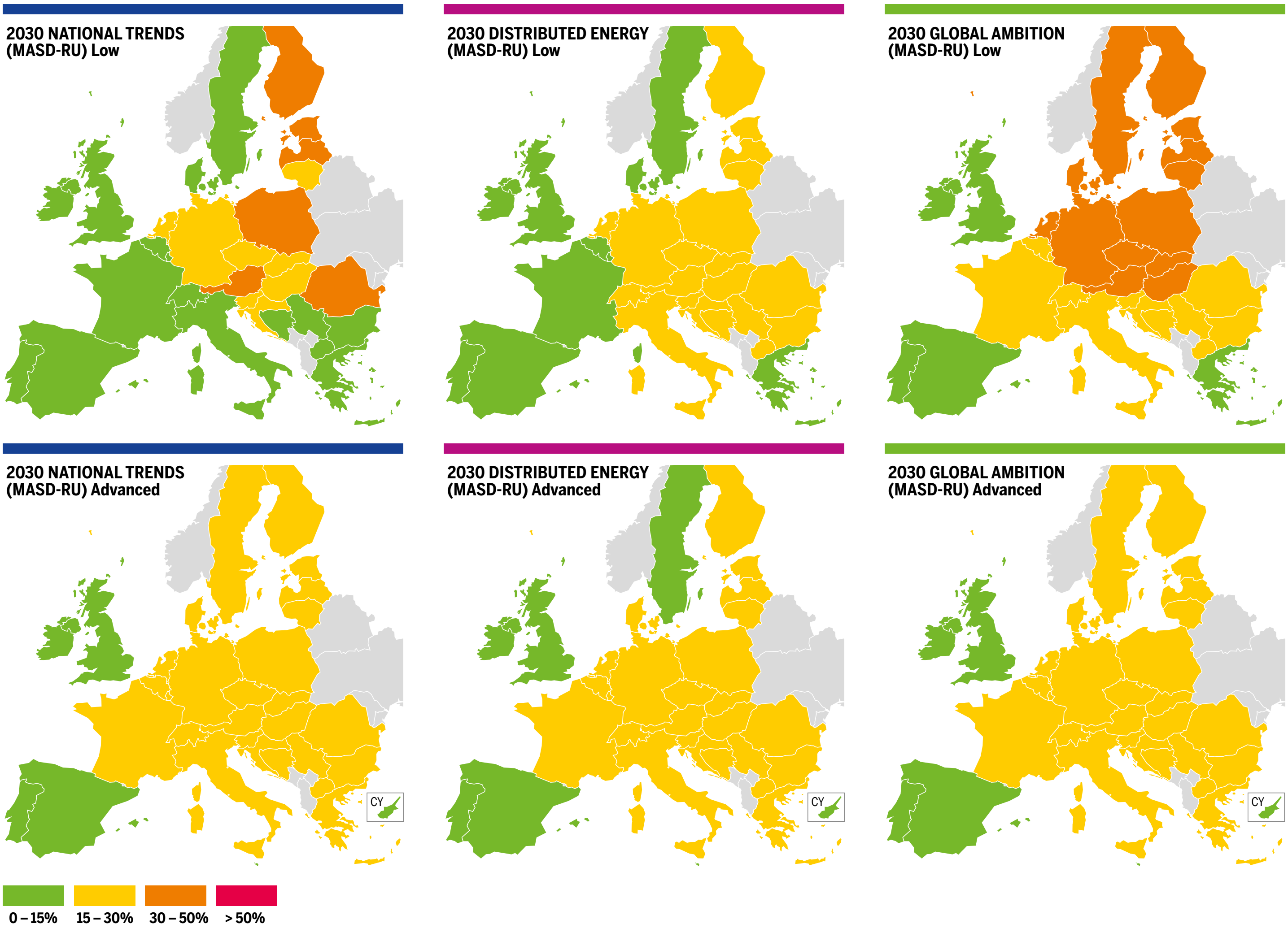


Figure 5.28 MASD RUSSIA – All scenarios – 2030 – Low and Advanced infrastructure levels.

2040

Advanced projects achieve to enable a full and efficient cooperation of EU countries which can reduce to the minimum the dependence of the EU on Russian supply in all scenarios (17 % in National Trends, 0 % in Distributed Energy and 13 % in Global Ambition).

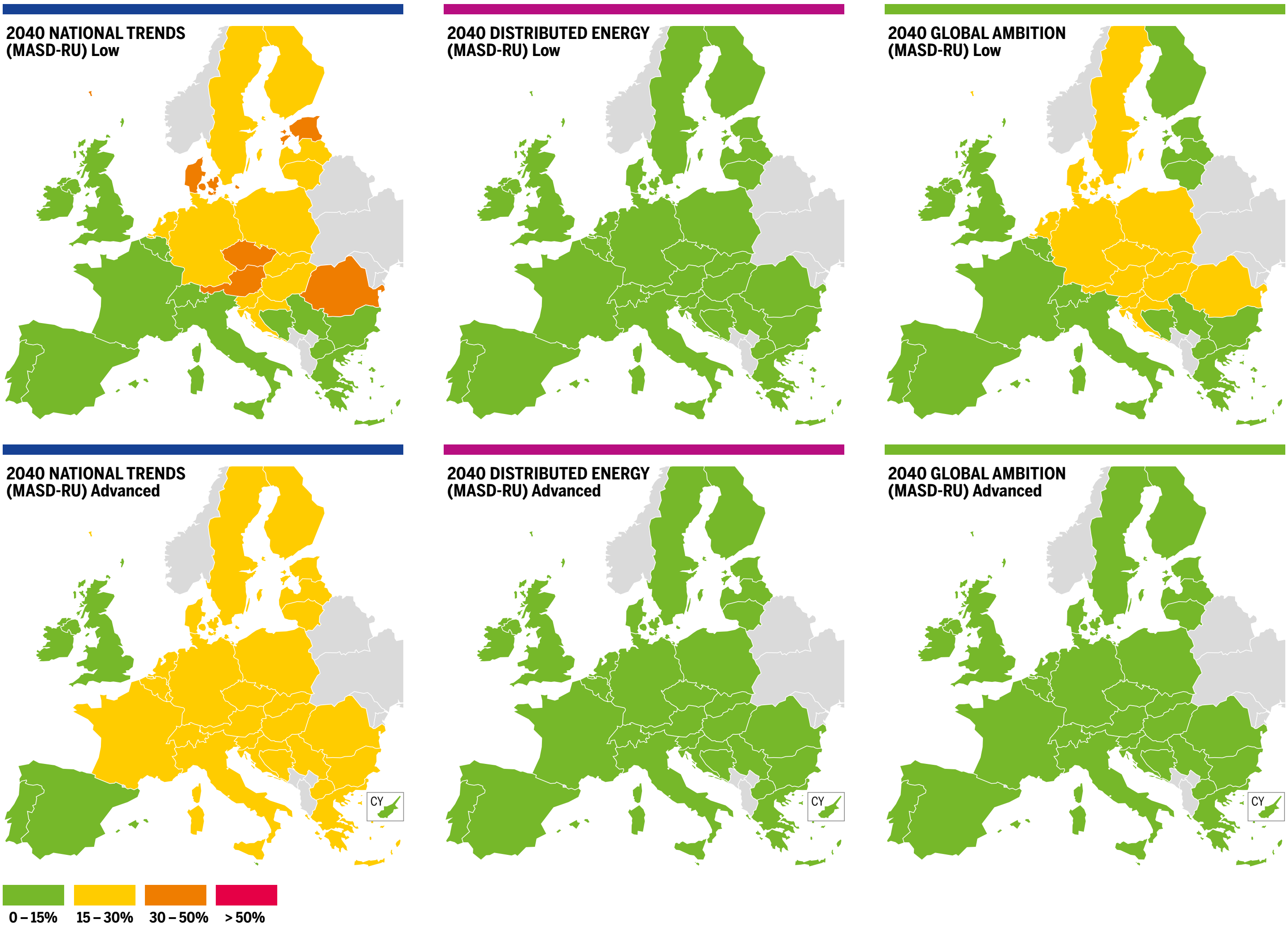


Figure 5.29 MASD RUSSIA – All scenarios – 2040 – Low and Advanced infrastructure levels.

5.2.3.4 PCI INFRASTRUCTURE LEVEL

At European level, the PCI infrastructure level (FID + PCI projects) shows very similar impact than the Advanced infrastructure level. PCI infrastructure level projects achieve to mitigate the dependence of the EU on the Russian supply by 2040 in Distributed Energy scenario. Furthermore, in National Trends and Global Ambition PCI infrastructure projects further reduce the dependence of Europe on Russian supply by 3 %, with a dependence of 10 % in 2040 in Global Ambition. However, at country level, the situation can remain more contrasted:

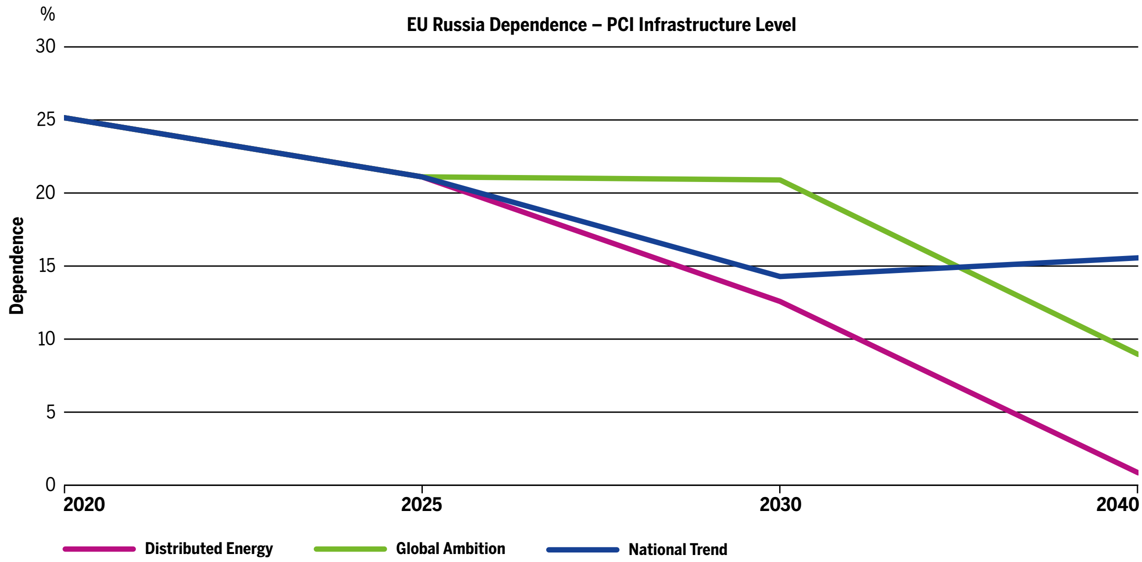


Figure 5.30 European dependence on Russian supply in the PCI infrastructure level.

2025

PCI projects partially mitigate the situation in Central-Eastern Europe with a general decrease of the Russian dependence by 13 %. PCI projects additionally enhance:

- The cooperation between Denmark-Sweden and their neighbouring countries all showing the same level of dependence on Russian supply (28 % in Coal Before Gas scenario).

However, some infrastructure limitations remain:

- Germany and the Netherlands cannot benefit from the limited dependence of their western neighbours (UK, Belgium and France),
- In the Balkan region, Romania and Bulgaria-Serbia remain isolated since their dependence cannot either benefit to Central-Eastern Europe because of infrastructure limitations between Romania and Hungary and between Serbia and Croatia-Hungary. Additionally, Bulgaria cannot take advantage of the low dependence of Greece on Russian supply due to the limited interconnection.

See Figure 5.31.

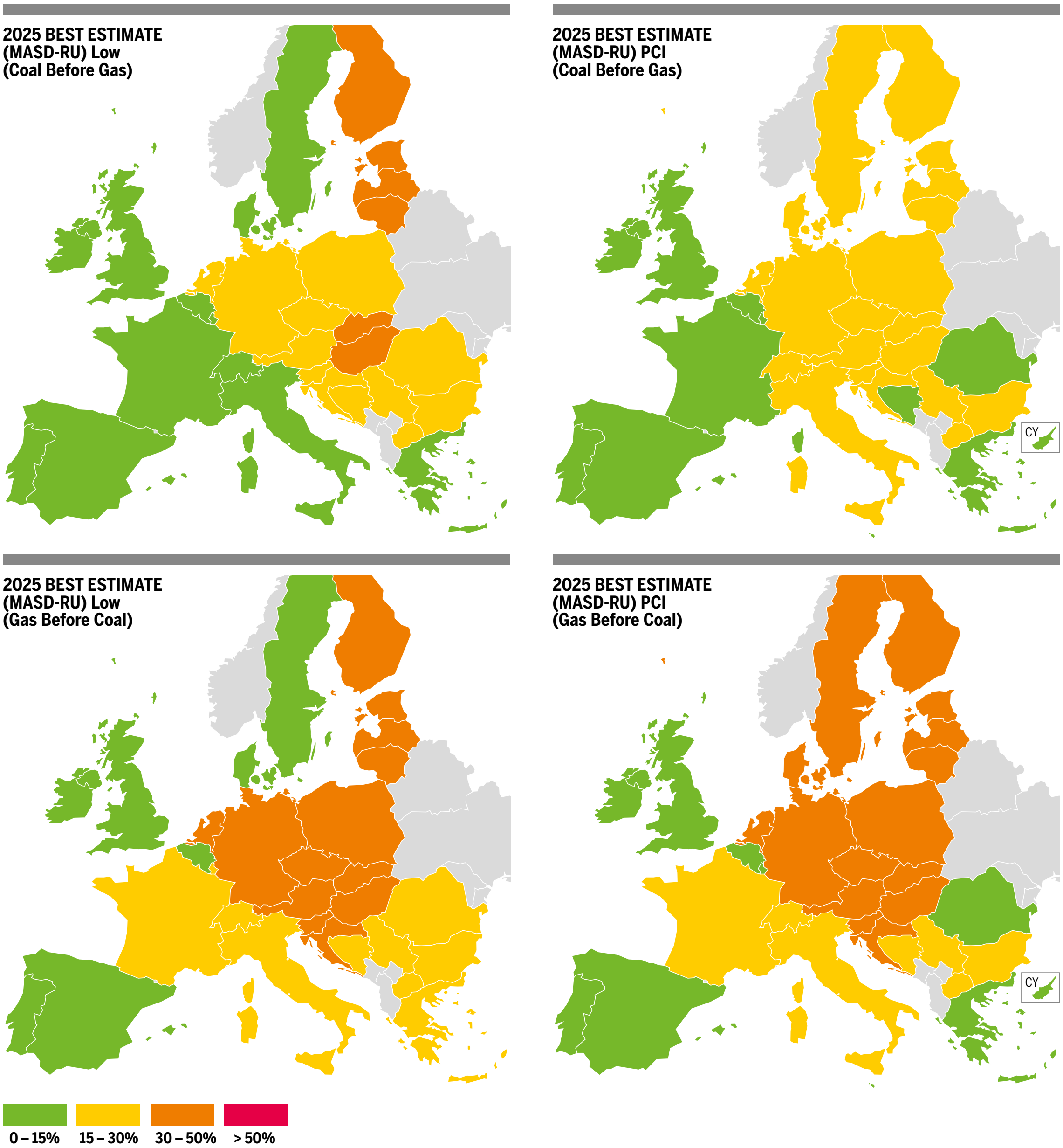


Figure 5.31 MASD RUSSIA – Gas Before Coal and Coal Before Gas – 2025 – Low and PCI infrastructure levels.

2030

PCI projects mitigate (not totally but the overall dependence is close to 5 %) the risk of dependence from Russia for all the West and South East European countries thanks to the significant increase renewable and decarbonized gas production in Distributed Energy scenario which allows these countries to mitigate their dependence. Eastern European countries still show higher dependence, but if we compare to other infrastructure levels, this is mitigated thanks to projects which allow a better cooperation with the other countries. The infrastructure shows limitations that cannot allow Western European countries to increase their cooperation with Eastern countries.

NATIONAL TRENDS

PCI projects significantly improve the dependence of Central and Eastern Europe on Russian supply (–10 % in average). In some areas, the impact of the PCI projects is even more visible:

- In the Balkans, Bulgaria, Serbia and Bosnia reduce their dependence down to 6 %.

However, some infrastructure limitations still prevent all EU countries to fully cooperate to mitigate further their dependence:

- Eastern European countries cannot benefit from the lower dependence of Western Europe due to some limitations between the Netherlands and Belgium-UK, between Germany and Belgium-France and between Austria and Italy,
- Central-Eastern countries cannot entirely benefit from the lower dependence of the Balkan region due to infrastructure limitations between Bulgaria and Romania, and between Serbia-Bosnia and Croatia-Hungary.

COP 21 SCENARIOS

Distributed Energy

PCI projects significantly reduce the dependence of Central-Eastern Europe on Russian supply from 42 % down to 23 %. Furthermore, PCI projects improve the cooperation in some regions:

- In the Balkan region that reduces its dependence down to 3 % by cooperating further with Greece.

However, some infrastructure limitations remain:

- Between the UK-Belgium-France and their Eastern neighbouring countries (The Netherlands, Germany, Switzerland and Italy) with a gap of 18 % in their dependence on the Russian supply.
- Romania remains isolated and cannot benefit from the lower dependence of the Balkan region, neither can help the more dependent Central and Eastern Europe region because of its limited interconnection with Bulgaria and Hungary.

Global Ambition

PCI projects significantly improve the cooperation of European countries so that:

- Central and North Eastern Europe show a homogenous dependence of 30 % (–17 % compared to the Existing infrastructure level).
- The Balkan region, from Bulgaria to Croatia shows a homogenous dependence of 18 % compared to a range of dependence from 16 % to 47 % in the Existing infrastructure level.
- Italy and Switzerland can cooperate efficiently with their Western neighbours to share the same dependence (18 %).

However, some infrastructure limitations remain:

- Between the UK and Ireland (0 %) and continental Europe.
- Between the Iberian Peninsula (0 %) and the rest of Europe.
- Between the UK-Belgium-France-Switzerland-Italy (19 %) and their Eastern neighbouring countries (the Netherlands, Germany and Austria), with a gap of 10 % in their dependence on the Russian supply.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria, Slovenia and Hungary (30 %) to further align their dependence with the South of Europe (18 %).
- Romania remains isolated and cannot benefit from the lower dependence of the Balkan region, neither can help the more dependent Central and Eastern Europe region because of its limited interconnection with Bulgaria and Hungary.

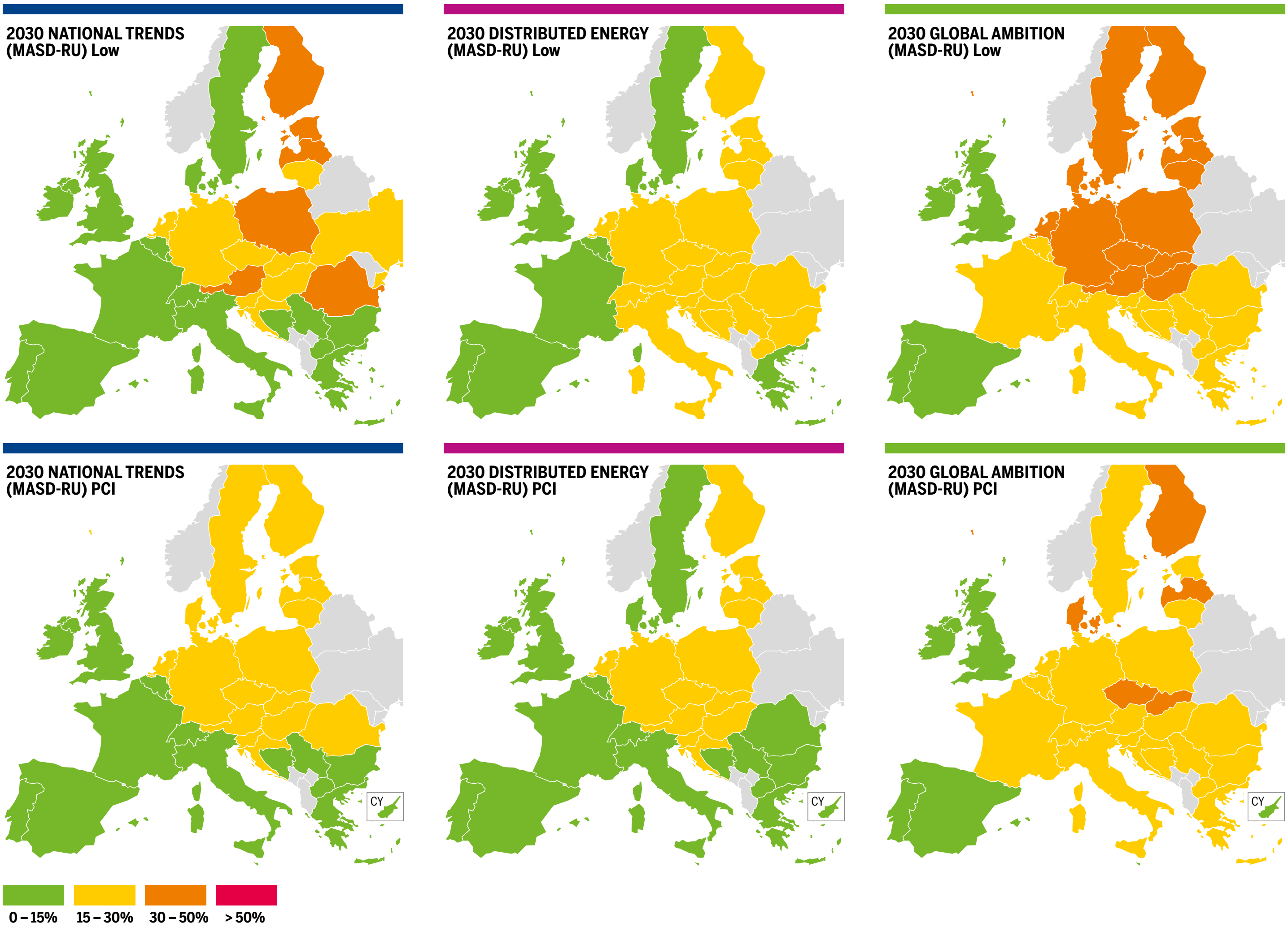


Figure 5.32 MASD RUSSIA – All scenarios – 2030 – Low and PCI infrastructure levels.

2040

NATIONAL TRENDS

PCI projects reduce significantly the dependence of Central and Eastern Europe on Russian supply (−17 %). In some areas, the impact of the PCI projects is even more visible:

- Italy and Switzerland can better cooperate with France and Belgium and fully mitigate their dependence on Russian supply.
- In the Balkans, Bulgaria, Serbia and Bosnia reduce their dependence to 10 %.

However, some infrastructure limitations still prevent all EU countries to fully cooperate to mitigate further their dependence:

- Eastern European countries cannot benefit from the lower dependence of Western Europe due to some limitations between the Netherlands and Belgium-UK, Germany and Belgium-France, and between Austria and Italy,
- Central-Eastern countries cannot entirely benefit from the lower dependence of the Balkan region due to infrastructure limitations between Bulgaria and Romania, and between Serbia-Bosnia and Croatia-Hungary.

COP 21 SCENARIOS

Distributed Energy

PCI projects achieve to fully mitigate the dependence of Europe on Russian gas supply in 2040. No infrastructure limitation is identified.

Global Ambition

PCI projects significantly improve the cooperation of European countries so that:

- Western Europe (Ireland, the UK, Belgium, France, Switzerland, Italy and the Iberian Peninsula) are no longer dependent on Russian supply.
- The South Eastern countries (Greece, Bulgaria, Serbia and Bosnia) is no longer dependent on the Russian supply in 2040.
- Central-Eastern European countries align further their dependence by compared to the Low infrastructure level (from 26 % to 23 %), benefiting the whole EU to reduce its dependence on Russian supply from 14 % to 11 %.
- The Balkan region (Greece, Bulgaria, Serbia and Bosnia) is no longer dependent on the Russian supply in 2040.

However, some infrastructure limitations remain:

- In the Baltics between Lithuania (0 %) and Poland (24 %)
- Between the UK-Belgium-France-Switzerland-Italy and their Eastern neighbouring countries (the Netherlands, Germany, Austria and Slovenia), with a gap of 23 % in their dependence on the Russian supply.
- Between the South-East region and Central Europe, where bottlenecks prevent Germany, Austria, Slovenia, Croatia, Hungary and Romania (24 %) to further align their dependence with the South of Europe (0 %).

See Figure 5.33.

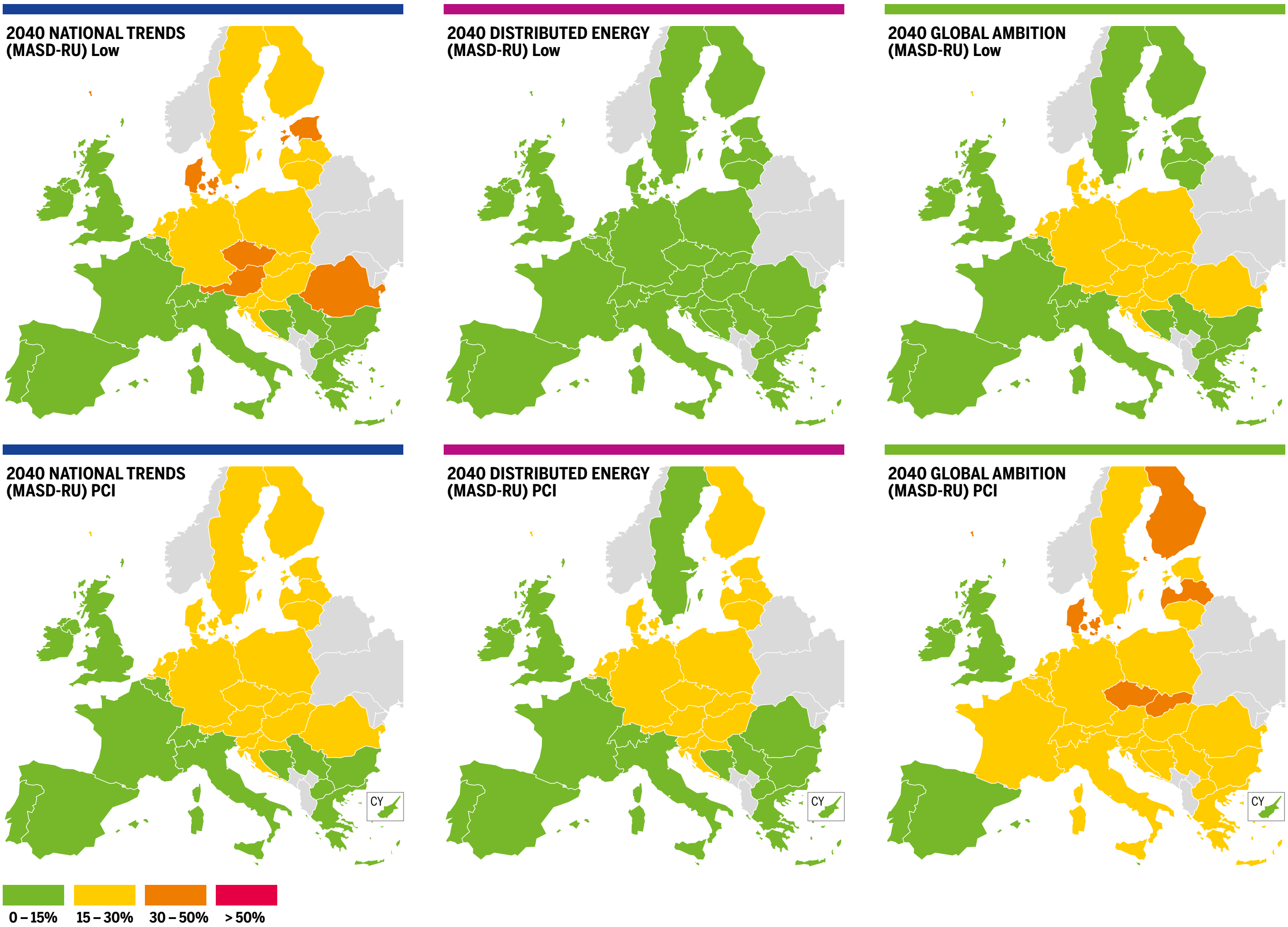


Figure 5.33 MASD RUSSIA – All scenarios – 2040 – Low and PCI infrastructure levels.

5.3 LNG AND INTERCONNECTION CAPACITY DIVERSIFICATION (LICD)

The LNG and Interconnection Capacity Diversification (LICD) does not consider the capacities from **import route** and **transit route** but only the **LNG terminals** capacities and the **interconnections** capacities between **European Countries**.

Each border **entry capacity is capped by the country average day demand**, to avoid results for a small demand country being distorted by a big transit capacity. The indicator, which is therefore scenario dependent, shows the diversification from the perspective of market integration. It measures the diversification of paths that gas can flow through to reach a market area.

For the concerned countries, the maritime border is considered as one border and therefore, all LNG capacities are aggregated and capped by the average demand of the country. Furthermore, the geographical location influences the LICD indicator since a country located at the border of the EU may be able to be interconnected with only one or two countries, including the maritime border. This explains why generally, the countries located in the corners of the EU like the Iberian Peninsula, South-Eastern Europe, the Baltics and Ireland show a higher LICD index than countries more centrally located with many borders, even if those countries have significant capacities (such as LNG capacities in Spain).

The LICD is an HHI indicator and ranges from 0 to 10,000. The lower the value, the better the diversification is. Where a country would have two borders the LICD cannot be lower than 5,000, and for a country having three borders the LICD cannot be lower than 3,333. See Annex D for more detailed information about the indicator's formula.

Results are given by market zone. Thus, Finland, Estonia and Latvia are grouped into a single zone and the results are therefore identical for these three countries. Also, Denmark and Sweden are grouped in one zone and therefore the results are identical for these two countries.

Table 5.1 gives the number of interconnections with neighbouring countries (LNG here is considering as a country) with which a specific country as at least an entry capacity, per country and infrastructure level for the year 2040. The number of interconnections is similar for the all the years (2025, 2030 and 2040). However, Poland, Hungary and Bulgaria increase their number of interconnections between 2025 and 2030 in Advanced infrastructure level and Greece increases its number of interconnections between 2025 and 2030 in PCI infrastructure level.

Country	EXISTING	LOW	ADVANCED	PCI
Austria	3	3	4	4
Belgium	5	5	5	5
Bosnia and Herzegovina	1	1	1	1
Bulgaria	1	2	3	2
Croatia	2	3	4	3
Czechia	2	2	4	2
Denmark	1	1	3	2
Estonia	1	1	2	1
Finland	1	1	2	1
France	5	5	5	5
Germany	8	8	9	8
Greece	1	2	2	3
Hungary	4	4	5	5
Ireland	1	1	1	1
Italy	4	4	6	6
Latvia	1	1	2	1
Lithuania	2	3	3	3
Luxembourg	2	2	2	2
Netherlands	3	3	3	3
North Macedonia	0	0	1	0
Poland	4	6	7	7
Portugal	2	2	2	2
Romania	2	2	4	2
Serbia	1	2	4	2
Slovakia	3	4	4	4
Slovenia	3	3	3	4
Spain	3	3	3	3
Sweden	1	1	3	2
Switzerland	3	3	3	3
United Kingdom	3	3	4	3

Table 5.1 Number of borders interconnected to neighbouring countries per country and infrastructure level for the year 2040.

5.3.1 EXISTING INFRASTRUCTURE LEVEL

The indicator shows a low diversification for the South Eastern European Countries (Greece, Bulgaria, Bosnia and Herzegovina) with only one interconnection with LNG or neighbouring countries. The indicator shows a low diversification for Finland, Estonia and Latvia which are now grouped on a single market and have only one interconnection with Lithuania. On the West side, Ireland has only one interconnection with United Kingdom. The results are similar for all the scenarios.

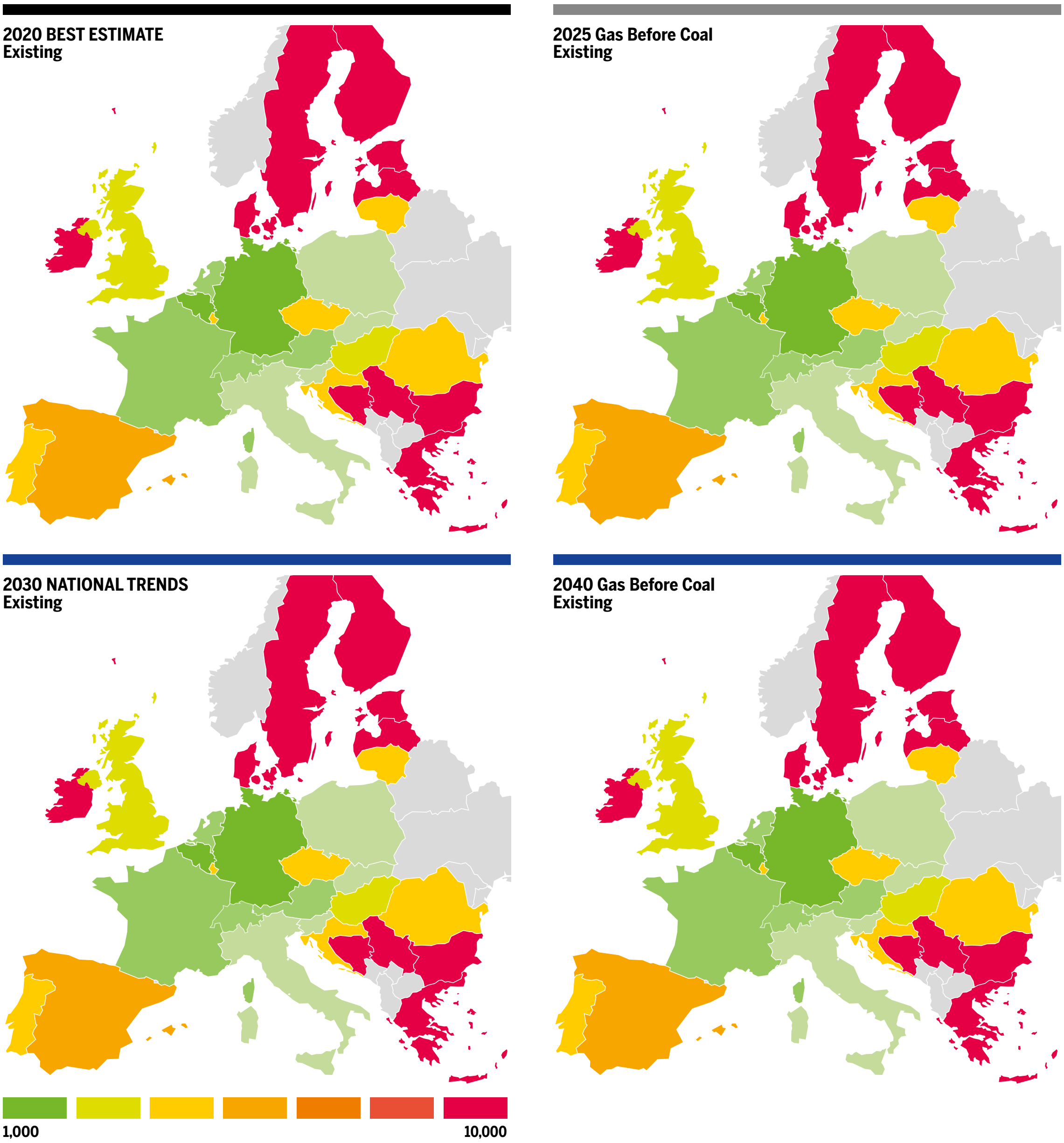


Figure 5.34 LNG and Interconnection Capacity Diversification – Existing infrastructure level.

5.3.2 LOW INFRASTRUCTURE LEVEL

The situation is improving for some South Eastern countries:

- Greece with new interconnection with Italy (Trans Adriatic Pipeline),
- Bulgaria with an increase capacity from Romania and a new interconnection with Serbia,
- Croatia with new Krk LNG Terminal,
- Hungary with increase capacities from Romania and Croatia,
- Serbia with increase capacity from Hungary and new interconnection with Bulgaria.
- Slovakia improves his diversification with a new interconnection with Poland.
- Poland improve his diversification with LNG terminal project in Świnoujście, new interconnection with Slovakia, and Lithuania (GIPL).
- Lithuania improve his diversification with new interconnection with Poland.

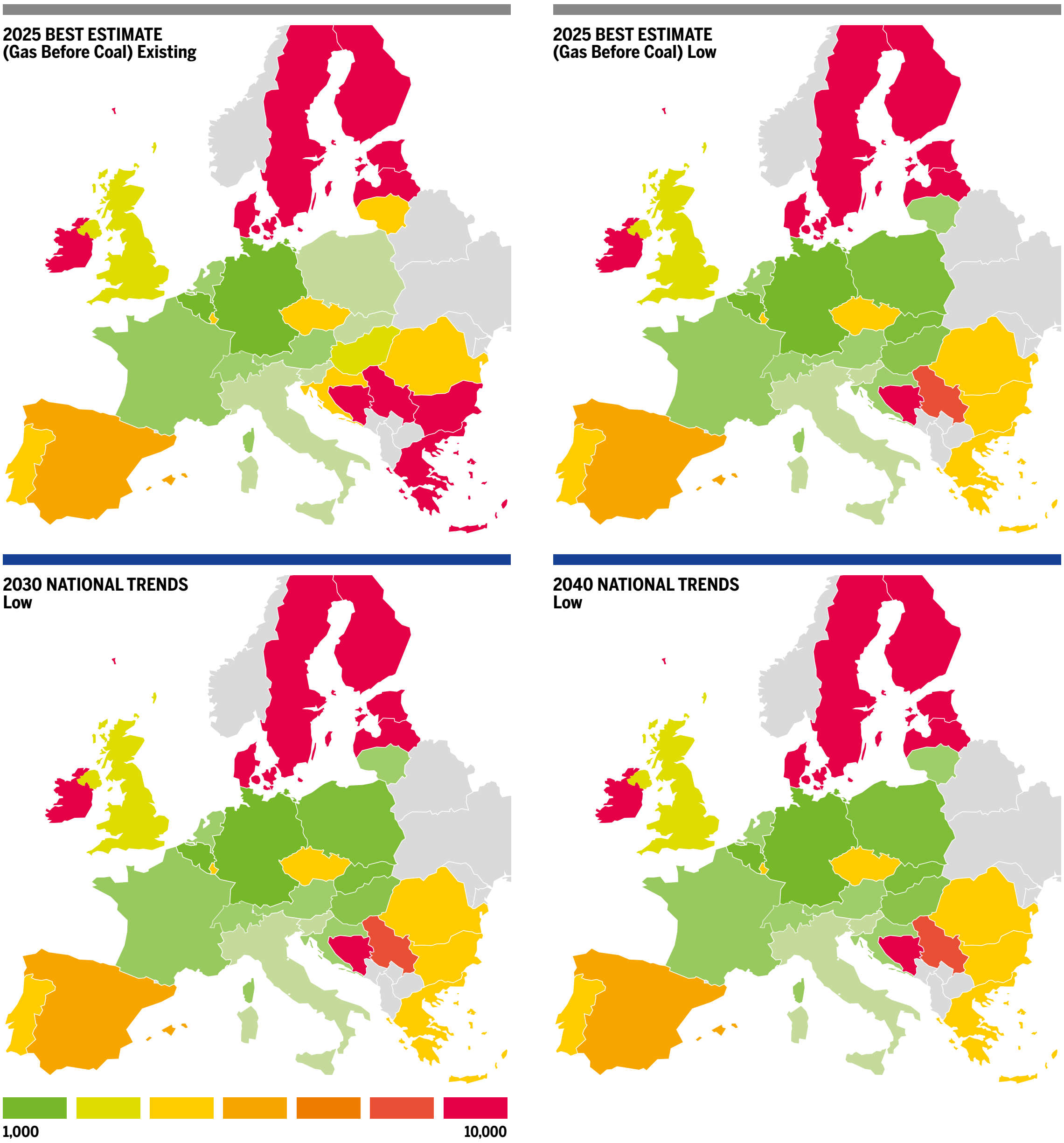


Figure 5.35 LNG and Interconnection Capacity Diversification – Existing and Low infrastructure levels.

5.3.3 ADVANCED INFRASTRUCTURE LEVEL

2025

Most of the South Eastern, North and Eastern countries improve their diversification:

- Austria with the new interconnection with Czech Republic,
- Croatia with the new interconnection with Serbia,
- Denmark and Sweden with the new interconnection with Poland,
- Germany with new LNG terminal and increase capacity with Netherlands,
- Estonia, Finland, Latvia with increase capacity from Lithuania and a new terminal,
- Czech Republic with the 2 new interconnections with Poland and Austria,
- Italy with the new interconnections with Greece and Malta,
- Poland with the new interconnections with Denmark and Czech Republic,
- Romania with new interconnection with Serbia and increase capacity with Hungary,
- Serbia with new interconnections with Romania and Croatia.

North Macedonia (with a value equal to 10,000) with a new interconnection with Greece is now taken into account in the calculations (the interconnection with Bulgar-Transgas Pipeline is considered as a source of supply and was not taken into account in the LICD calculation). **See Figure 5.36.**

2030

Romania, Hungary and Bulgaria with the new interconnection Eastring improve their diversification significantly from 2030. **See Figure 5.37.**

5.3.4 PCI INFRASTRUCTURE LEVEL

2025

Most of the South Eastern, North and Eastern countries improve their diversification:

- Austria with the new interconnection with Slovenia,
- Bulgaria with increase capacity with Serbia
- Hungary with increase capacity with Romania
- Denmark and Sweden with the new interconnection with Poland,
- Italy with the new interconnections with Greece and Malta,
- Poland with the new interconnections with Denmark and Czech Republic,
- Romania with increase capacity with Hungary,
- Serbia with new interconnections with Bulgaria,
- Slovenia with the new interconnection with Hungary.

See Figure 5.38.

2030

Greece improve its diversification with new interconnection with Cyprus (commissioning year in 2025). **See Figure 5.39.**

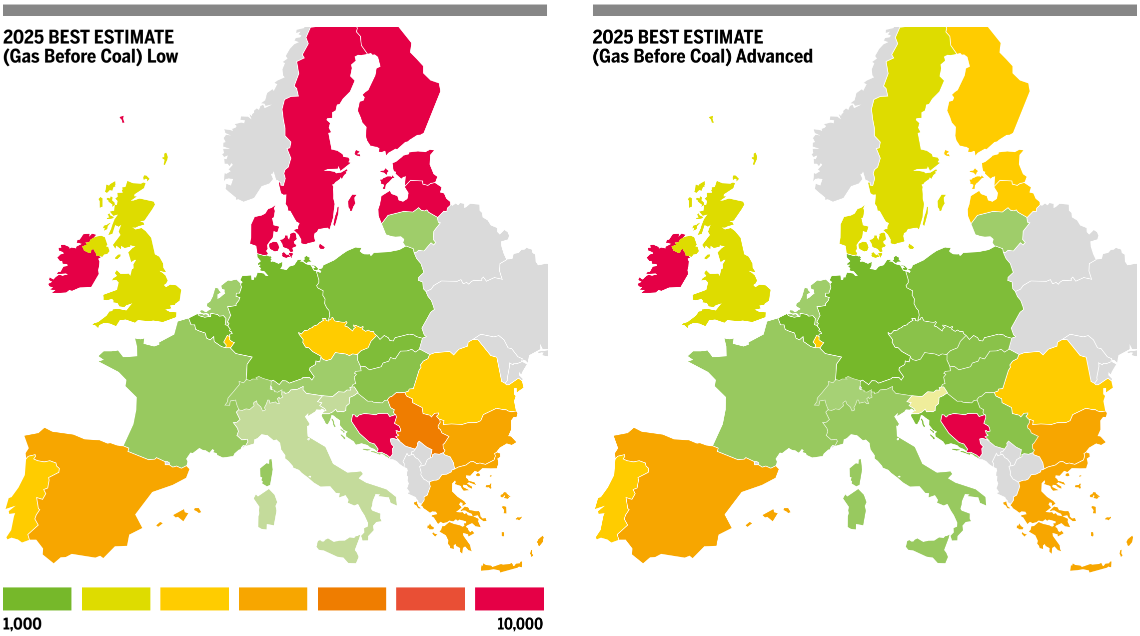


Figure 5.36 LNG and Interconnection Capacity Diversification – 2025 – Low and Advanced infrastructure levels.

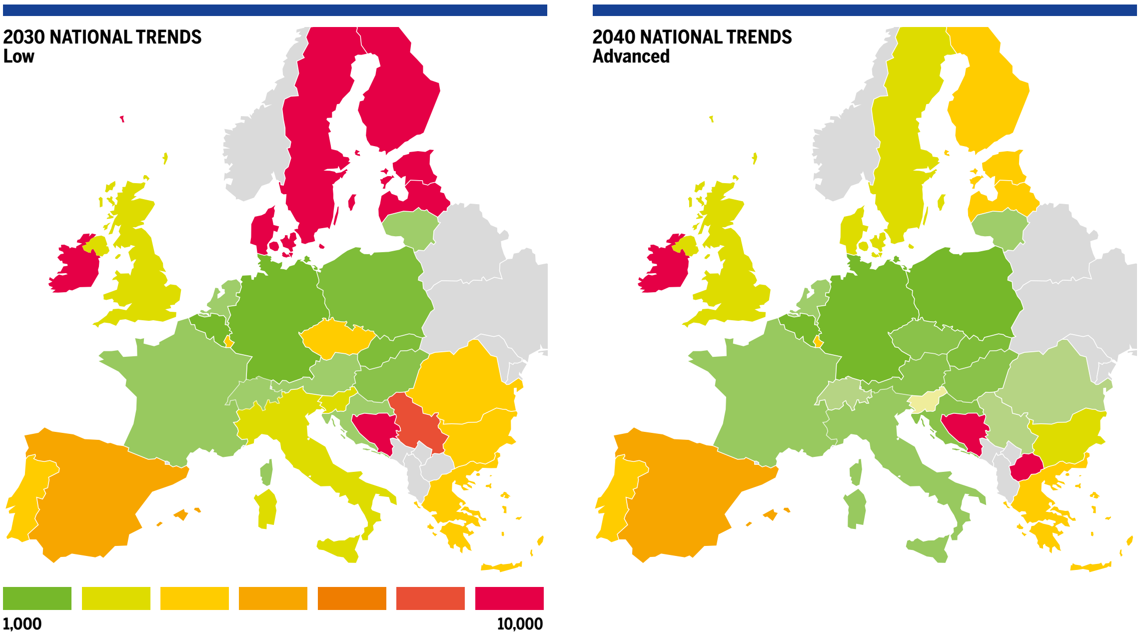


Figure 5.37 LNG and Interconnection Capacity Diversification – 2030 – Low and Advanced infrastructure levels.

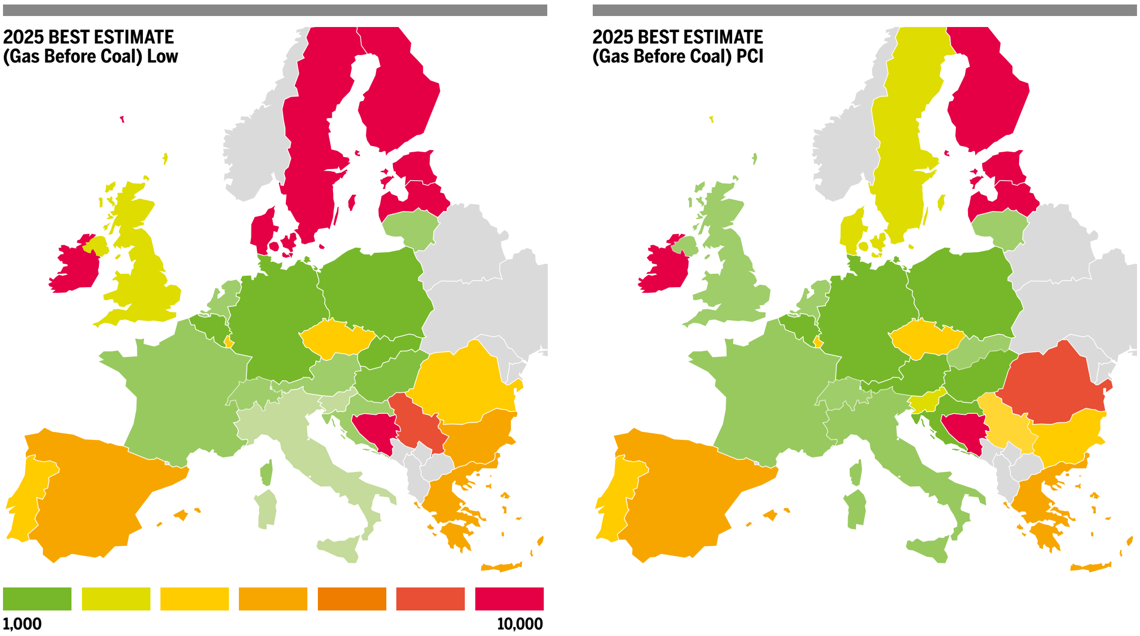


Figure 5.38 LNG and Interconnection Capacity Diversification – 2025 – Low and PCI infrastructure levels.

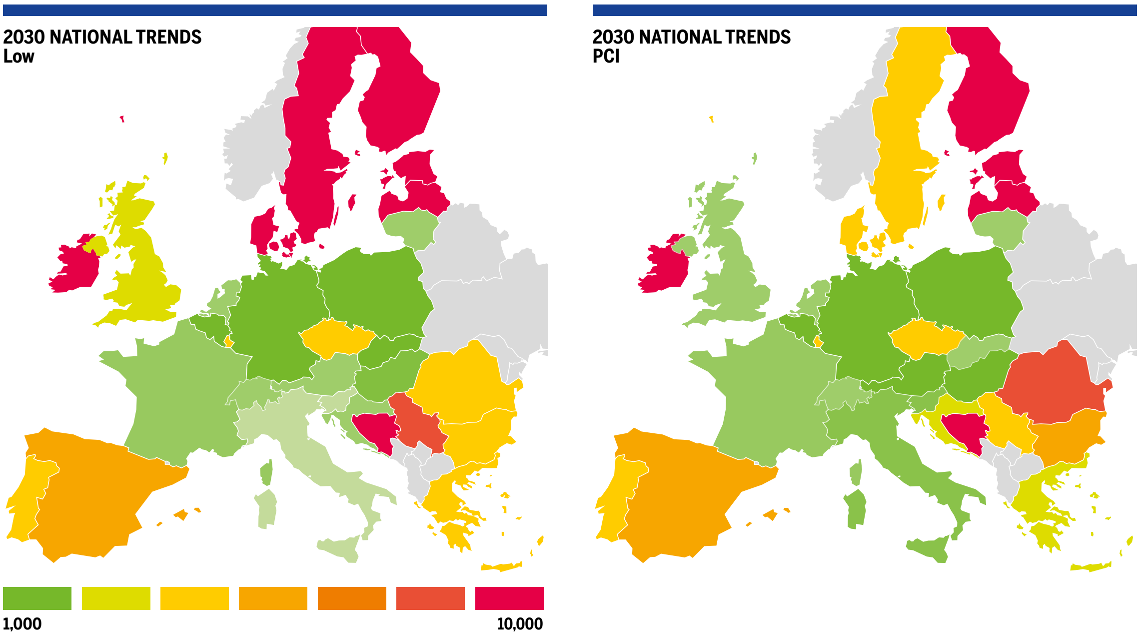


Figure 5.39 LNG and Interconnection Capacity Diversification – 2030 – Low and PCI infrastructure levels.

5.4 COMMERCIAL SUPPLY ACCESS (CSA) AND SUPPLY SOURCE DIVERSIFICATION INDEX (SSDi)

INTRODUCTION

The access to different supply sources is a prerequisite for competition. The ability to have access to different supplies, as well as the volumes of these supplies, is taken into account for the identification of supply diversification needs.

The Commercial Supply Access indicator (CSA) measures the number of supply sources (including national production as a source) an area can commercially access.

This commercial supply diversification ability is calculated from a market perspective, as the ability of each area to benefit from a decrease in the price of the considered supply source (such ability does not necessarily mean that the area has a physical access to the source – **example presented on Figure 5.40**).

The ability of an area to access a given source is measured through the Supply Source Diversification indicator (SSDi). The SSDi is expressed as a percentage in the range 0 to 100 %, with e. g. 30 % corresponding to the supply cost of the area being 30 % responsive to a decrease in price of source S. The higher the SSDi, the better the access to source S from a price perspective. A country has been considered as having a significant access to a supply source when the SSDi to this source is higher than 20 %, which means that a decrease in the price of this supply source would impact at least 20 % of the country supply bill. Alternatively, an SSDi of 0 % means the country gets no benefit from a low price of the concerned source.

Of course, the indicated reference threshold must be read considering the demand of each country. For the larger gas markets, a lower threshold could be relevant to indicate diversification provided by some supply sources – **example presented on Figure 5.41**.

In the following, all results are presented using a 20 % threshold in continuity with the previous TYNDP and PCI selection processes.

General observation is whenever one country is having high score of specific SSDi comparing to countries in same area, it means that there is an infrastructure limitation preventing sharing benefit of cheap gas from this specific source. Along with next levels of infrastructure in the Europe, countries are more able to share cheap gas between themselves.

Figure 5.40 Example: Hungary can benefit from a decrease in the price of the LNG even if country has no direct physical connection to LNG terminal

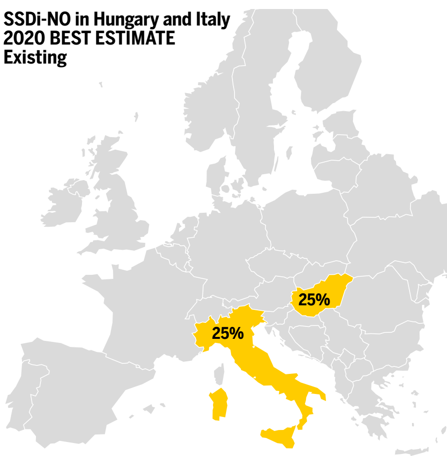


Figure 5.41 Example: SSDi in Italy and Hungary are at the same level but 25 % of demand in Italy in this scenario and year is more than 5 time bigger than in Hungary.

5.4.1 EXISTING INFRASTRUCTURE LEVEL

SSDi results for Existing infrastructure level across the Europe are influenced only by specific scenario assumption such as demand and national production. Analysing specific scenarios, there is possibility to assess evolution of the indicator values. Infrastructure remains unchanged in all years.

In Existing infrastructure level most of the countries are not passing 20 % threshold (and be counted in CSA) for national production. In the same time, SSDi result for LNG in most of the countries oscillates around 20 % threshold and show below or above values depending on the combination of demand and NP values for countries in Europe. Those results are having the most significant influence on CSA results (**presented on Figure 5.42**).

2020–2025

Most countries in the centre of the EU access 3 supply sources or more (mainly LNG, Norway and Russia), however peripheral EU regions of Central-East, the Baltics and the Iberian Peninsula access mainly 2 sources.

- Iberian Peninsula has access mainly to LNG and Algerian supply,
- The Baltic states and Finland to LNG and Russian Supply,
- CEE and South (Croatia, Hungary, Romania) access mainly the Russian and Norwegian supply.

National Trends

In 2030, despite the decreasing demand in the overall gas demand indicated in the NECPs, the coincident decline of conventional natural gas production and the very limited uptake of indigenous renewables shows a stabilisation of the situation. Some changes occur in Poland better accessing indigenous EU gas production and in Czech Republic and Slovakia with limited access to LNG.

In 2040, further decline in the demand changes the situation for the CEE region where most countries are having limited access to the LNG supply just below the selected threshold. The Baltic states and Finland as well as the Iberian Peninsula see no improvement in the National Trends scenario.

Distributed Energy and Global Ambition

North-Eastern Europe

The development of indigenous production of renewable gas in the EU, and in particular in the region, allows the Baltic states and Finland to diversify their commercial access up to 3 sources in 2040 for both scenarios (as of 2030 for Distributed Energy), while supporting an increasing gas demand mainly driven by the transport and power sectors.

Central-Eastern Europe

In 2030, compared to National Trends, Slovakia and Hungary keep on having a commercial access to the LNG supply, whereas Poland sees its access to LNG more limited (from 23 % in 2025 to 14 % in 2040).

Iberian Peninsula

In 2030, the situation remains similar for all scenarios with a commercial access limited to LNG and Algerian supply.

In 2040, the combination of a decreasing gas demand and penetration of indigenous renewable and decarbonised gases allows the region to commercially access the Norwegian supplies in Global Ambition 2040. In Distributed Energy 2040, the more significant uptake of indigenous renewable and decarbonised gases production brings a significant access to national production.

Elsewhere in the EU, in Global Ambition, the increasing penetration of indigenous renewable and decarbonised gases does not compensate the overall decrease in conventional national production and therefore, the higher demand in Global Ambition translates into more restricted benefits from a low price of the different supplies: most of central Europe access only Norwegian and Russian supplies whereas western Europe additionally access LNG and to some extent, Algerian supply.

In Distributed Energy, the decreasing demand combined with higher penetration of new indigenous gas production allow all European countries to access 3 sources or more in 2030 and 4 sources in 2040, all including the new indigenous production. Only Romania is slightly below threshold in case of LNG supply source.

SSDi NP

Only few countries are passing 20 % threshold in SSDi – NP (beside of Distributed Energy 2040 where all countries are scoring for CSA mostly due to the significant penetration of renewable and decarbonised gas production)). Only Ireland and Romania are passing 20 % in all years and scenarios. Bulgaria, Greece and North Macedonia are passing the 20 % threshold in all scenarios and years except Best Estimate 2020. In other countries in some specific years and scenarios the threshold is passed (see detailed SSDi charts).

SSDi NO

The Norwegian supply has a significant maximum potential and is connected to countries which are well connected to the European market. This combination allows a large number of EU countries to benefit from a decrease in the Norwegian gas price.

Across all scenarios, the assessment confirms that most of the European countries are able to benefit from decrease in price of Norway gas besides Bulgaria, Estonia, Finland, Greece, Latvia, Lithuania, North Macedonia, Portugal, Romania and Spain. In Global Ambition 2040 Spain and Portugal are passing threshold as well.

SSDi LNG

Most of the countries can benefit in case of decrease in the LNG price, allowing them to pass 20 %. In Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czechia, Germany, Hungary, Netherlands, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia and Sweden situation is changing across scenarios and years and it can be tracked on detailed SSDi charts below. Most of the changes are in Global Ambition and National Trends scenarios.

SSDi RU

All countries, with the exception of Portugal and Spain are passing the 20 % threshold.

SSDi DZ

Over Europe only Italy, Portugal and Spain are passing 20 % threshold in all scenarios. This situation is mainly due to the relative limited volumes imported from Algeria via pipelines compared to the European demand. Therefore, the Algerian supply cannot influence to a significant extent the SSDi indicator of many countries.

SSDi CA (Caspian)

In this infrastructure level, no country is passing 20 % threshold. Like for the Algerian supply, this situation is explained by the limited volumes that can be imported for the Caspian region with the existing capacities compared to the EU demand. Therefore, a decrease in price of the Caspian supply can influence the cost of gas supply for some countries. However, no country can show a significant impact of the Capsian supply on its SSDi indicator.

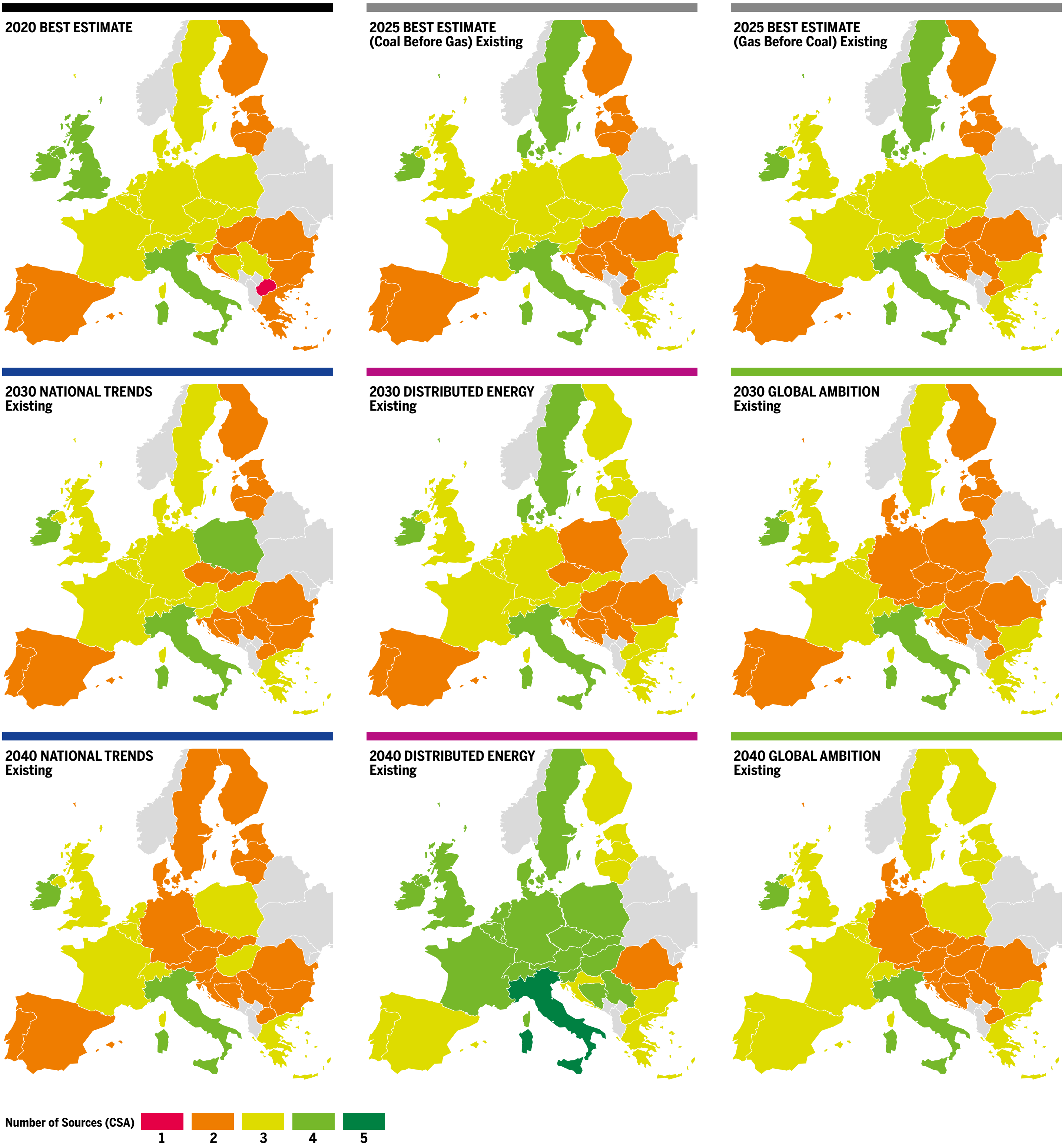


Figure 5.42 CSA – Existing infrastructure level

DETAILED RESULTS FOR SSDi OVER THE EUROPE IN EXISTING INTRASTRUCTURE LEVEL.

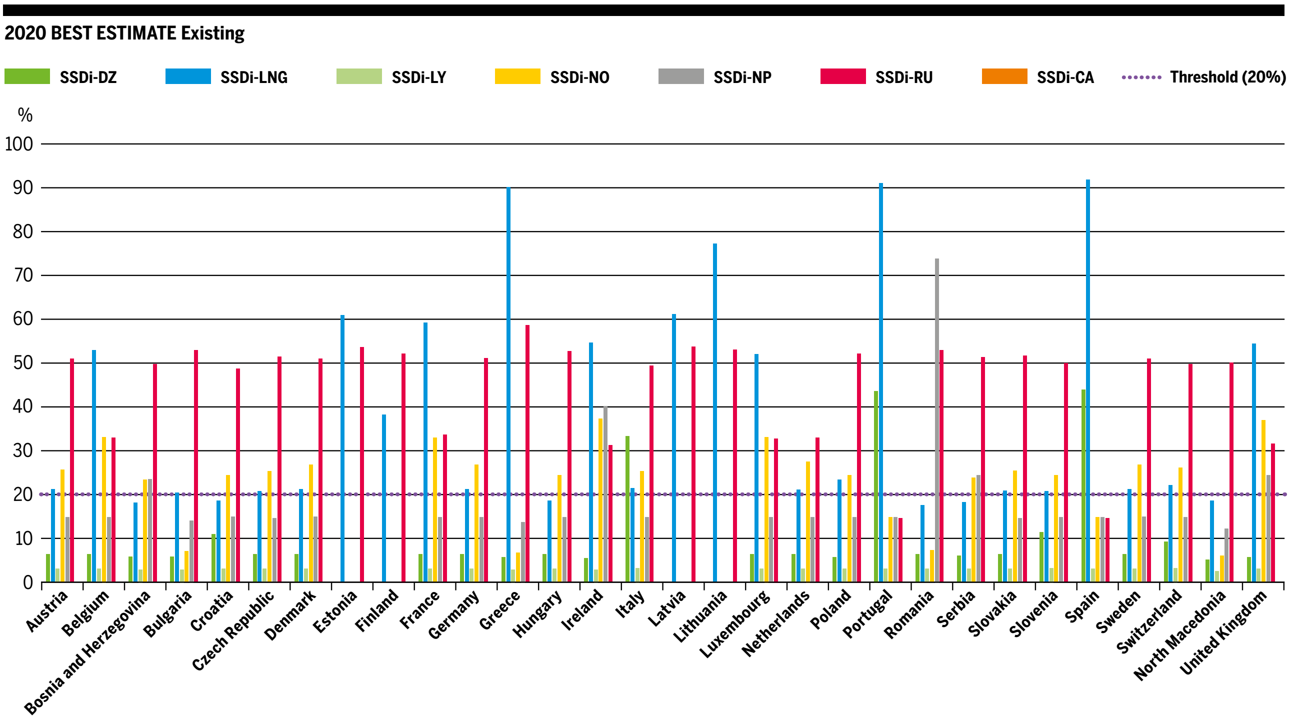


Figure 5.43 SSDi – Existing infrastructure level – Best Estimate 2020

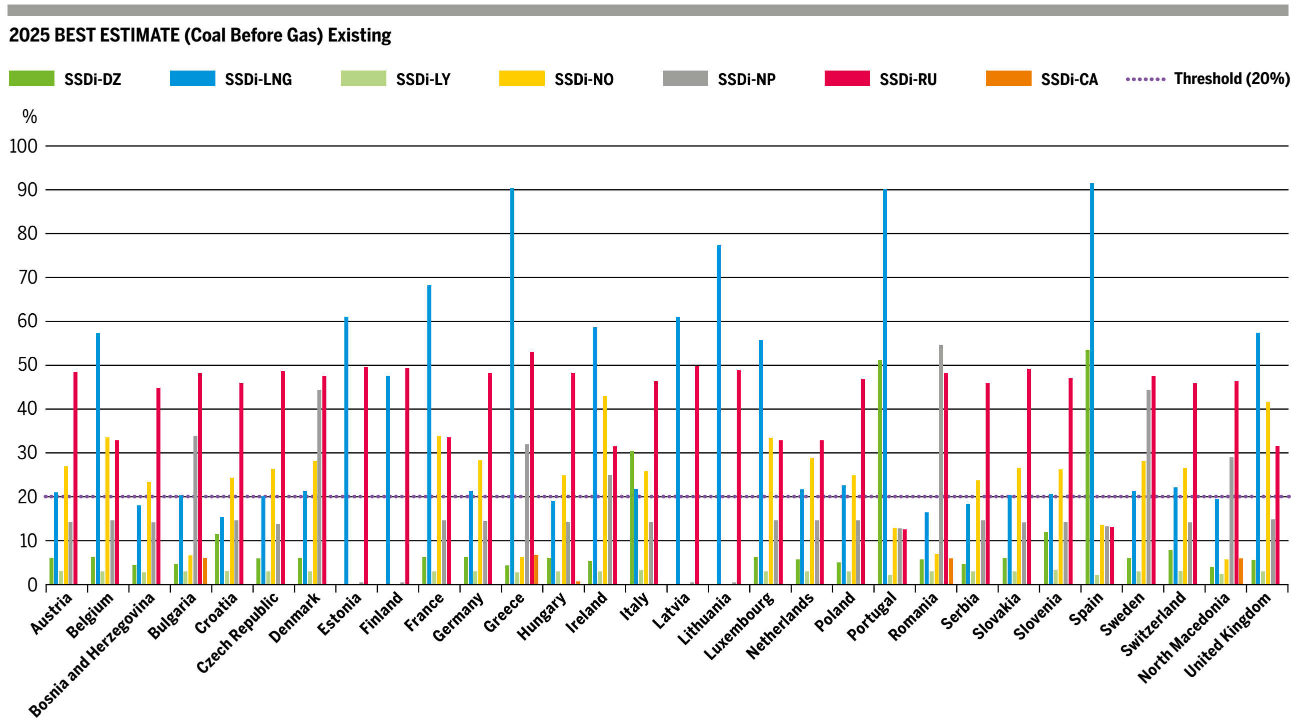


Figure 5.44 SSDi – Existing infrastructure level – Coal Before Gas 2025

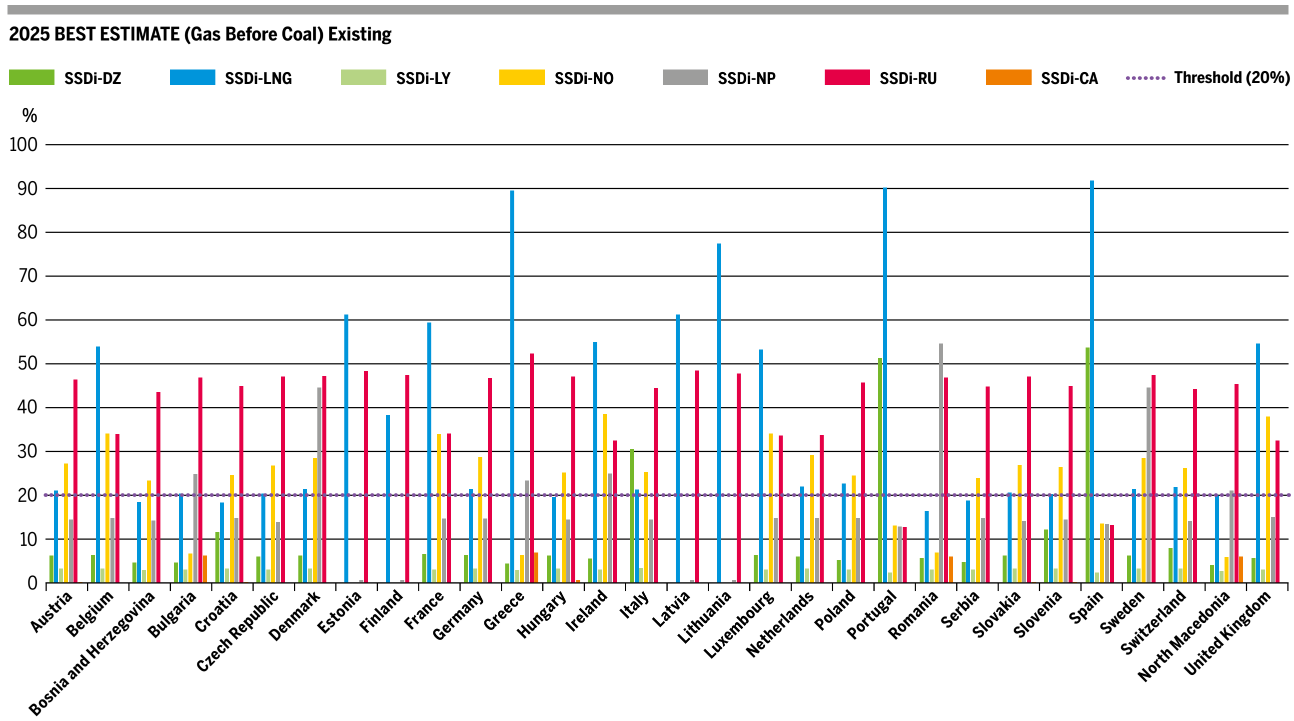


Figure 5.45 SSDi – Existing infrastructure level – Gas Before Coal 2025

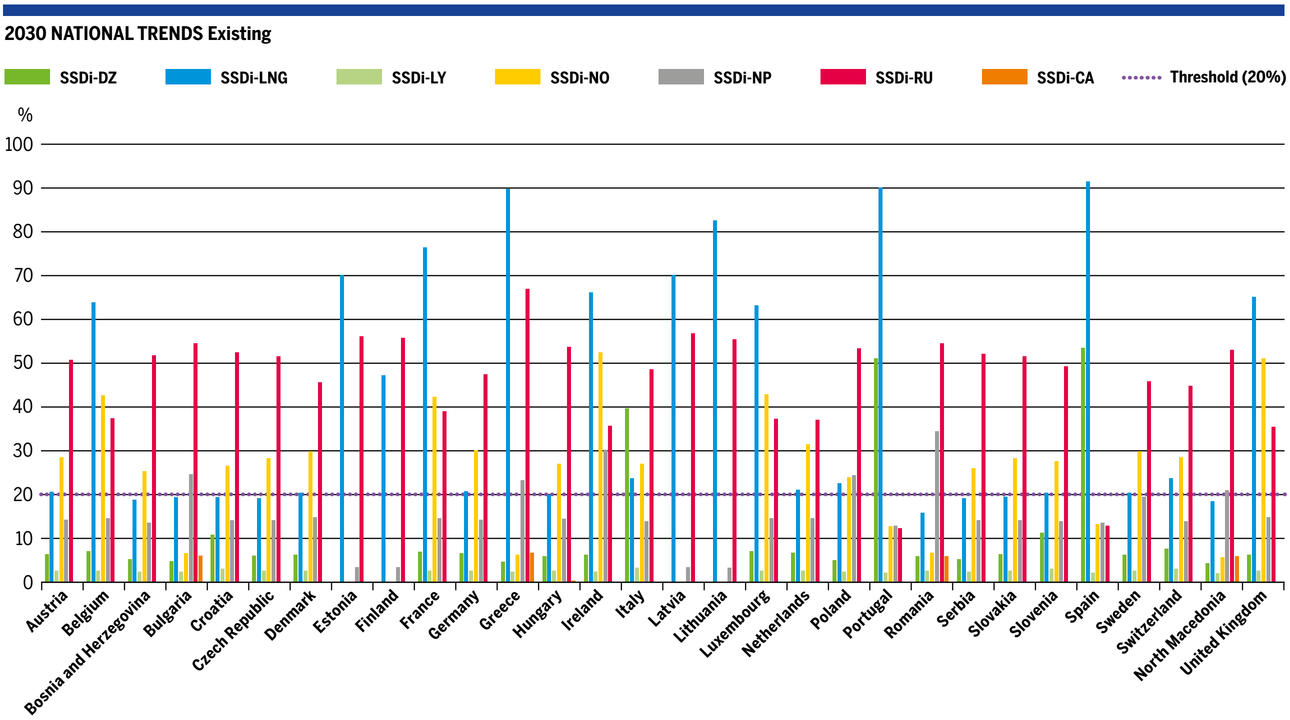


Figure 5.46 SSDi – Existing infrastructure level – National Trends 2030

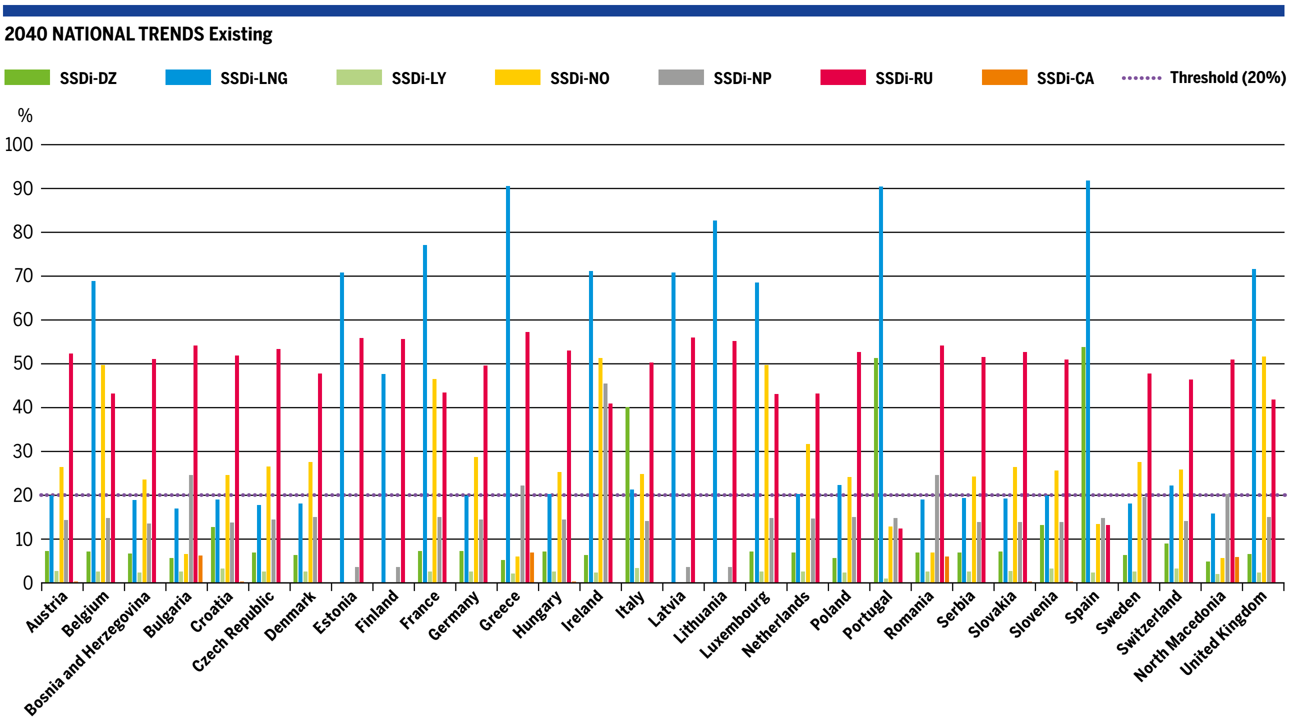


Figure 5.47 SSDi – Existing infrastructure level – National Trends 2040

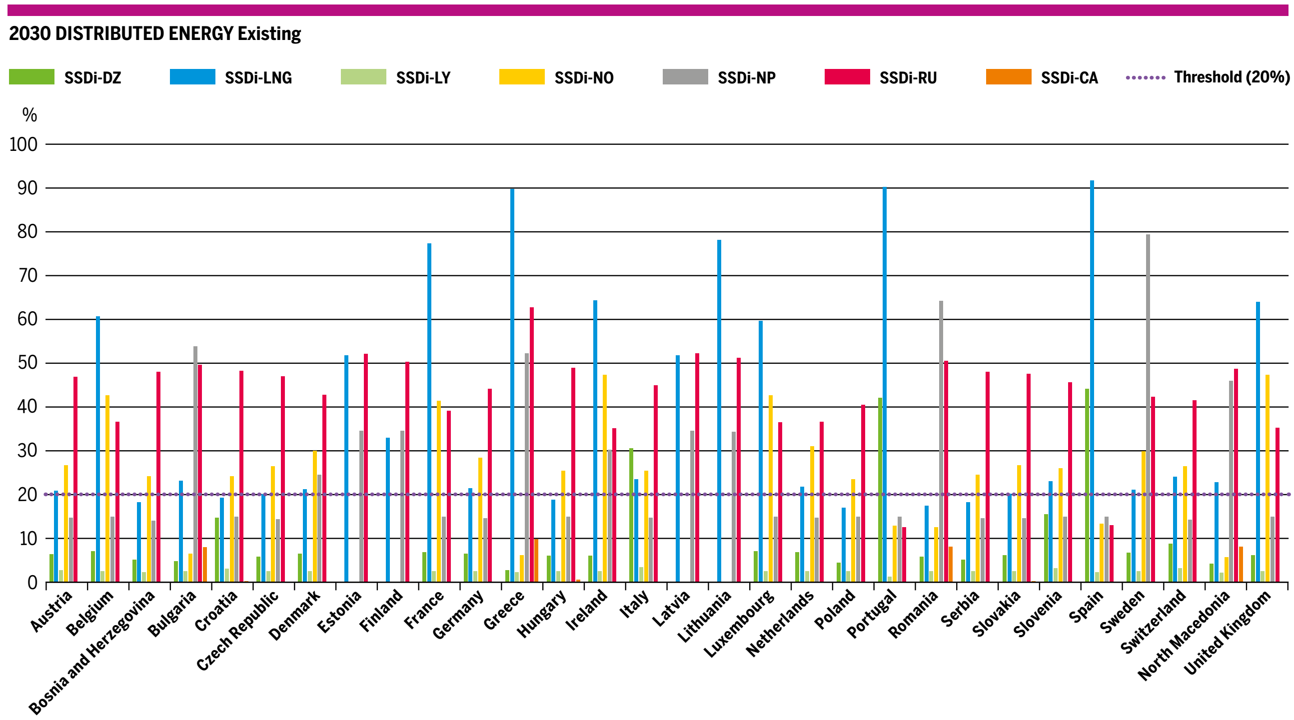


Figure 5.48 SSDi – Existing infrastructure level – Distributed Energy 2030

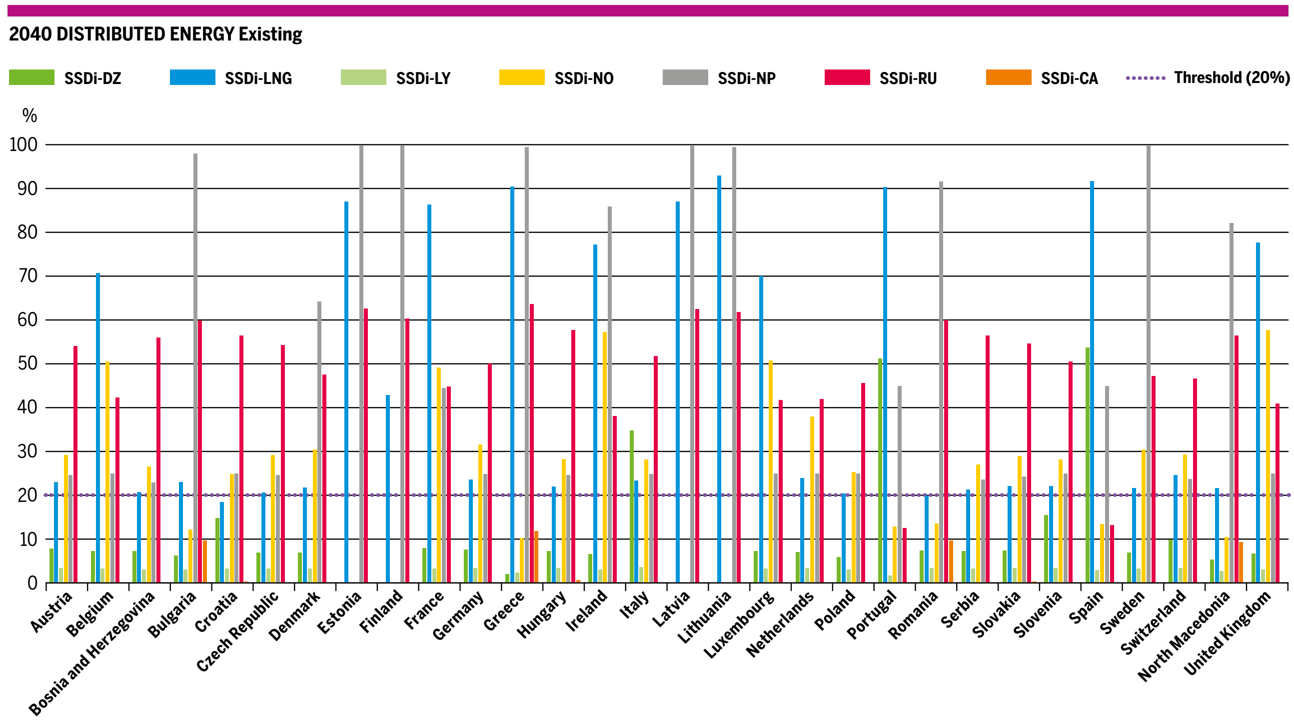


Figure 5.49 SSDi – Existing infrastructure level – Distributed Energy 2040

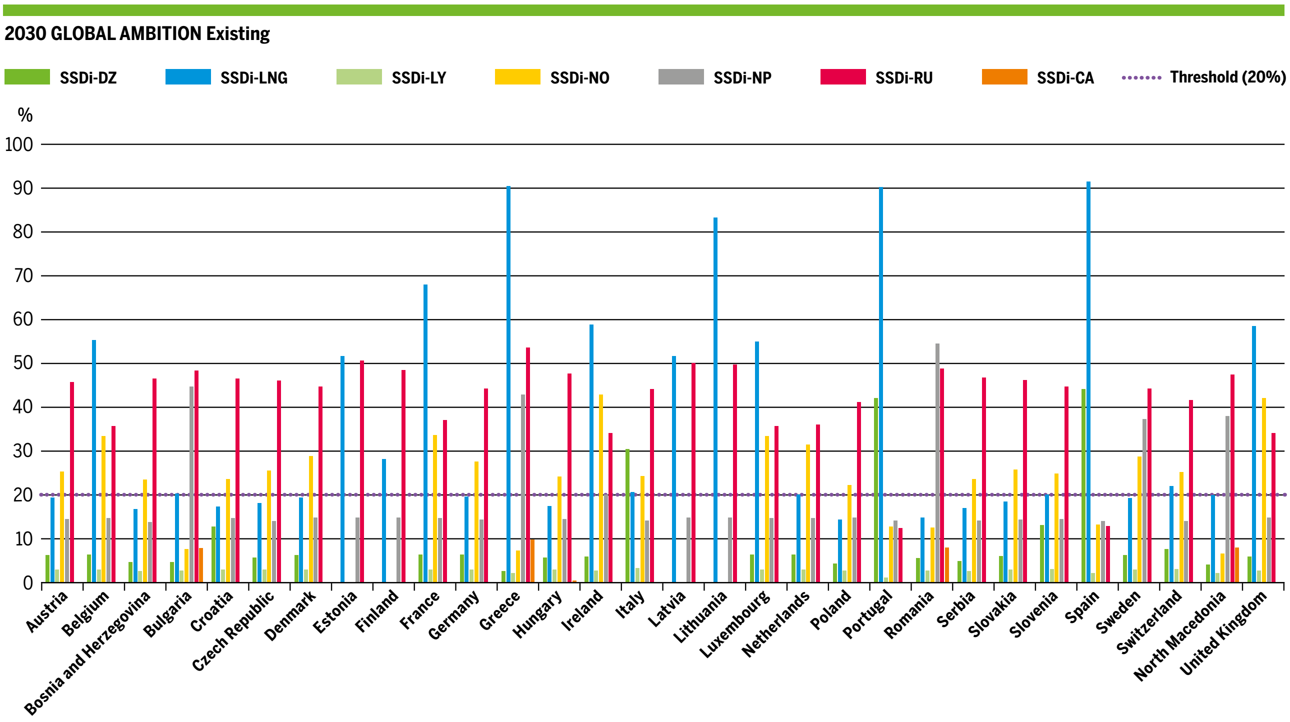


Figure 5.50 SSDi – Existing infrastructure level – Global Ambition 2030

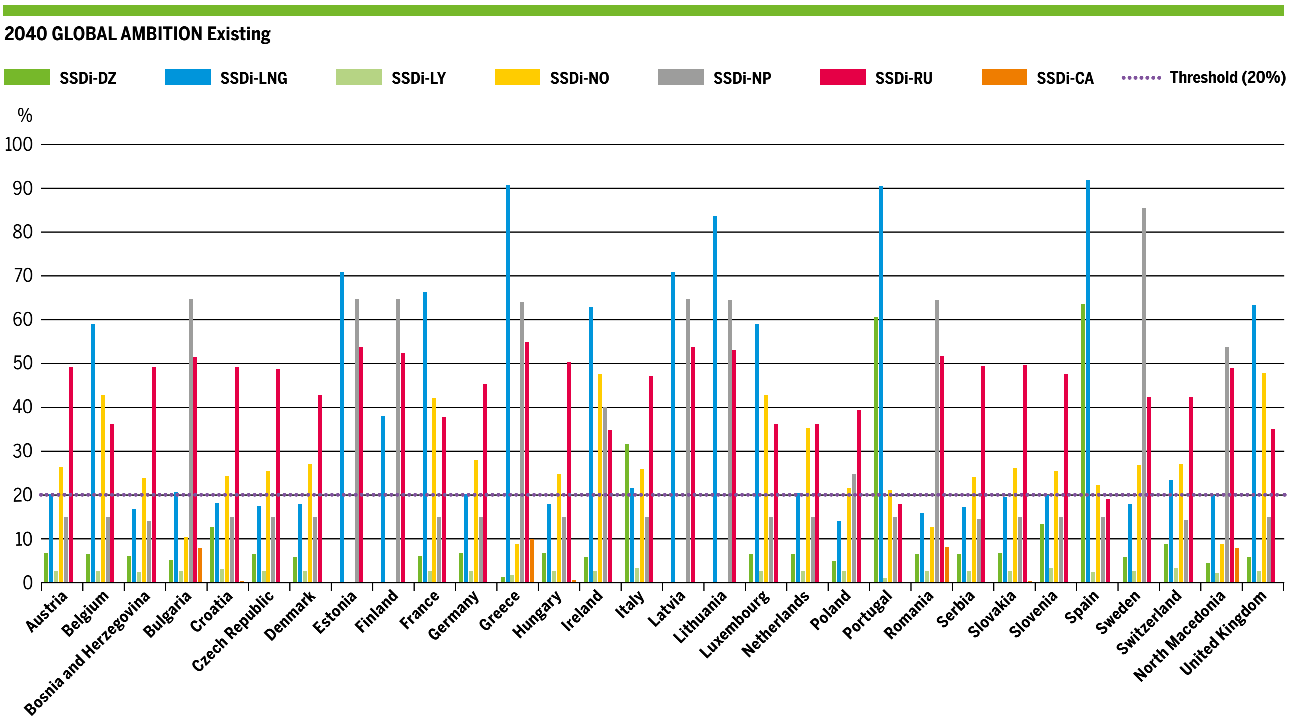


Figure 5.51 SSDi – Existing infrastructure level – Global Ambition 2040

5.4.2 LOW INFRASTRUCTURE LEVEL

FID projects composing the low infrastructure level improve the Commercial Supply Access indicator for most countries. New investments are increasing the capability of the Member States to benefit more from a decrease in the price of the different supply sources. Apart from transmission infrastructure investments, this infrastructure level provides additional LNG import capacity.

Note: It is important to remember that new infrastructure can potentially allow a country to share additional cheap gas. This would result in affecting SSDi results also by lowering it in a country which was previously showing a relatively high score compared to its neighbouring countries. In some of the cases it might even result in a drop below 20 % threshold. However, it still means that convergence in specific region improves and allows to share cheap source of gas in higher volumes, benefitting to the overall EU social-economic welfare.

SSDi value might change even if CSA remains the same. Changes in SSDi values can be observed in detailed SSDi charts.

RESULTS

2025

The impact of the FID projects on the CSA is visible as of 2025 with most countries accessing 3 supply sources in both scenarios in Baltic states and Finland (having access to Norwegian gas), and Balkan region improving access to national production in Bosnia and Herzegovina, Croatia, Serbia and Hungary. Indigenous gas produced in the region, thanks to FID projects, has a better distribution which reduce its share in Bulgaria and Greece going below threshold.

National Trends

2030: With a decreasing European demand and a rather limited development of indigenous renewable gases, the impact of the FID projects keeps on being visible in 2030 with most of the EU being able to benefit from a decrease in price of 3 or more supply sources. The Iberian Peninsula is the only region accessing 2 supply sources (LNG and Algeria) and Greece, Bulgaria and North Macedonia (LNG and Russian gas).

2040: the gas demand decreases, partially compensated by the penetration of gas in the transport. However, the limited development of indigenous renewable gases does not compensate for the decline of the conventional national production, especially in the Balkan region. Therefore, in 2040, the assessment shows that the situation in term of Market Integration in South-Eastern Europe deteriorates with Romania, Bulgaria and Greece accessing only 2 supply sources.

Distributed Energy and Global Ambition

Most significant improvements from CSA perspective can be observed in Baltic State Region and South – Central Europe. New infrastructure is allowing to access more LNG and NO gas allowing to reach 20 % threshold.

According to assumptions, results for Best Estimate 2020 are not changing together with infrastructure level and map (contoured with dotted line) is provided for comparison purpose only.

See Figure 5.52.

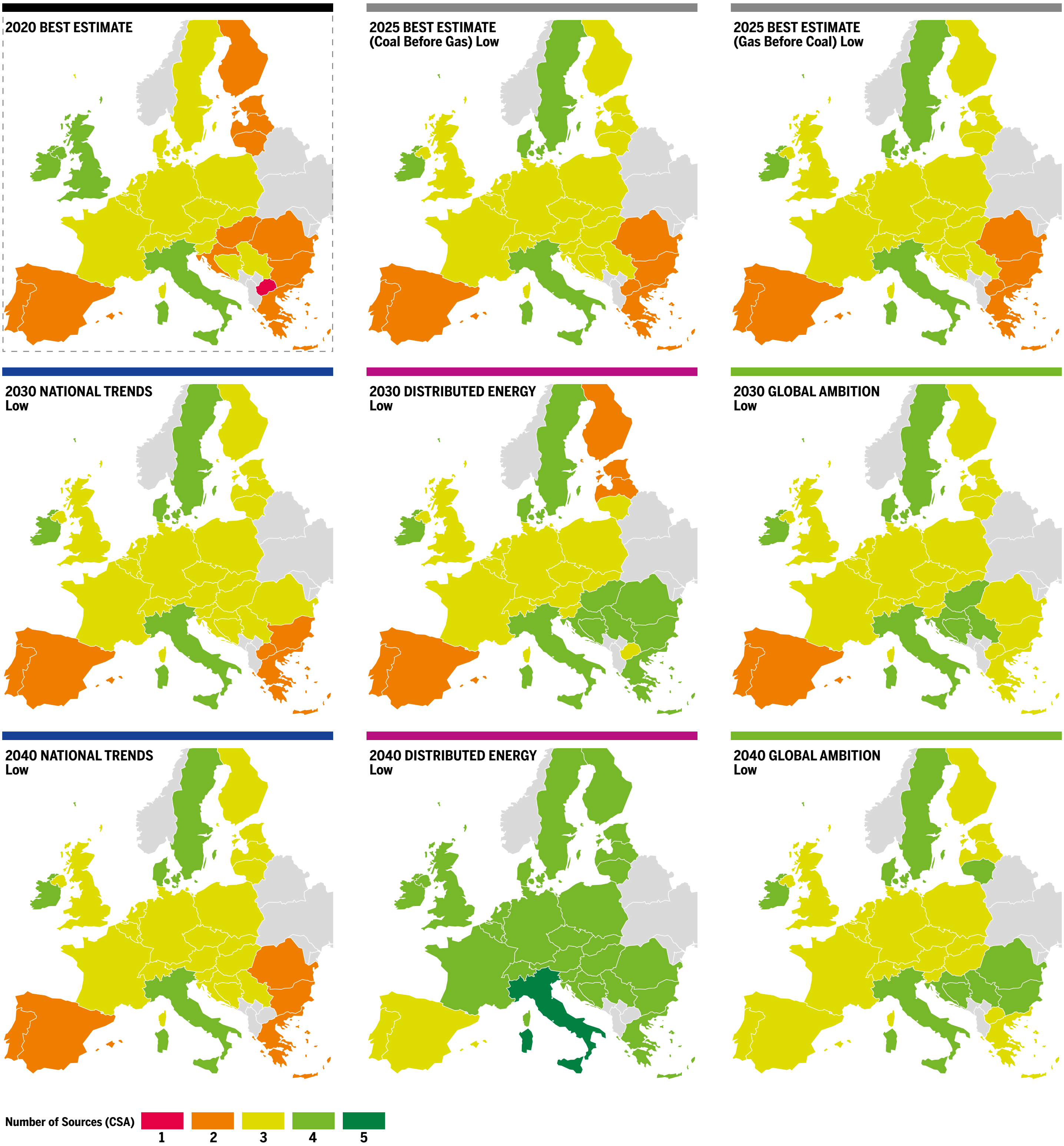


Figure 5.52 CSA – Low infrastructure level

SSDi NP

Comparing with Existing infrastructure level, Low infrastructure level is bringing investments allowing to share more gas from national production across the Europe. Considering the previous infra configuration some of the countries were having limited possibilities to share gas from national production, but together with additional infrastructure they can share more, even if the gas from national production was having origins in different, well connected neighbour. That is why in specific scenarios and years, in countries like Bulgaria, Estonia, Finland, Greece, Latvia, Lithuania, Poland and North Macedonia result for SSDi NP is dropping below 20 % in certain years. Thanks to infrastructure investments situation improves in Bosnia and Herzegovina, Croatia, Denmark, Hungary, Serbia and Sweden.

SSDi NO

FID projects bring significant improvement, allowing to cross 20 % threshold in this SSDi. Improvement in various years and scenarios can be observed in Bulgaria, Estonia, Finland, Greece, Latvia, Lithuania, North Macedonia and Romania. Most vital in this case seems to be improvement in Baltic states region connecting them to rest of the Europe and investments in South East Europe region.

SSDi LNG

SSDi LNG is one of the indicators being significantly improved across Europe. Even if the value is not changing drastically (in some of the cases improvement about 2 or 3 percentiles) it allows some countries to score above the 20 % threshold. In Low infrastructure level all countries across the EU (Beside Romania in Coal Before Gas and Gas Before Coal 2025) can benefit from a decreasing price of the LNG supply. That Improvement was observed in Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Denmark, Germany, Hungary, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia, Sweden.

SSDi RU

No change comparing with Existing infrastructure level.

SSDi DZ

No change comparing with Existing infrastructure level.

SSDi CA (Caspian)

No change comparing with Existing infrastructure level.


Picture courtesy of GAZPROM

DETAILED RESULTS FOR SSDi OVER THE EUROPE IN LOW INFRASTRUCTURE LEVEL

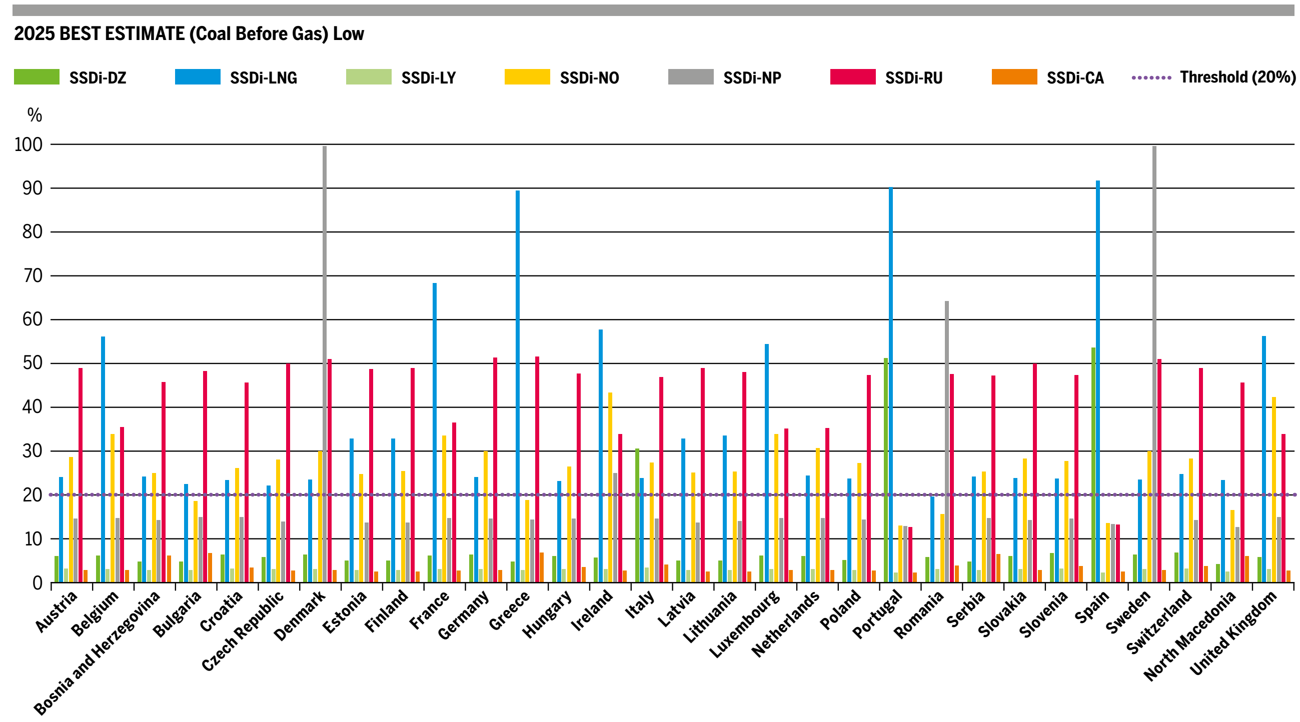


Figure 5.53 SSDi – Low infrastructure level – Coal Before Gas 2025

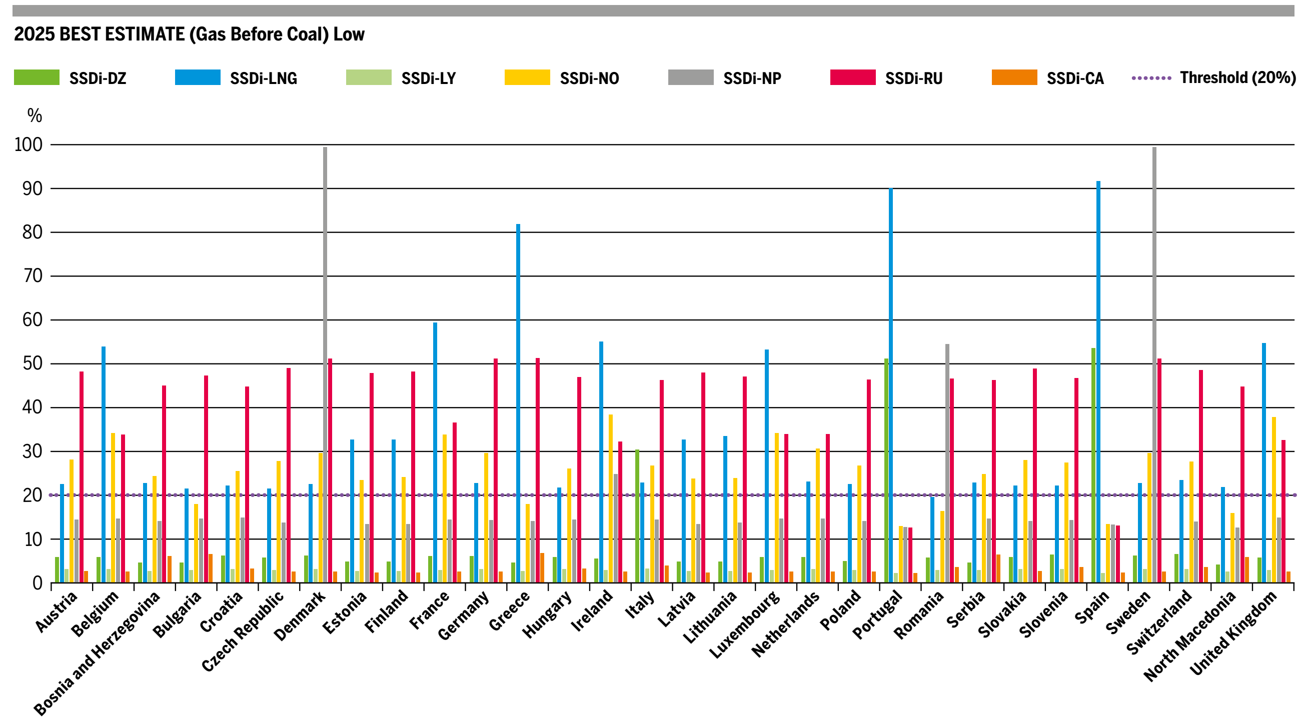


Figure 5.54 SSDi – Low infrastructure level – Gas Before Coal 2025

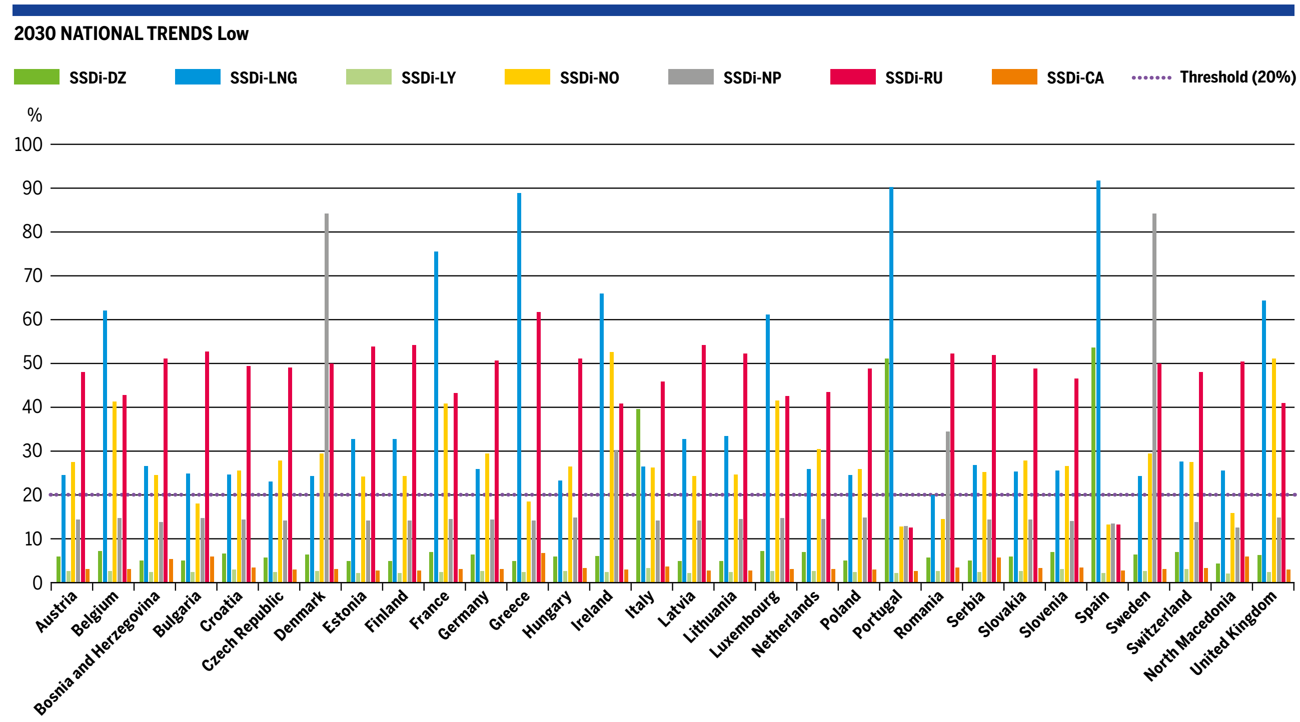


Figure 5.55 SSDi – Low infrastructure level – National Trends 2030

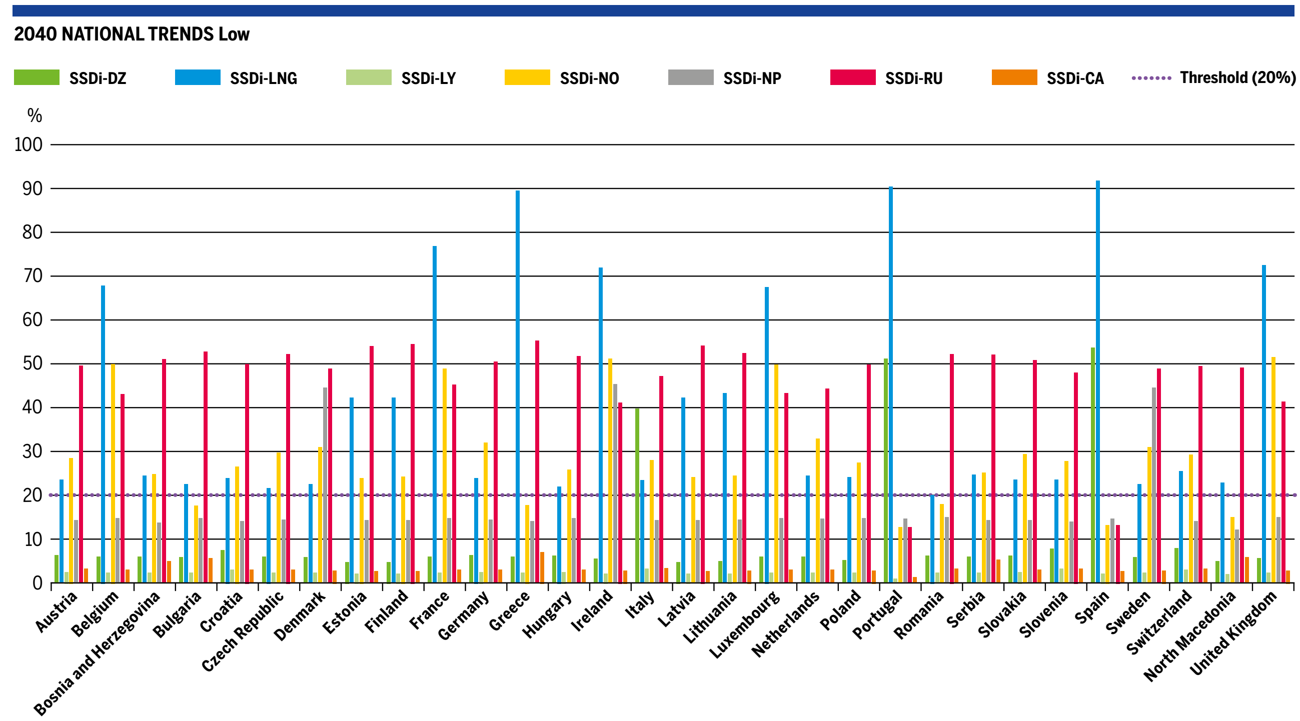


Figure 5.56 SSDi – Low infrastructure level – National Trends 2040

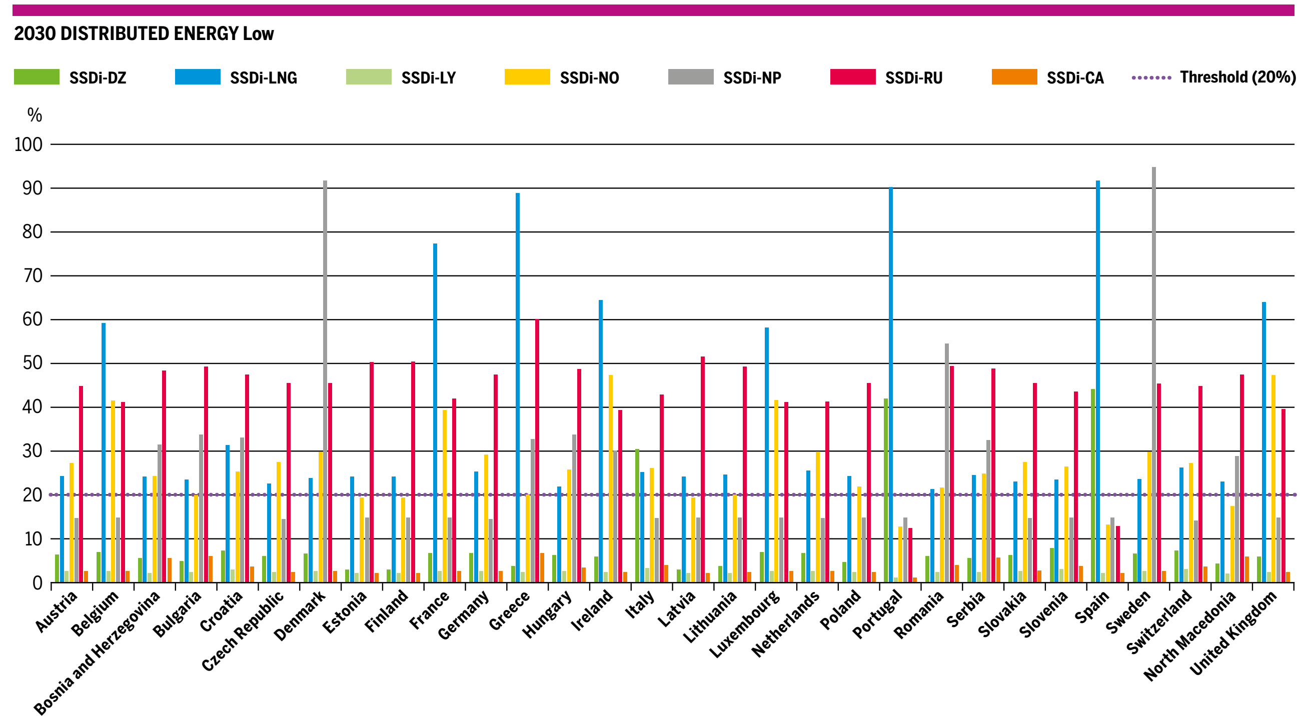


Figure 5.57 SSDi – Low infrastructure level – Distributed Energy 2030

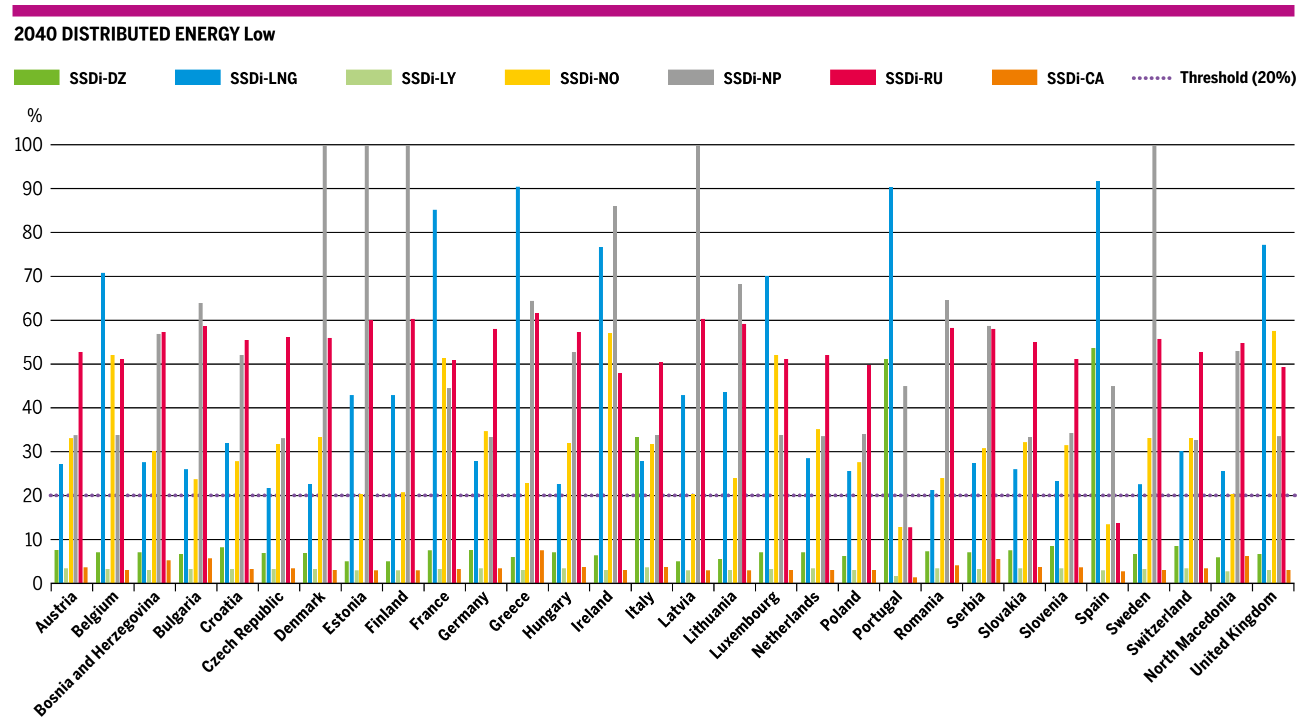


Figure 5.58 SSDi – Low infrastructure level – Distributed Energy 2040

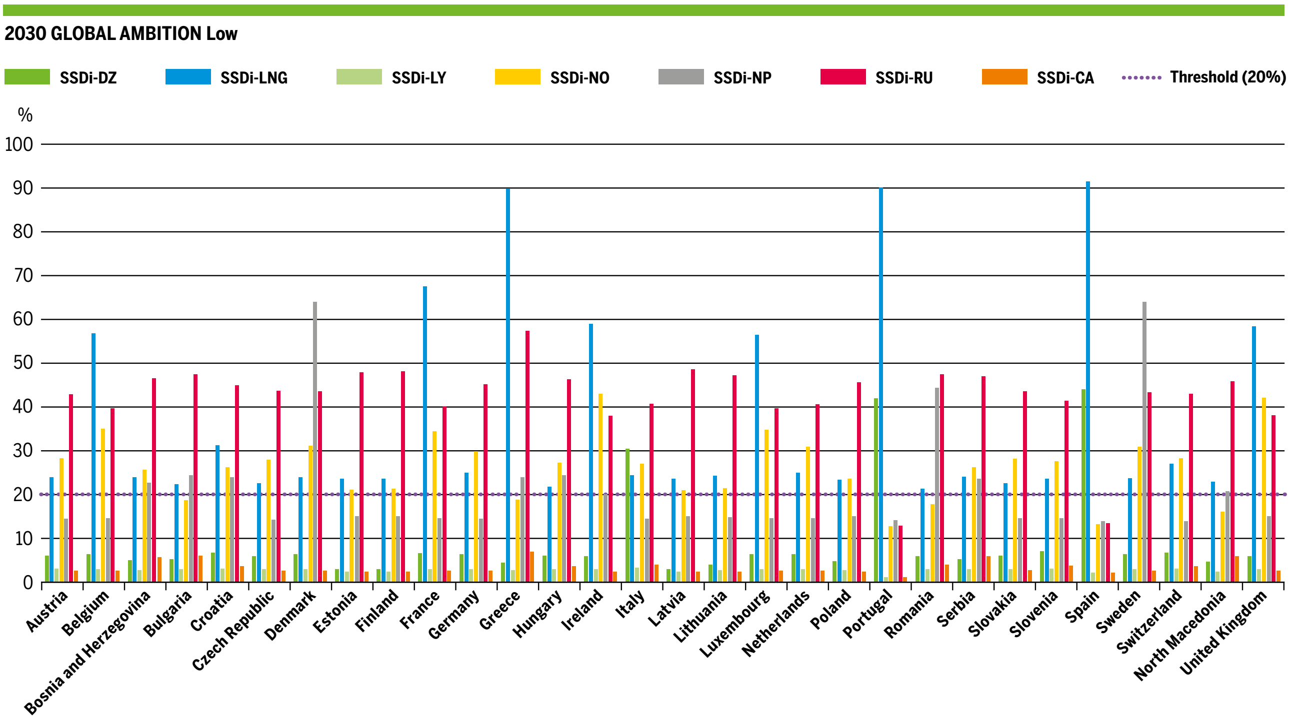


Figure 5.59 SSDi – Low infrastructure level – Global Ambition 2030

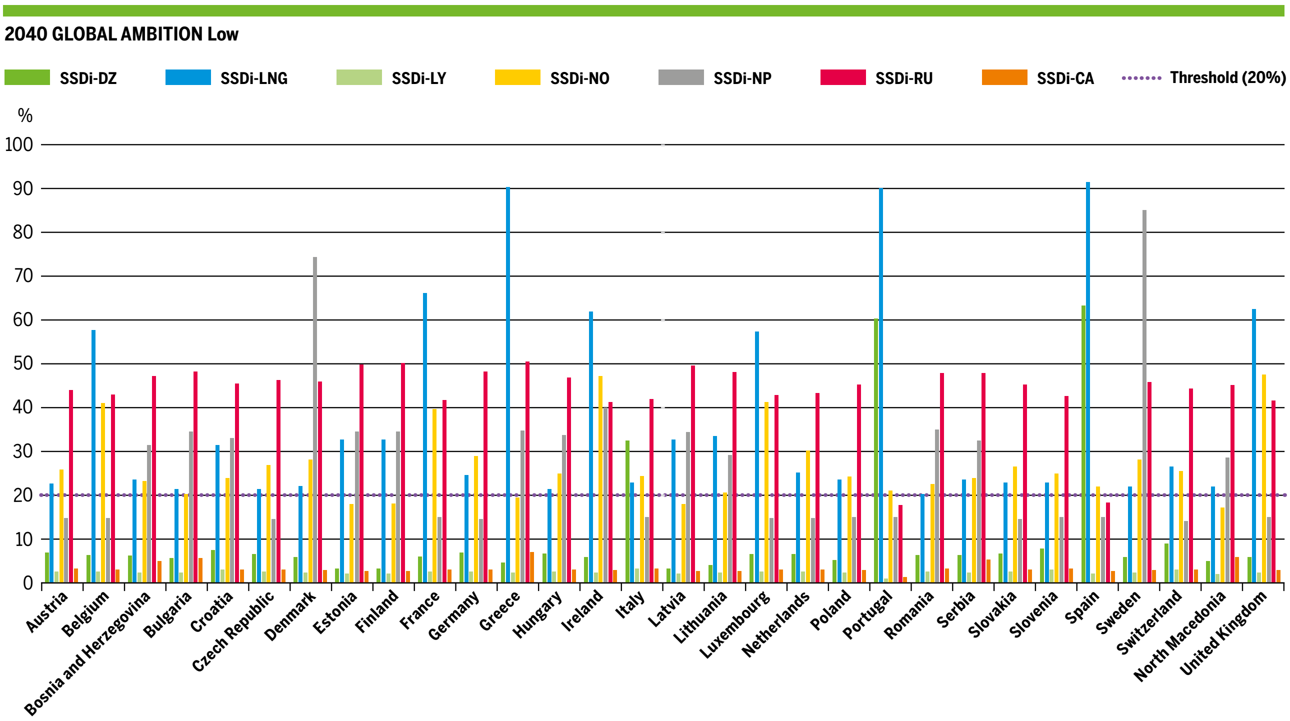


Figure 5.60 SSDi – Low infrastructure level – Global Ambition 2040

5.4.3 ADVANCED INFRASTRUCTURE LEVEL

Advanced projects are providing additional capacities between EU Countries compared to Low, including additional LNG capacities. During results evaluation process situation in Southern Europe and Baltic states improves further. In Global Ambition 2040 all countries in Europe beside North Macedonia are having at least 4 points in CSA indicator. Together with additional infrastructure level, results for Cyprus and Malta are provided.

2025

The impact of the advanced but not FID projects in comparison to FID projects alone on the CSA is visible, especially through improvement in East-South Europe. As of 2025 entire region access to 4 supply sources in both scenarios. This is achieved mainly through better access to national production and Norwegian gas. Denmark and Sweden through new infrastructure are in position to share national produced gas, going below 20 % threshold, loosing score for CSA.

National Trends

2030: Advanced projects improves situation in South East Europe allows to benefit from a decrease in price of 4 supply sources.

2040: limited development of indigenous renewable gases does not fully compensate for the decline of the conventional national production, especially in the Balkan region. Beside that fact, the assessment shows that the situation in term of Market Integration in Europe is significantly improved and countries are able to benefit from 3 or more supply sources when gas prices drops. Only Iberian Peninsula remains with access to two.

Distributed Energy and Global Ambition

Biggest improvements from CSA perspective can be observed in Baltic State Region and South – Central Europe. New infrastructure is allowing to access more LNG and NO gas allowing to reach 20 % threshold. In 2040 thanks to deep level of infrastructure development being implemented, relatively low demand and higher penetration of renewable gas sources, all the Europe can access 4 or 5 sources. Iberian Peninsula and North Macedonia remains with 3. **See Figure 5.61.**

Picture courtesy of SGI

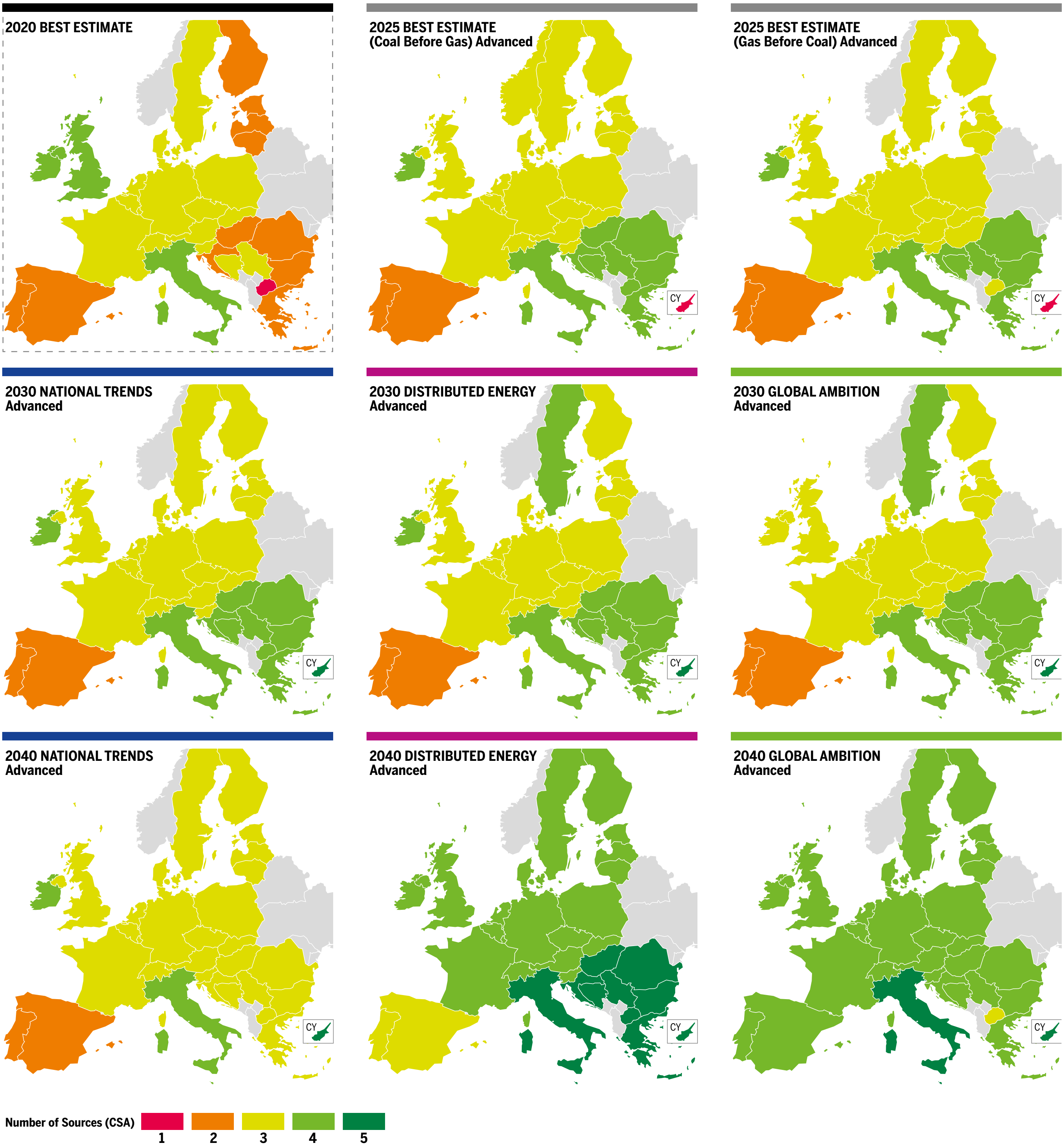


Figure 5.61 CSA– Advanced infrastructure level

SSDi NP

Same as in case of Low infrastructure level, Advanced is bringing investments allowing to share more gas from national production across the Europe. It can be again observed that some of the countries were having limited possibilities to share gas from national production, but together with additional infrastructure they can share more, even if the gas from national production was having origins in different, well connected neighbour. That is why, comparing situation to Low, in specific scenarios and years, countries like Denmark and Sweden result for SSDi NP is dropping below 20 %.

Due to infrastructure improvements in Distributed Energy and Global Ambition 2040 all countries in EU are passing 20 % for this indicator. Beside of that improvement, in specific scenario and year combination situation improves in Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, North Macedonia and Serbia.

SSDi NO

Compering with Low infrastructure level, in case of this indicator a significant improvement can be observed. Most of the European countries are crossing 20 % threshold. Only in Portugal and Spain there is no change, Cyprus is not crossing threshold in few scenario and year combination

SSDi LNG

In Advanced infrastructure level all countries in all scenarios and years are matching 20 % criterion to score for CSA. Only improvement in the meaning of passing 20 % was observed in Romania in 2025 Coal Before Gas and Gas Before Coal.

SSDi RU

No change comparing with Low infrastructure level in most of the countries. Only Cyprus, in both 2025 scenarios is not able to pass 20 % threshold but it improves further on.

SSDi DZ

No change comparing with Low infrastructure level in most of the countries. Only Cyprus, in both 2025 scenarios is not able to pass 20 % threshold but it improves further on. Malta in all scenarios is scoring for CSA.

SSDi CA (Caspian)

For the first time, together with Advance infrastructure level, countries like Bosnia and Herzegovina, Bulgaria, Croatia, Greece, Hungary, North Macedonia, Romania and Serbia are passing 20 % threshold and included CSA.

DETAILED RESULTS FOR SSDi OVER THE EUROPE IN ADVANCED INFRASTRUCTURE LEVEL

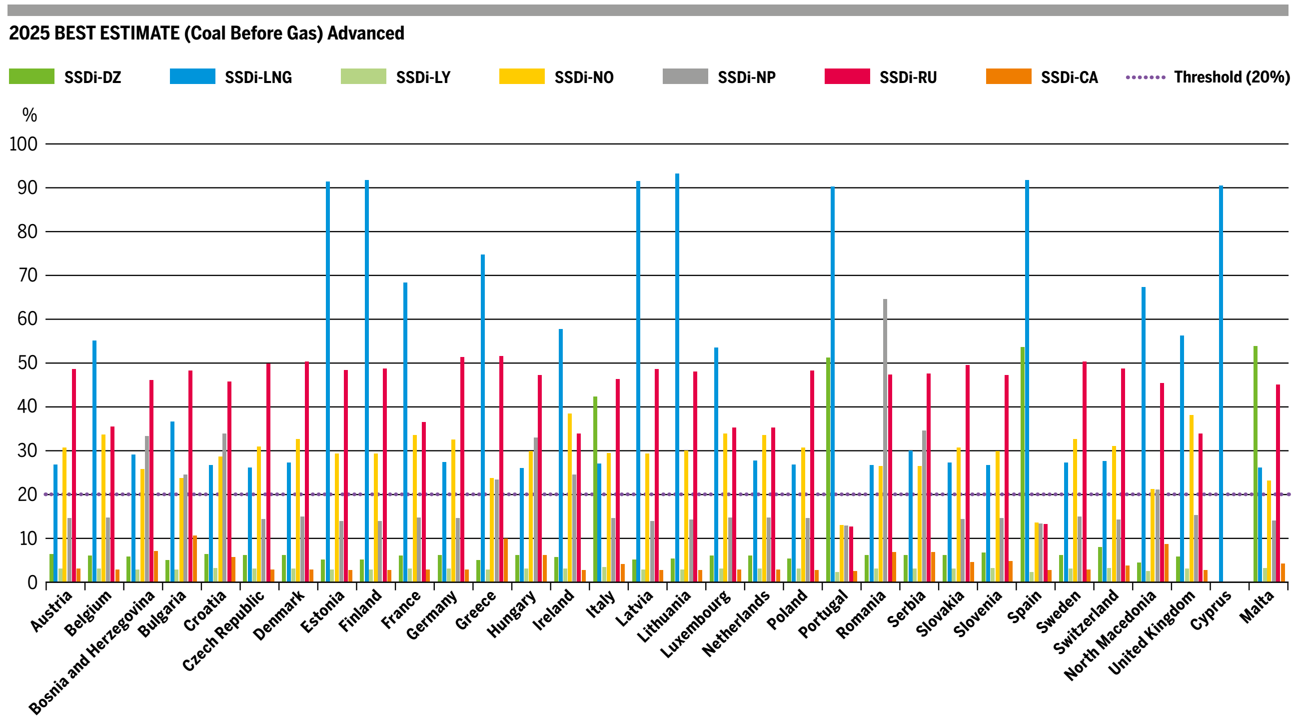


Figure 5.62 SSDi – Advanced infrastructure level – Coal Before Gas 2025

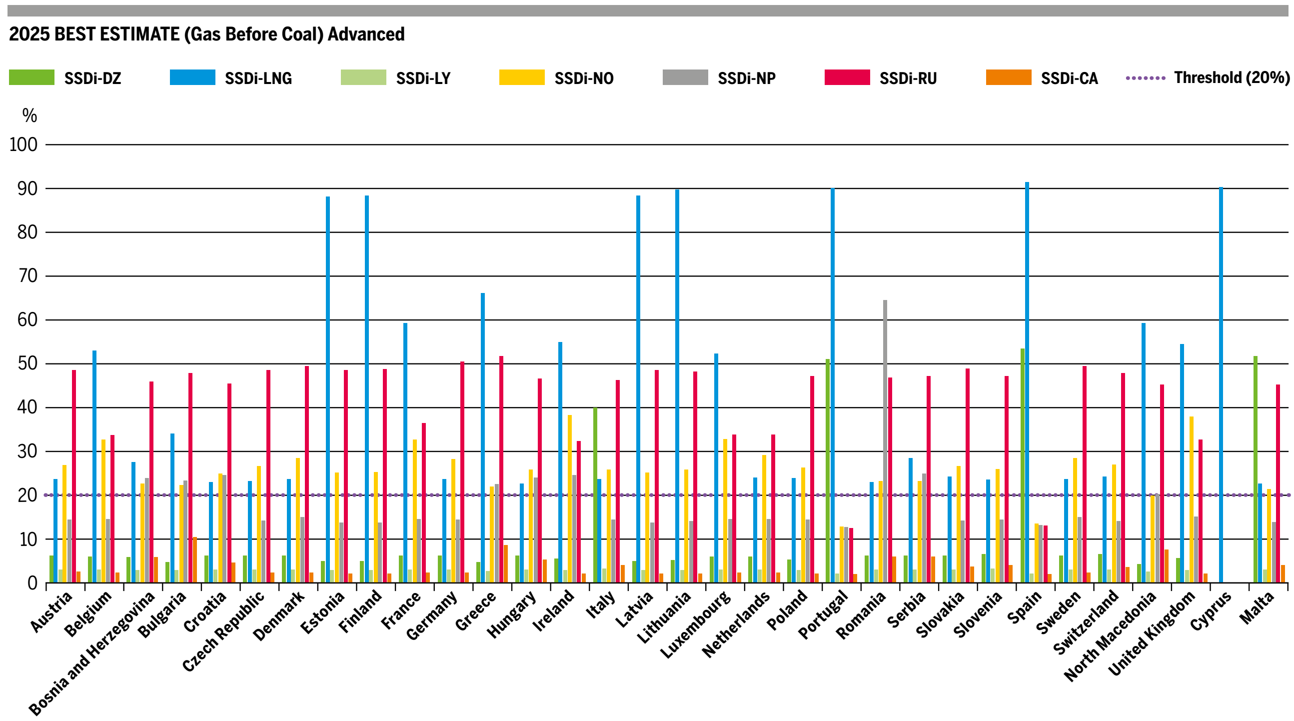


Figure 5.63 SSDi – Advanced infrastructure level – Gas Before Coal 2025

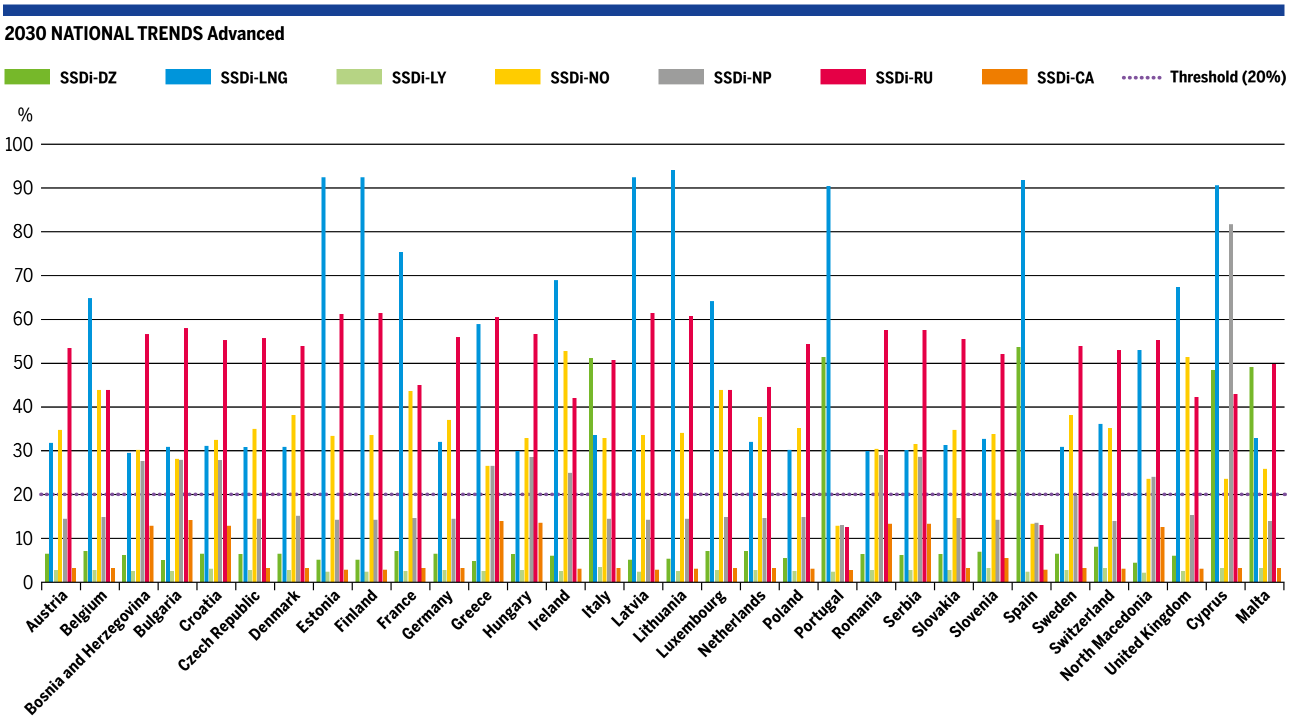


Figure 5.64 SSDi – Advanced infrastructure level – National Trends 2030

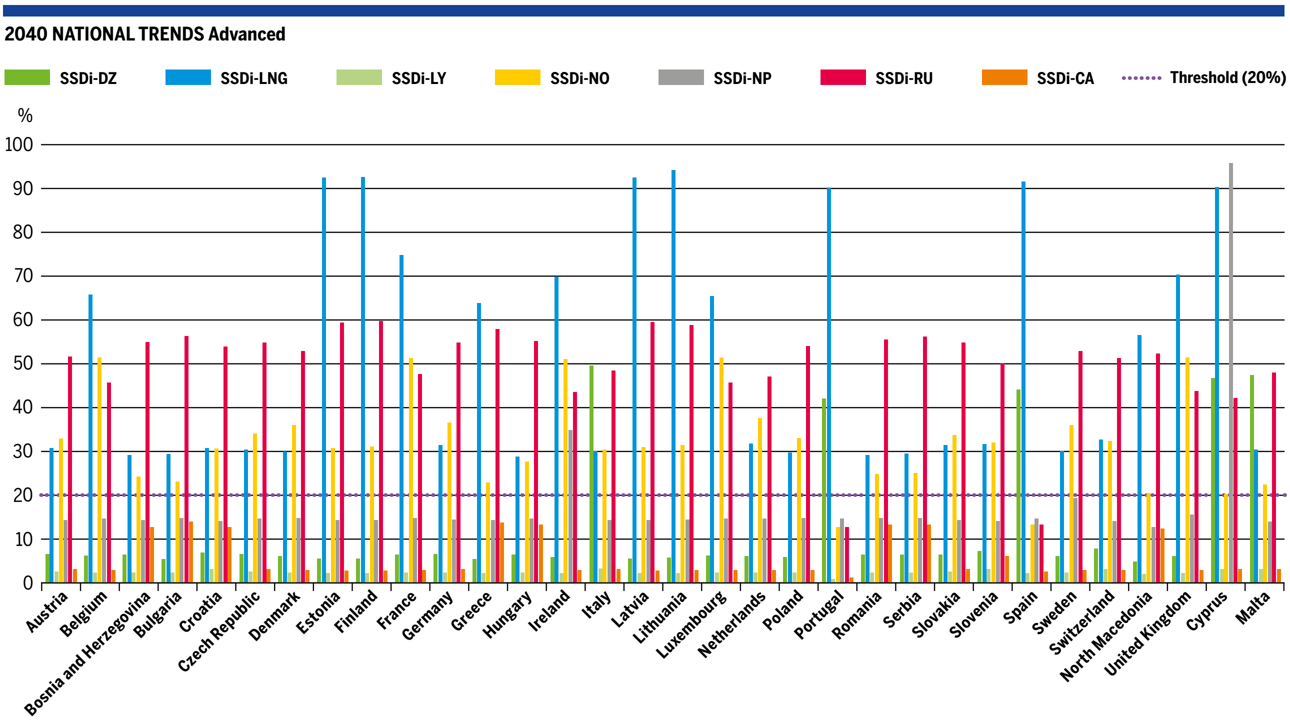


Figure 5.65 SSDi – Advanced infrastructure level – National Trends 2040

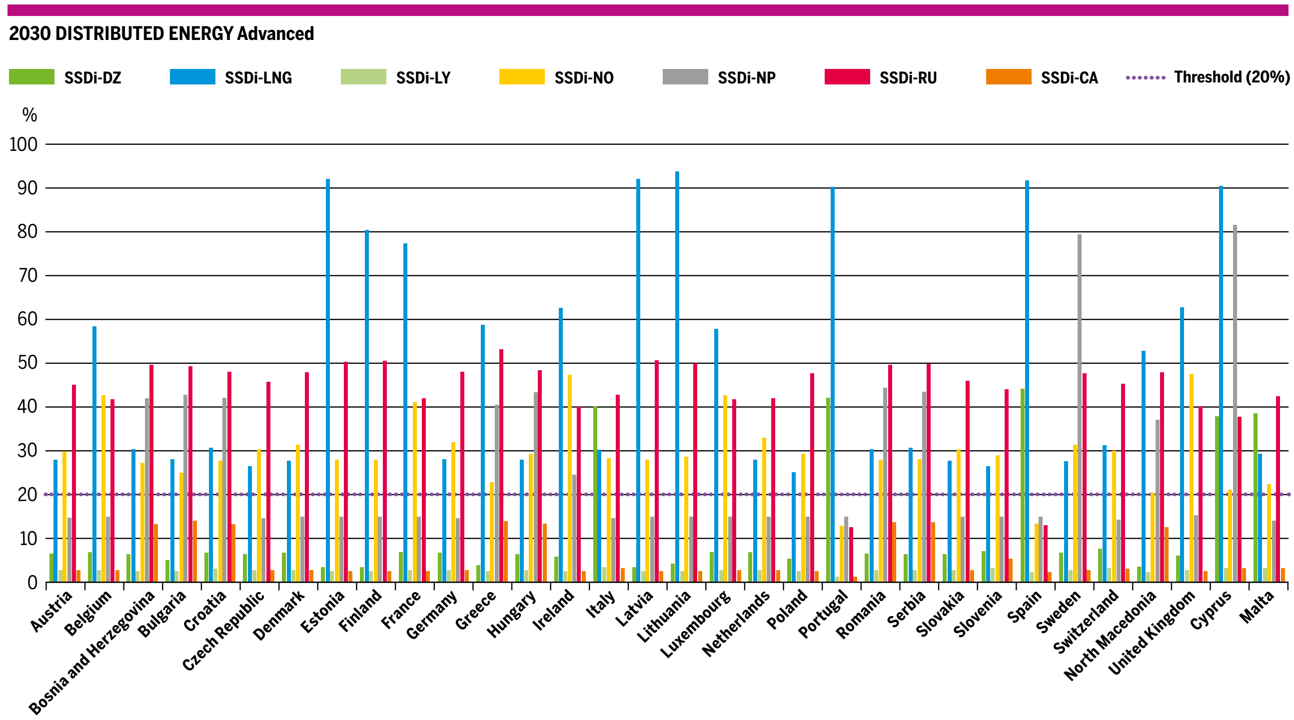


Figure 5.66 SSDi – Advanced infrastructure level – Distributed Energy 2030

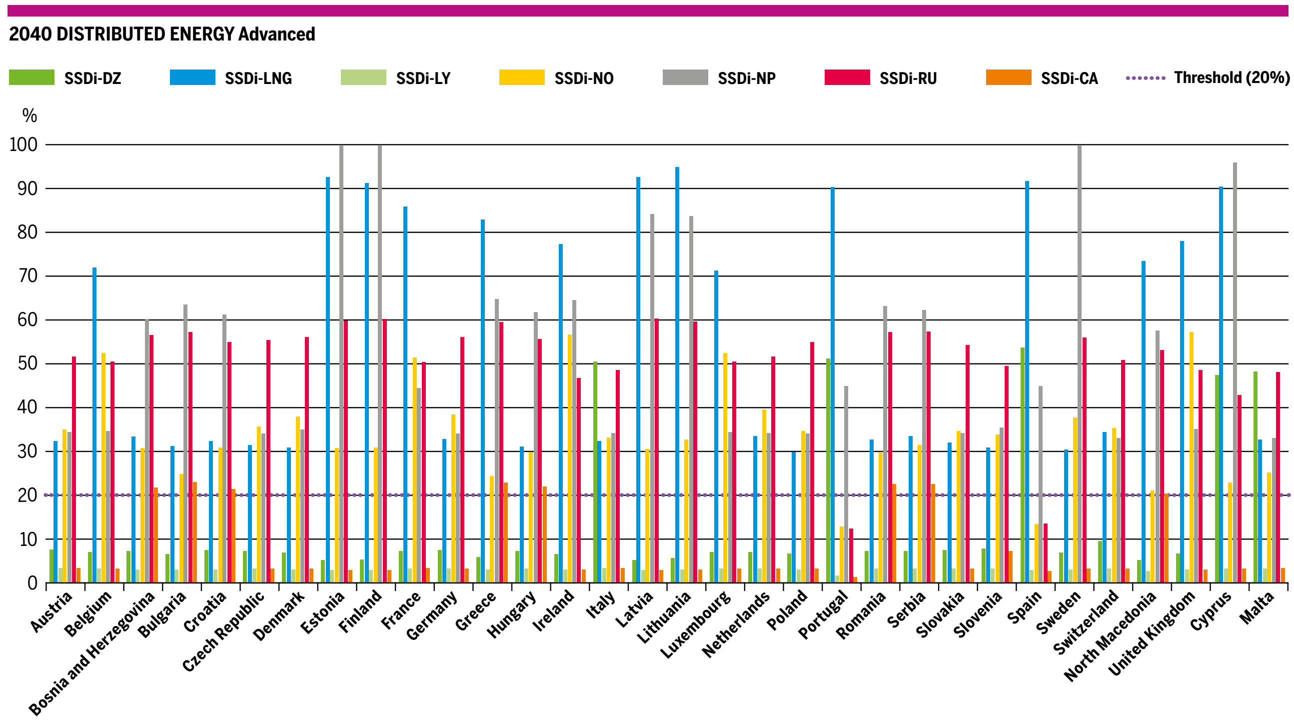


Figure 5.67 SSDi – Advanced infrastructure level – Distributed Energy 2040

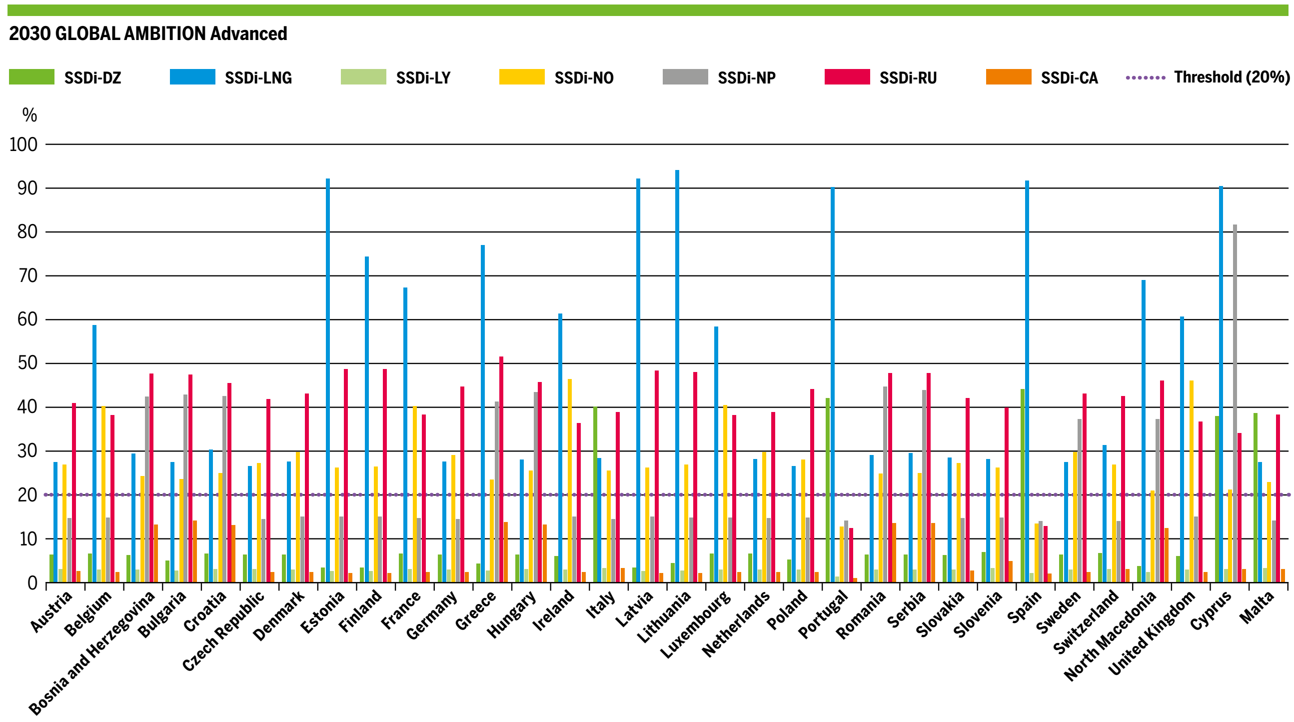


Figure 5.68 SSDi – Advanced infrastructure level – Global Ambition 2030

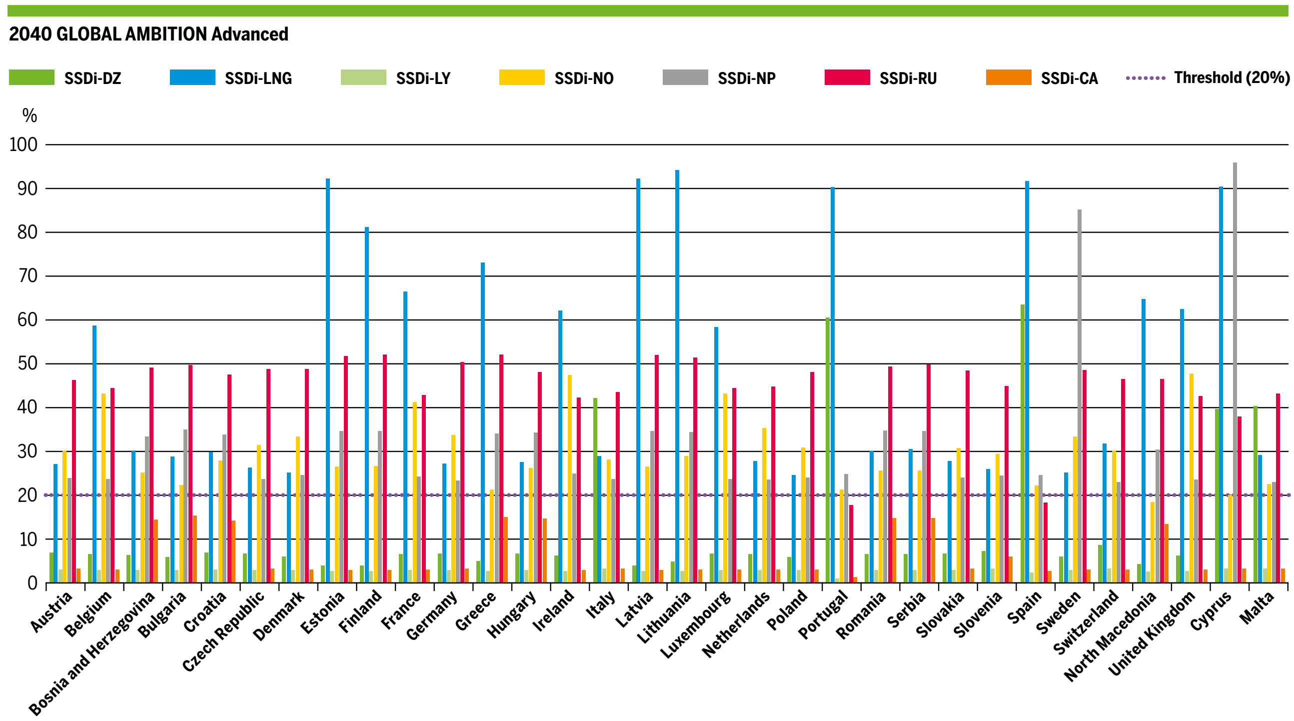


Figure 5.69 SSDi – Advanced infrastructure level – Global Ambition 2040

5.4.4 PCI INFRASTRUCTURE LEVEL

PCI infrastructure level including FID and PCI labeled projects changes situation over the Europe. Those projects are providing additional capacities between EU Countries, such as new import capacities (further expansion of Southern Gas Corridor) and additional LNG capacities in Poland, Croatia, Greece and Cyprus.

2025

The impact of the PCI projects in comparison to FID projects alone on the CSA is visible, especially through improvement in East-South Europe. As of 2025 all European countries are having access to at least 3 supply sources in both scenarios. Denmark and Sweden through new infrastructure are in position to share national produced gas, going below 20 % threshold, loosing score for CSA. Romania and Greece through new infrastructure are in position to increase the number of possible cheap supply sources to 4. LNG and Norwegian gas in case of Romania and Norwegian and Caspian gas in case of Greece. Iberian Peninsula remains with access to two sources: Algeria and LNG.

National Trends

2030: Advanced projects improve situation in South East Europe allows to benefit from a decrease in price of 4 supply sources (5 in case of Greece). Relatively low conventional national production over the Europe does not allow to pass the threshold, but projects grouped in this infrastructure level allows to equally share the similar level of benefit across the Europe (SSDi approx. 14–15 %), when only Ireland is an exception (45 %).

2040: limited development of indigenous renewable gases does not fully compensate for the decline of the conventional national production, especially in the Balkan region. Beside that fact, the assessment shows that the situation in term of Market Integration in Europe is improved and countries are able to benefit from 3 or more supply sources when gas prices drops. Only Iberian Peninsula remains with access to two.

Distributed Energy and Global Ambition

Biggest improvements from CSA perspective can be observed in Baltic state region and South – Central Europe. New infrastructure is allowing to access more LNG and Norwegian gas allowing to reach 20 % threshold. In 2040 thanks to deep level of infrastructure development being implemented, relatively low demand and higher penetration of renewable gas sources all the Europe can access 4 or 5 sources. Only Finland, Estonia and Latvia are having access to 3 sources, but this is because result for SSDi-NO is just below the 20 % threshold. Iberian Peninsula is benefiting from better access to renewable gas sources. **See Figure 5.70.**

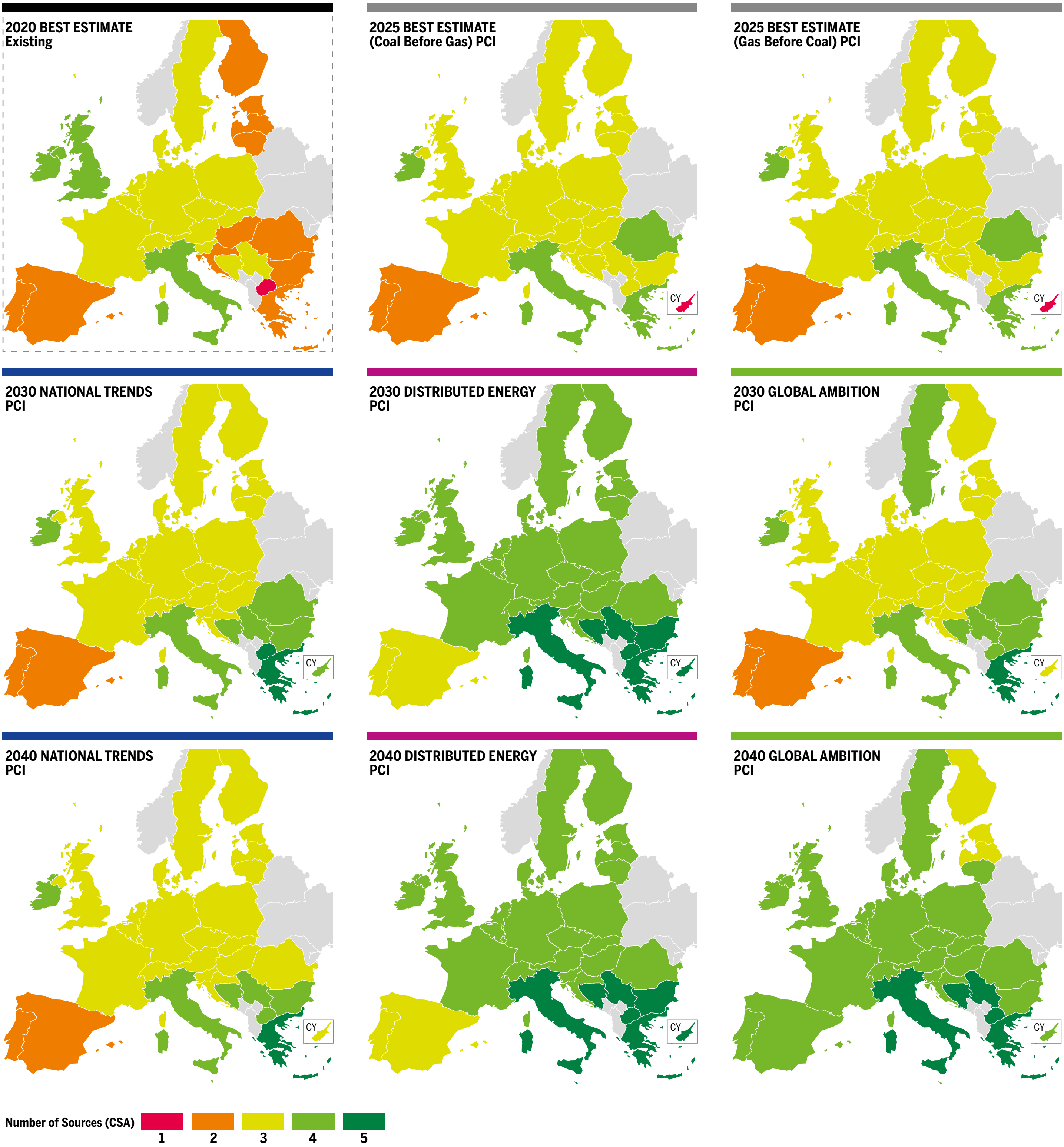


Figure 5.70 CSA – PCI infrastructure level

SSDi NP

PCI infrastructure level is bringing investments allowing to share more gas from national production across the Europe. It can be again observed that some of the countries were having limited possibilities to share gas from national production, but together with additional infrastructure they can share more, even if the gas from national production was having origins in different, well connected neighbour. That is why, comparing situation to Low, in specific scenarios and years, countries like-Denmark and Sweden result for SSPDI NP is dropping below 20 %. In specific situation in 2030 Global Ambition, this indicator is going below 20 % also for Bulgaria, Bosnia and Herzegovina, Croatia, Greece, Hungary, North Macedonia and Serbia. In the same time, those countries are scoring for CSA in other specific scenario and year combination (see detailed SSDi charts).

Thanks to infrastructure improvements in Distributed Energy 2030 and Global Ambition 2040 all countries in EU are passing 20 % for this indicator.

SSDi NO

Compared to Low infrastructure level a significant improvement can be observed. Most of the European countries are crossing 20 % threshold. Only in Portugal and Spain there is almost no change (only in Global Ambition 2040), Cyprus is crossing threshold in 2030 National Trends and Distributed Energy 2040. In case of Bulgaria and North Macedonia, additional infrastructure causing drop of SSDi below 20 % in 2040 Global Ambition and 2040 Distributed Energy for North Macedonia.

SSDi LNG

In PCI infrastructure level all countries in all scenarios and years are matching 20 % criterion to score for CSA. Only improvement in the meaning of passing 20 % was observed in Romania in 2025 Coal Before Gas and Gas Before Coal.

SSDi RU

No change comparing with Low infrastructure level in most of the countries. Only Cyprus, in both 2025 scenarios is not able to pass 20 % threshold but it improves further on.

SSDi DZ

There is an improvement observed in Greece and North Macedonia in specific scenario and year combination. Cyprus, in both 2025 scenarios is not able to pass 20 % threshold but it improves further on. Malta in all scenarios is scoring for CSA.

SSDi CA (Caspian)

Together with PCI infrastructure level, countries like Bosnia and Herzegovina, Bulgaria, Greece, North Macedonia and Serbia are passing 20 % threshold which is included in their CSA.

Picture courtesy of Conexus

DETAILED RESULTS FOR SSDi OVER EUROPE IN PCI INFRASTRUCTURE LEVEL

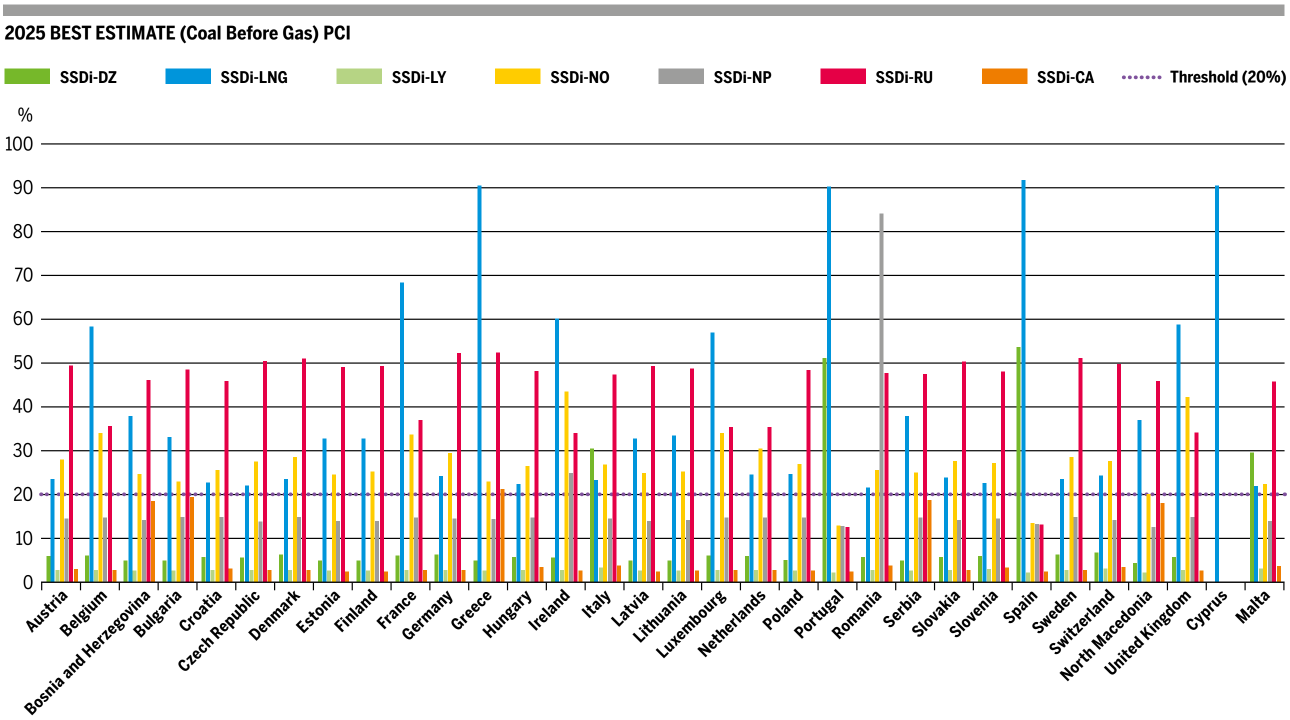


Figure 5.71 SSDi – PCI infrastructure level – Coal Before Gas 2025

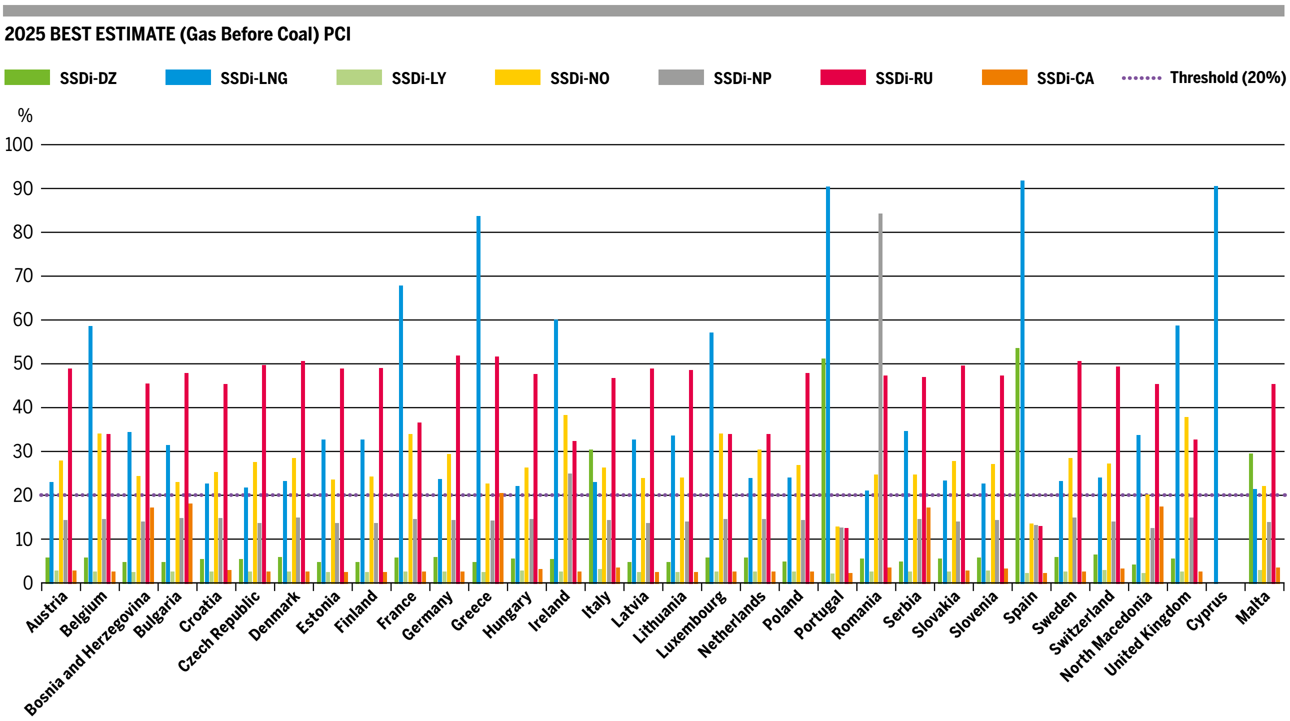


Figure 5.72 SSDi – PCI infrastructure level – Gas Before Coal 2025

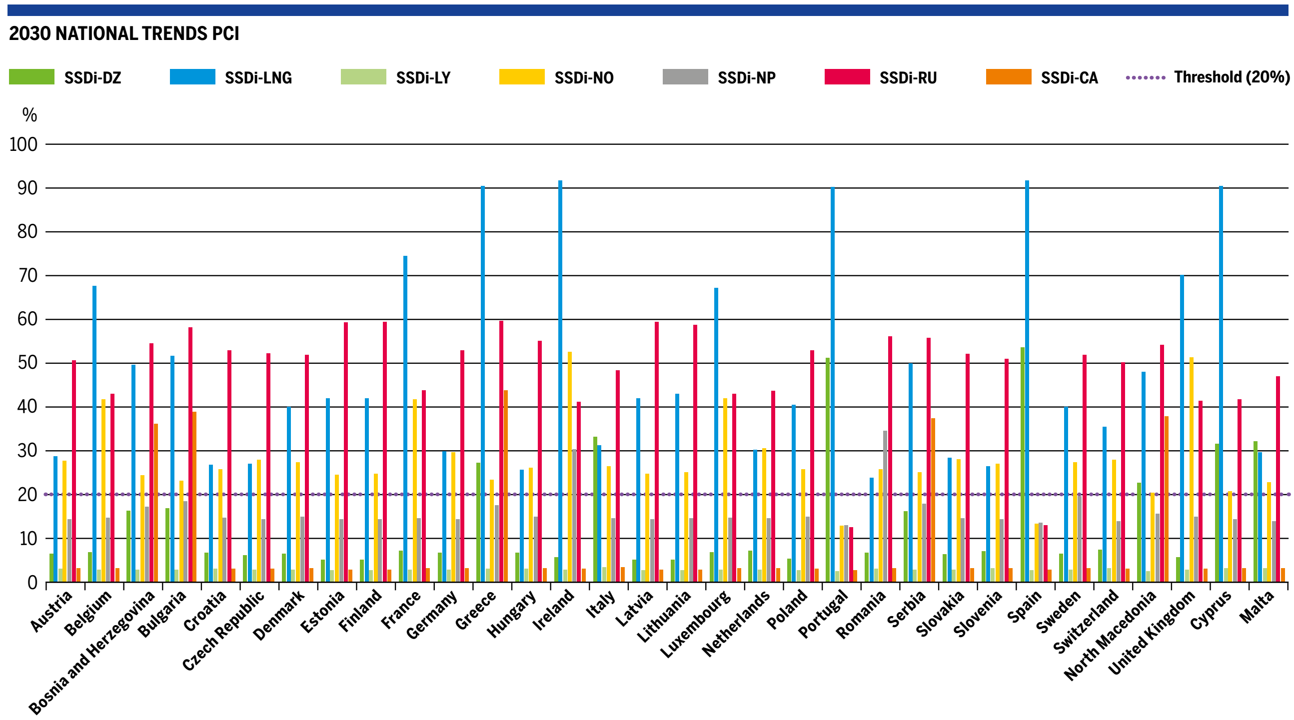


Figure 5.73 SSDi – PCI infrastructure level – National Trends 2030

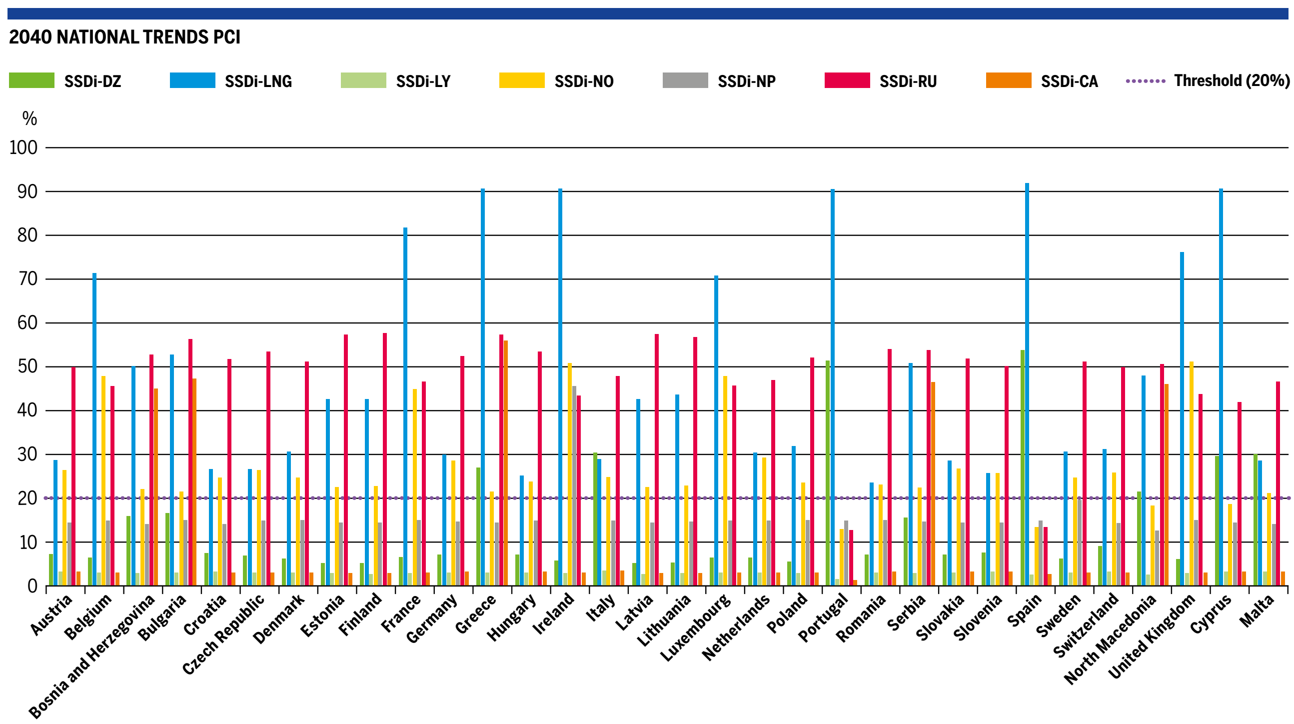


Figure 5.74 SSDi – PCI infrastructure level – National Trends 2040

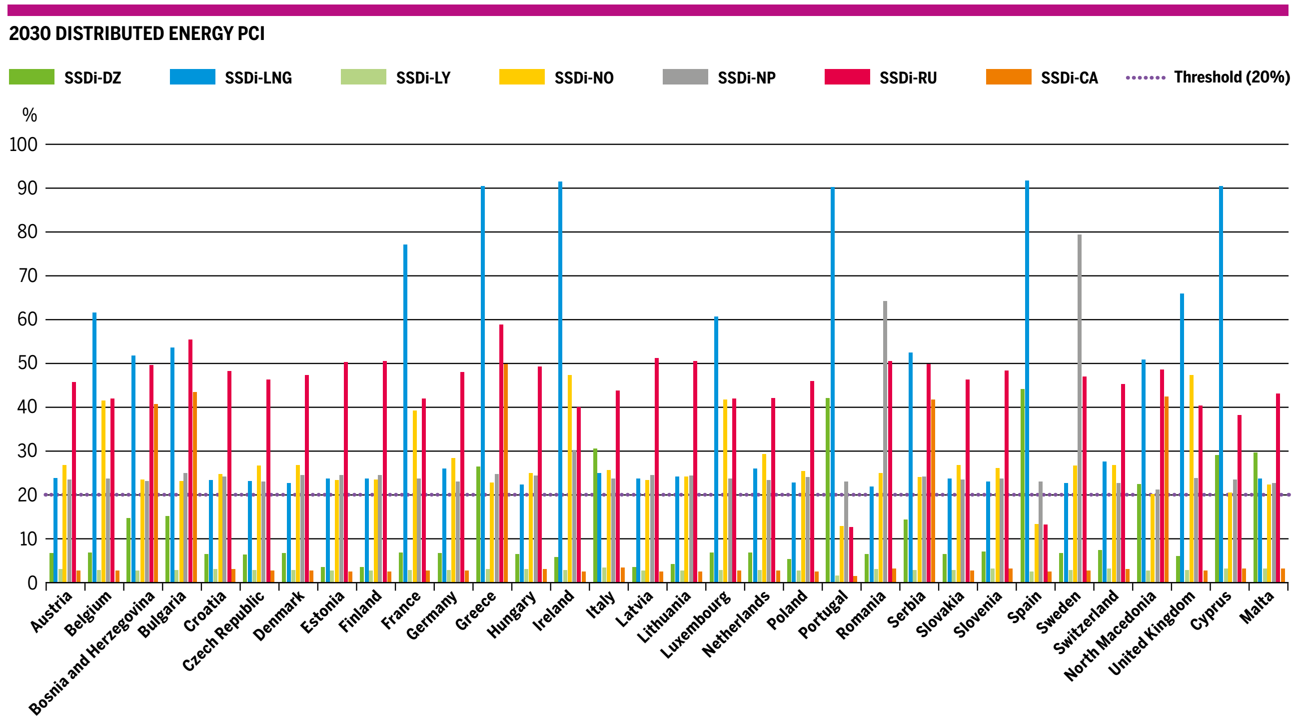


Figure 5.75 SSDi – PCI infrastructure level – Distributed Energy 2030

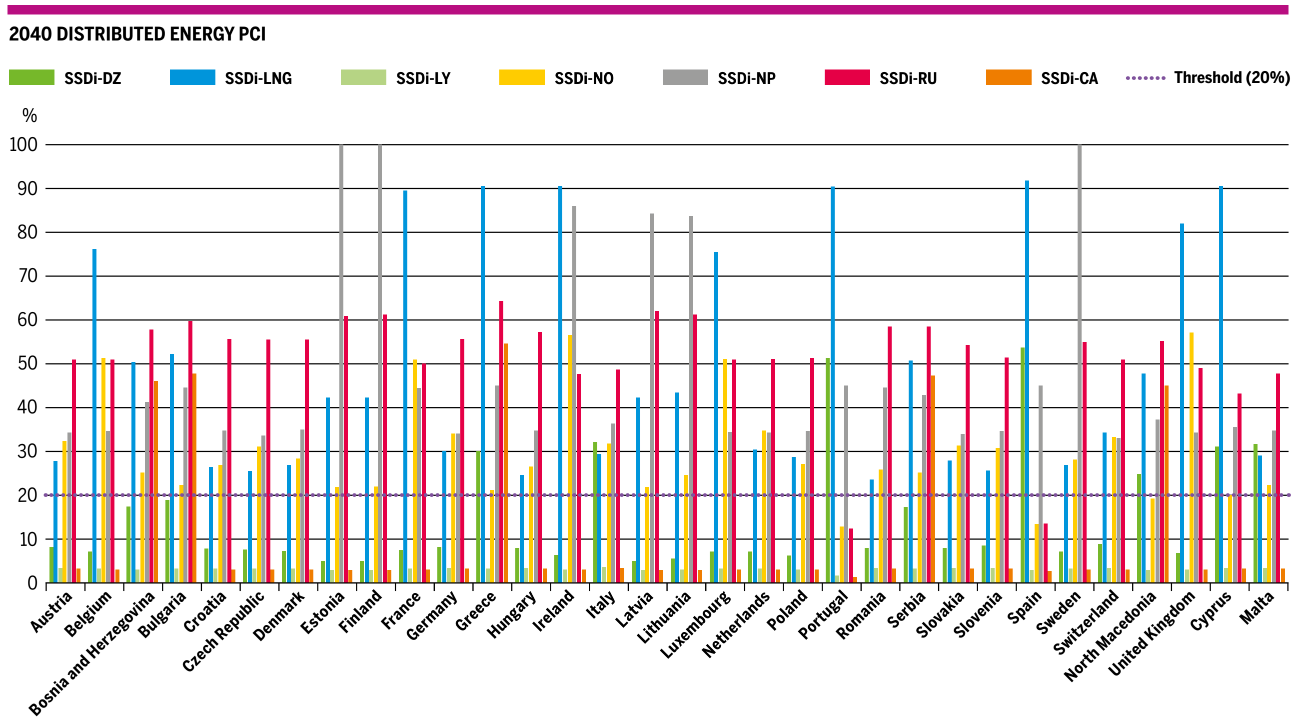


Figure 5.76 SSDi – PCI infrastructure level – Distributed Energy 2040

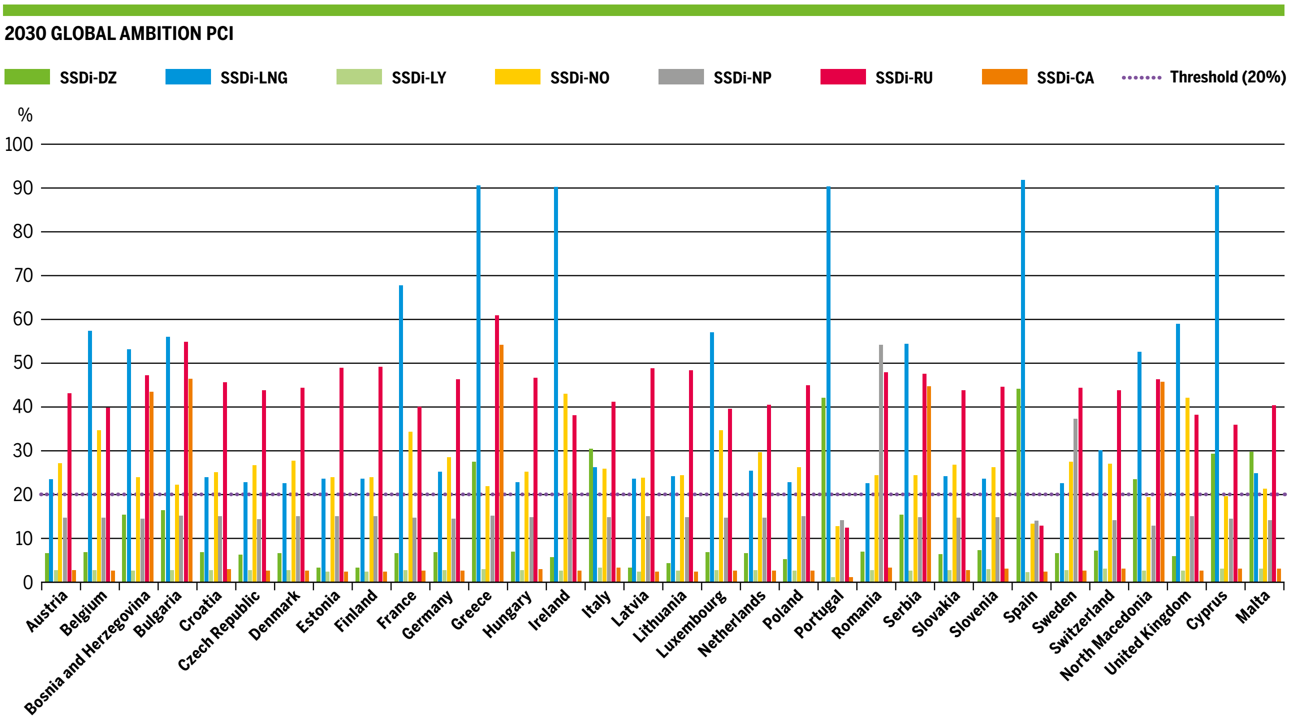


Figure 5.77 SSDi – PCI infrastructure level – Global Ambition 2030

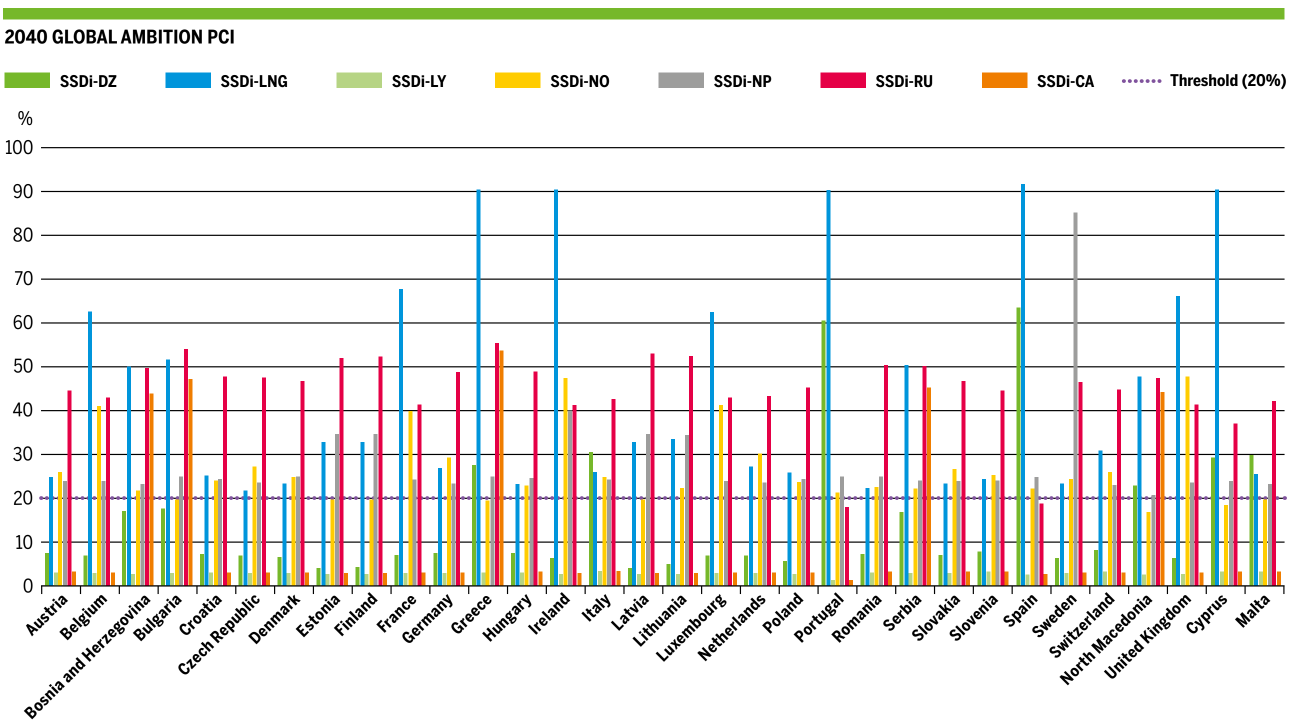


Figure 5.78 SSDi – PCI infrastructure level – Global Ambition 2040

5.5 MARGINAL PRICE

This section investigates how Marginal Prices of European countries are sensitive to contrasted supply price configurations and their ability to converge. Data presented on maps are focused on Gas Before Coal and National Trends scenario line. The rest of the data is available on the interactive website[21].

The Reference price per scenario and time horizon have been built using a methodology described in annex D for the different supply sources using price information from IEA World Energy Outlook 2019 and is detailed in the TYNDP Scenario report.

Infrastructure tariffs used for this TYNDP reflects the 2019 tariffs for Transmission and tariffs used for LNG and Storage are described in the annex D.

It is not expected that the reference supply prices, or arbitrary price differentials selected will materialise in the future, nor that the prices determined in the EU's internal hubs by modelling will fully reflect internal demand and supply drivers. As the market context is continuously evolving it is hard to provide an up-to-date representation. However, the Marginal Price Indicator delivers results and insights based on the assumed gas prices by showing how market forces could interact and evolve.

Interpretation of marginal prices

A difference in marginal price between two connected countries can be the result of a transmission tariff, an infrastructure limitation or both.

As reference marginal prices are different for every year, every scenario and every infrastructure level of the assessment, comparisons between countries and supply configurations are valuable only when comparing within the same year and same scenario.

For the purpose of maximising and minimising supply flows from individual sources in order to assess extreme transportation potentials of the grid a standardised approach has been defined. For the minimisation and maximisation of supplies the price curves of these supplies are set higher or lower by an arbitrary spread of 5 €/MWh making this supply more or less preferred to meet the demand. The import price of the other sources is not changed.

The following supply configurations were analysed:

- Russian gas supply maximised (low Russian price)
- Russian gas supply minimised (high Russian price)
- LNG supply maximised (low LNG price)
- LNG supply minimised (high LNG price)
- South gas supply gas maximised (low Caspian, Libyan, Algeria prices)
- South gas supply gas minimised (low Caspian, Libyan, Algerian prices)

In the presented further maps, the reference price is used to compare the marginal prices. It is the same average price used in the Reference Supply Configuration case for the same scenario and the same years in each infrastructure level. It is the demand weighted average taking into consideration all investigated countries. As the main goal is to measure convergence across the Europe, this way of setting the reference price does not allow directly compare numerical results between two different infrastructure level, but it is more focused to observe how specific infrastructure level and scenario assumptions are affecting range of Marginal Prices and its evolution with specific supply configurations.

Simulation of maximum usage of one gas source by setting its price lower than others is affecting the result by lowering Marginal Price value. And in the same way it is elevating the results of Marginal Price when there is a need to investigate high price of gas from specific source. This is not the way to investigate convergence. To properly investigate results, it is important to compare how results of the Marginal Prices are converging (approaching the same value). The numerical result value of Marginal Price is not that important as similar reaction to signal from the market. Bottleneck or no connection between countries will limit possibility of convergence and it will be visible in Reference supply price configuration case or any other supply price configuration. In the same way prices in countries are not converging when price in one country is much higher or much lower than Reference Marginal Price calculated for each scenario, year and infrastructure level.

21 https://tyndp2020.entsog.eu

5.5.1 EXISTING INFRASTRUCTURE LEVEL

In Existing infrastructure level, results of the indicator are not influenced by any project layer, it means that in all years and scenarios infrastructure remain the same as at the end of 2019 year. Marginal Price results in different countries (and in the same time on the Reference Marginal Price for specific year and scenario) are consequence of assumptions regarding the demand, national production, transmission tariffs and existing capacities between different countries. This way of calculation of the Marginal Price is used for Reference supply price configuration. For further investigation of the convergence between European countries, calculations were repeated with application of supply configurations explained at the beginning of the chapter.

Reference supply price configuration

Reference supply price configuration in Existing infrastructure level shows that gas prices generally converge in Europe and mainly reflect the cross-border transmission tariffs. However, gas prices in Central and South of the Europe together with Baltic states are not fully aligned with Western Europe due to infrastructure limitations and could not further converge. Convergence means that prices react in similar way to gas price signals. This situation is affected by lack of the infrastructure, bottlenecks and high tariffs in the context of input data such as demand, gas production, and tariffs. Together with the years and scenarios there is change in convergence observed, which is caused only by input data. Central-Eastern Europe (specifically Poland), Southern Europe and Baltic states have limited possibility to satisfy demand using gas on the same price level as Western Europe. Situation in Poland is related to increase in demand because of the coal to gas switch projects. Denmark and Sweden in 2025 Gas Before Coal and 2030 National Trends are not converging with rest of the Europe as well, having relatively high national production compared to demand and in the same time having limited possibility share this gas with rest of the Europe.

Maps show a relation between the Reference Marginal Price calculated for each infrastructure level and Marginal price of specific country. When the Marginal Price is lower than the Reference Marginal Price, countries are coloured in one of the green shades (according to range of the difference). When difference is close to zero the colour of country is yellow, and if value is close to one or higher it is covered with orange-red colour (according to range of the difference). **See Figure 5.79.**

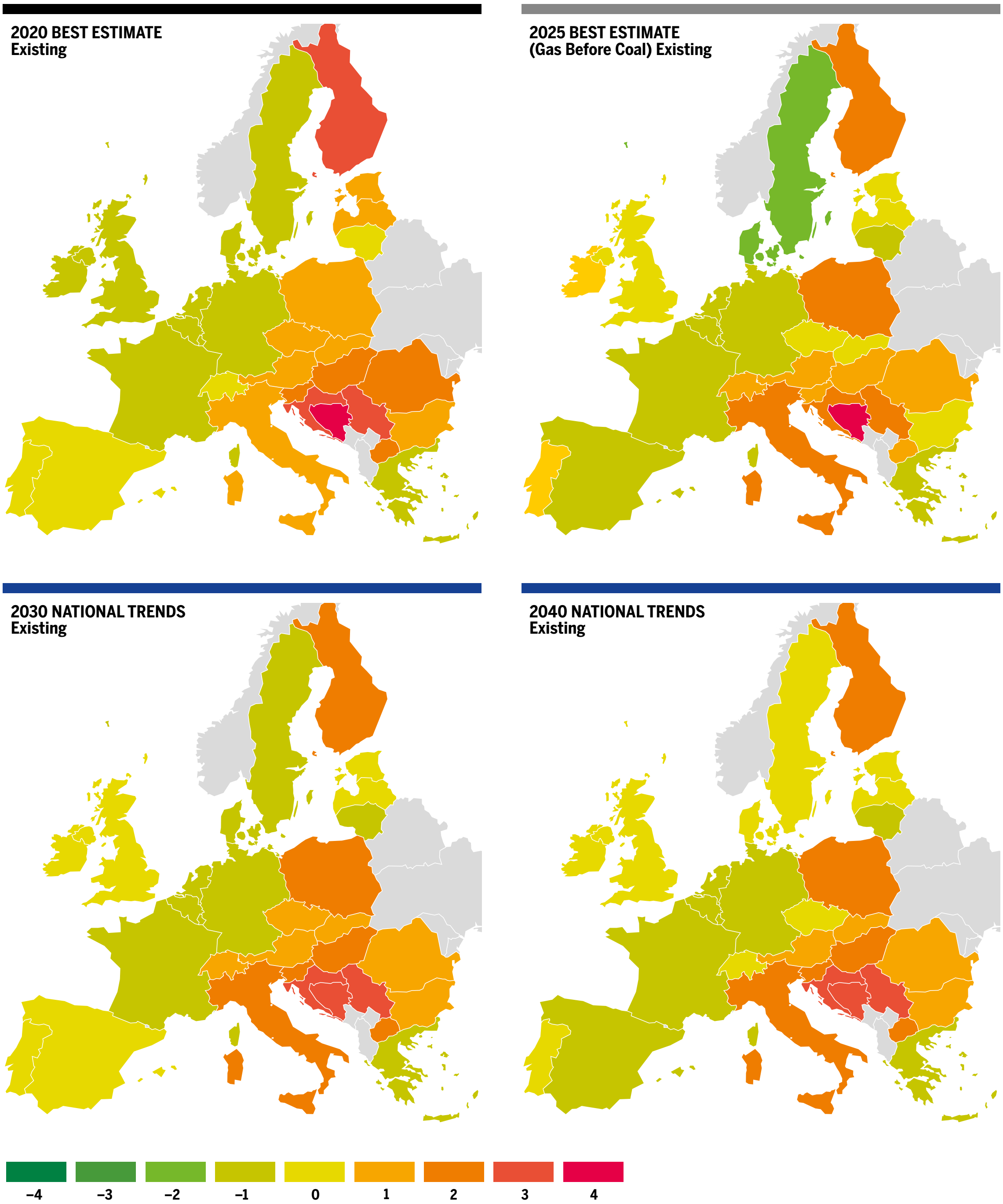


Figure 5.79 MP delta (EUR/MWh) – Existing infrastructure level, Reference supply price configuration

LNG Max

Central-Eastern and South Europe together with Baltic states are not converging with Western Europe.

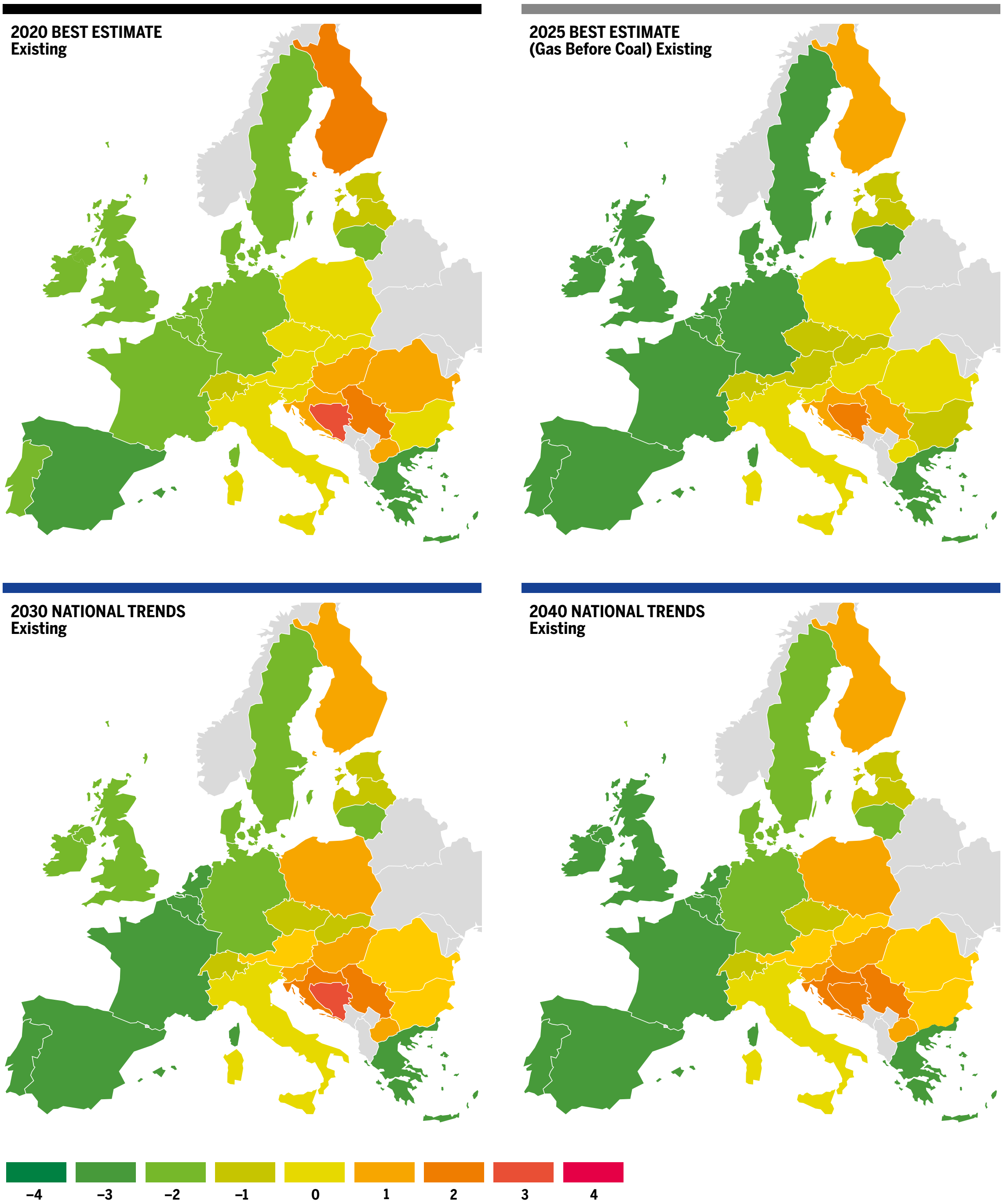


Figure 5.80 MP delta (EUR/MWh) – Existing infrastructure level, LNG Max supply configuration

LNG Min

Central-Eastern and South Europe together with Baltic states are not converging with Western Europe. In Gas Before Coal 2025 trend is the same but delta between Reference Marginal Price and Marginal Price in South and Eastern Countries is going above 4 EUR/MWh.

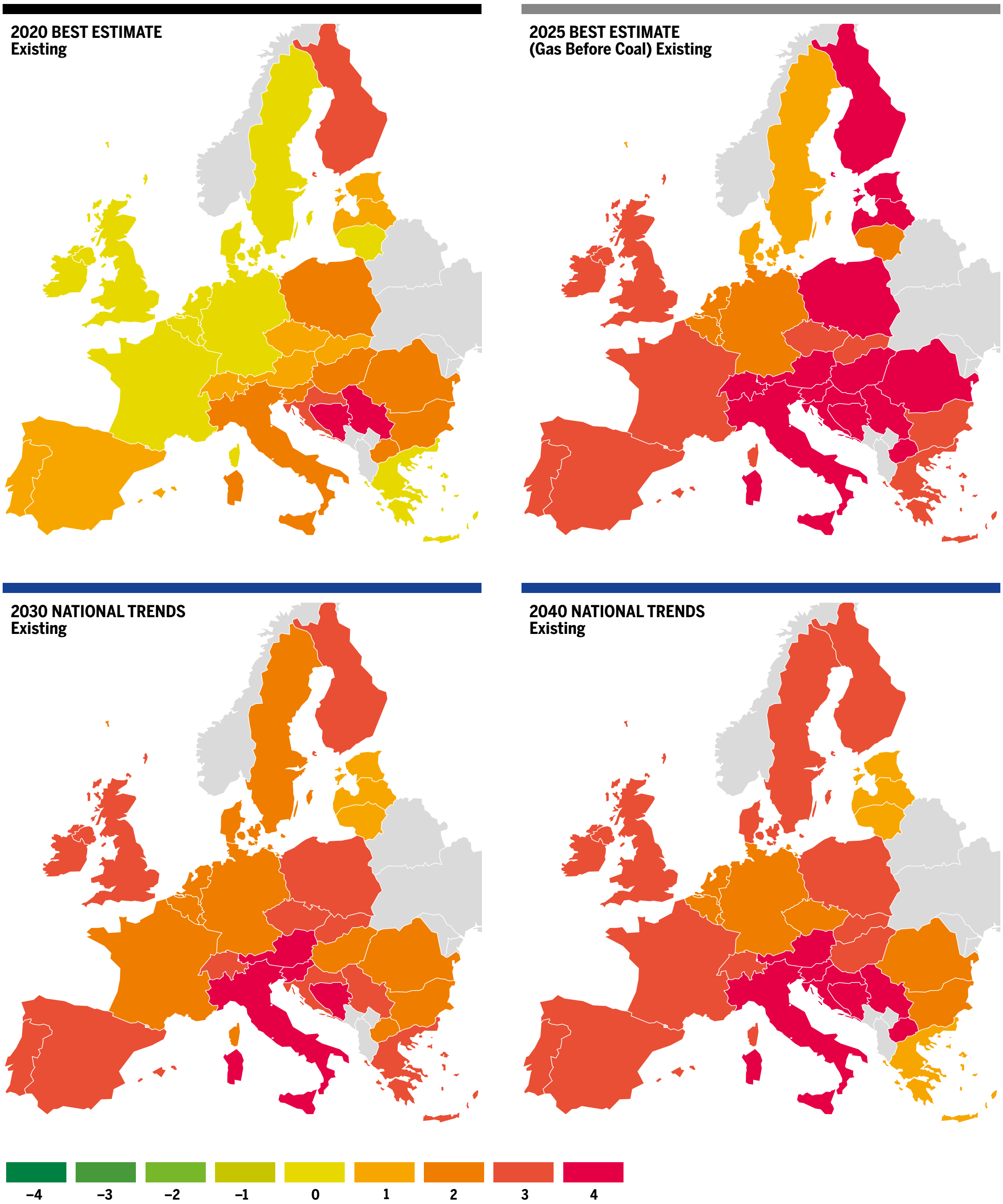


Figure 5.81 MP delta (EUR/MWh) – Existing infrastructure level, LNG Min supply configuration

RU Max

In countries with relatively high demand comparing to limited cross-border capacities and national production, possibility to observe price convergence is limited. In 2025 Gas Before Coal in Poland, Italy, Bosnia and Herzegovina, Finland, Croatia and Serbia, Marginal Price is not converging like in the rest of Europe. In National Trends 2030 and 2040 Italy, its northern and eastern neighbours are not converging with the rest of the Europe on the same level which indicates infrastructure limitations and higher cost of gas transportation.

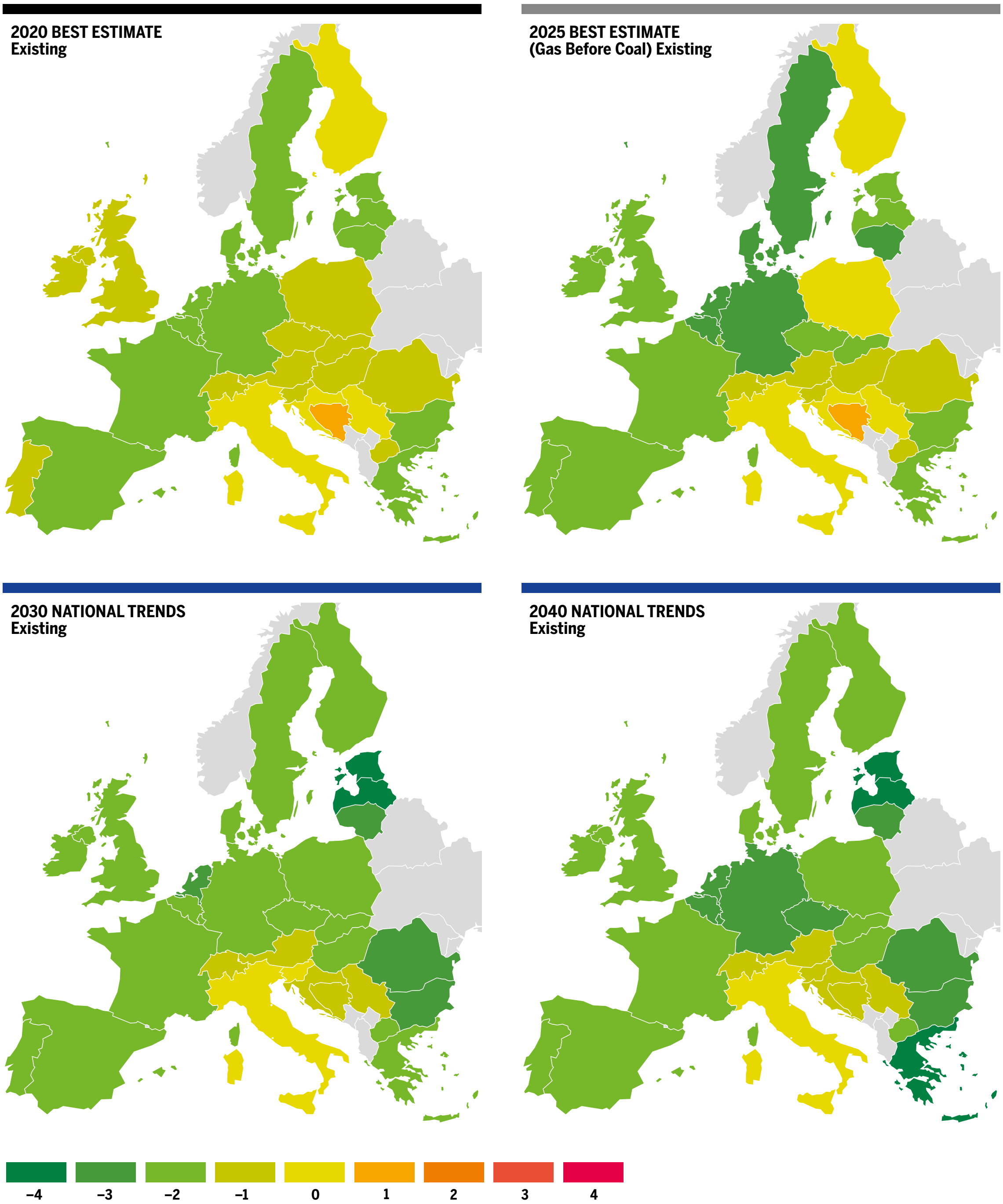


Figure 5.82 MP delta (EUR/MWh) – Existing infrastructure level, RU Max supply configuration

RU Min

Central-Eastern and South Europe together with Baltic states are not converging with Western Europe.

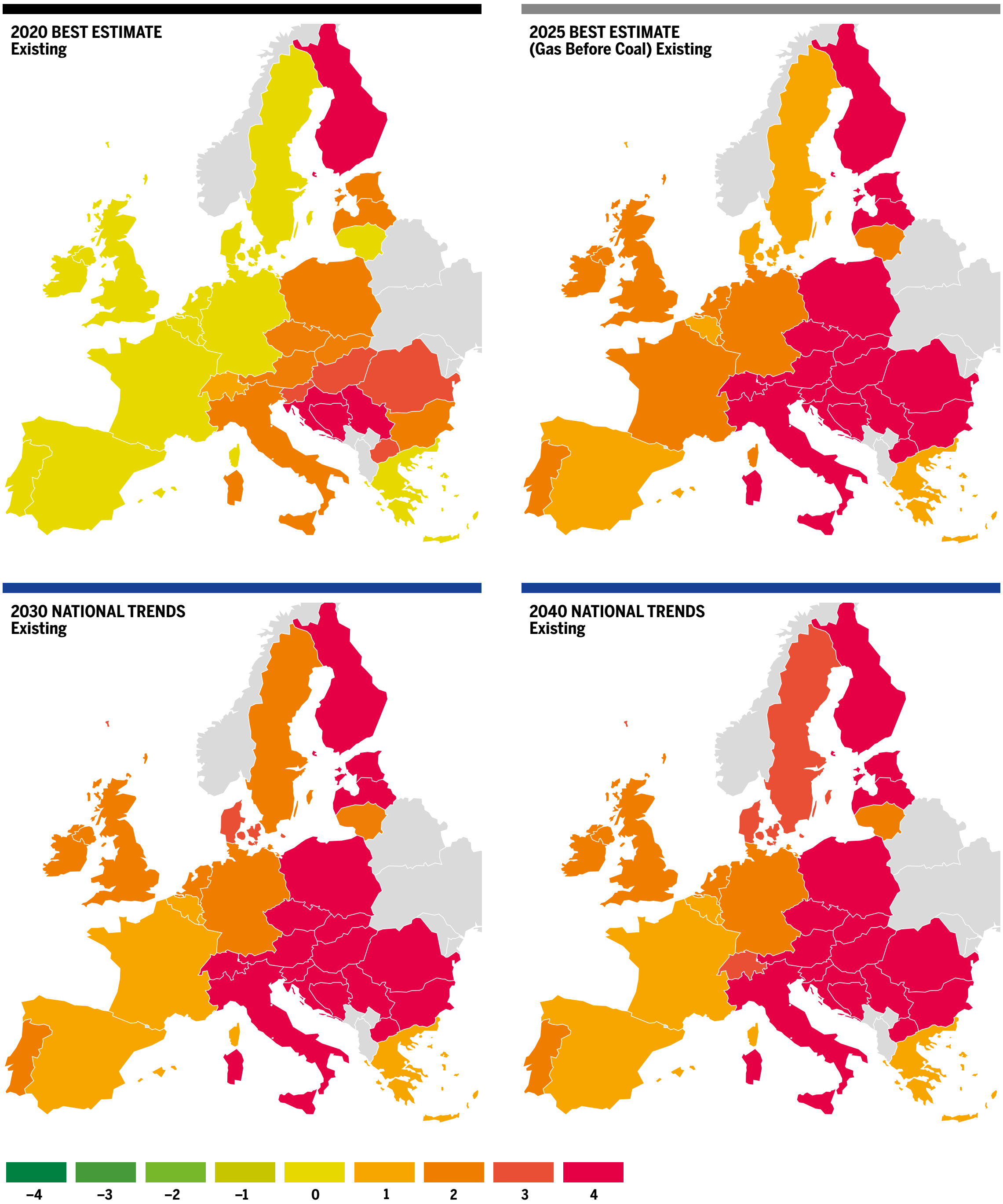


Figure 5.83 MP delta (EUR/MWh) – Existing infrastructure level, RU Min supply configuration

South Max

Central-Eastern and South Europe together with Baltic states are not converging with Western Europe. No significant differences were observed in comparison to Reference case.

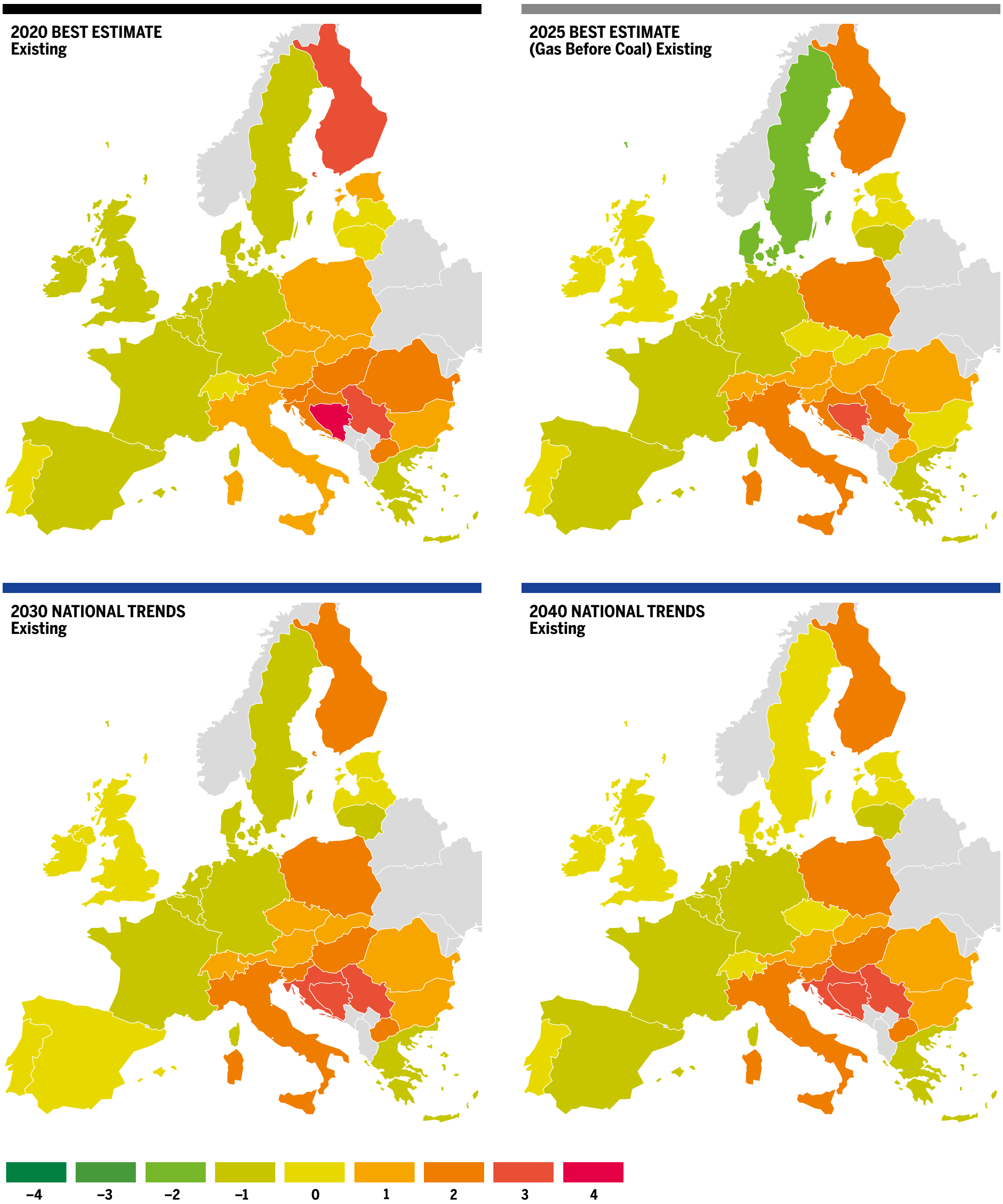


Figure 5.84 MP delta (EUR/MWh) – Existing infrastructure level, South Max supply configuration

South Min

Central-Eastern and South Europe together with Baltic states are not converging with Western Europe slightly affected by this supply situation.

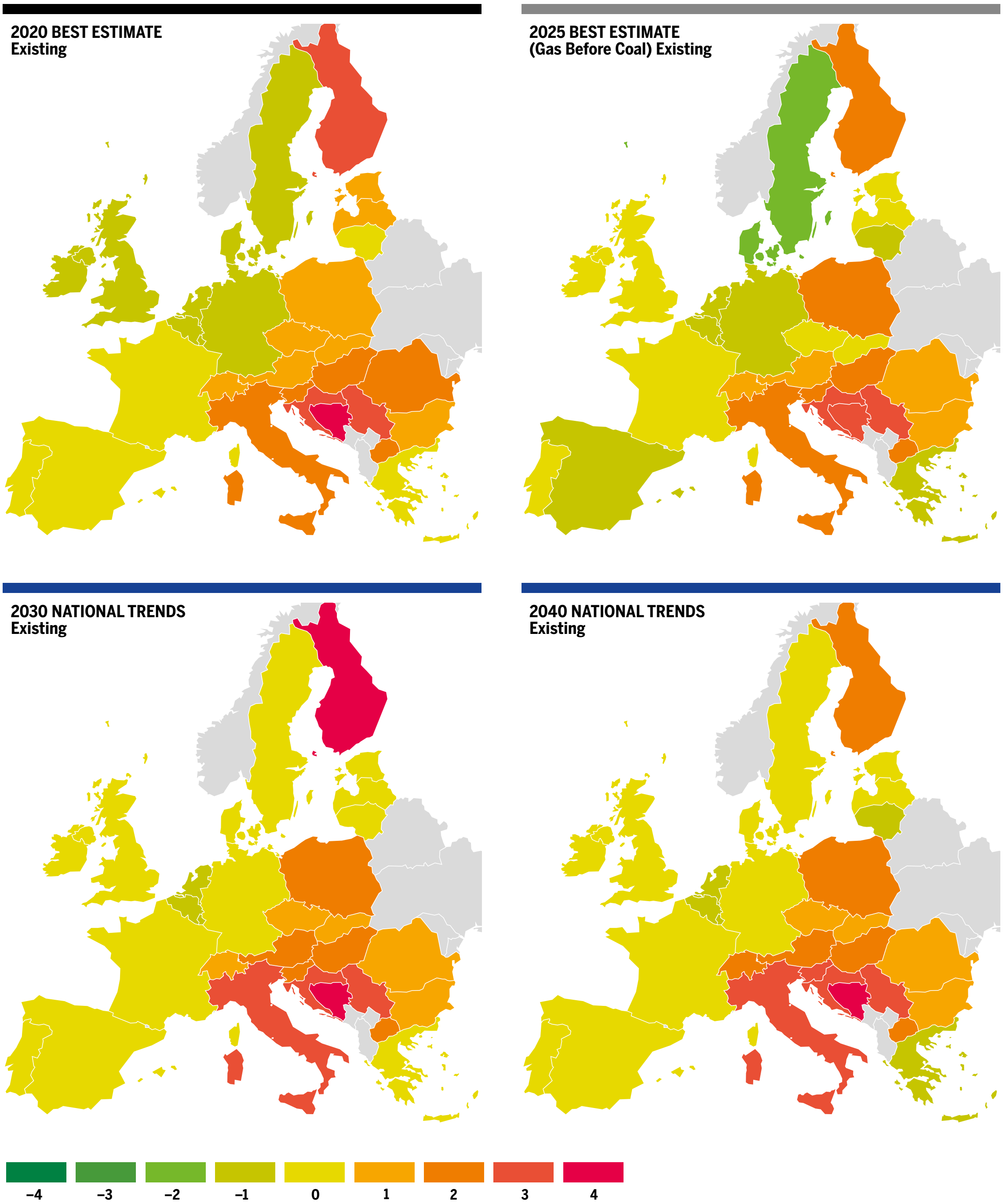


Figure 5.85 MP delta (EUR/MWh) – Existing infrastructure level, South Min supply configuration

CONCLUSION

2020

East → West: The existing gas infrastructure can ensure an efficient price convergence in case of competitive Eastern supply: in case of cheap Russian supply or expensive LNG supply, most European countries can benefit from a cheaper Eastern supply.

West → East: Thanks to its access to LNG, the western part of the EU can generally benefit from a competitive LNG supply (see LNG max configuration). In the same time cost of gas transportation of the LNG from Western Europe and infrastructure limitations between Germany and Poland, between Germany and Austria, between Austria and Hungary and Slovakia, prevent Eastern Europe from being protected from the impact of an expensive Eastern supply or from benefiting from a competitive LNG supply.

North Eastern Europe: LNG regasification capacities can help Poland and the Baltic states to benefit from a competitive LNG supply or prevent them from being too much exposed to an expensive Eastern supply. However, because of limited Indigenous production or limited access to alternative supply, those capacities are not enough for the cheapest supply in the region.

South-Eastern Europe: Greece is generally prevented from the impact of an expensive Eastern supply and can benefit from a competitive LNG price. However, infrastructure limitations between Greece and Bulgaria prevent those benefits to be shared further North.

2025

The gas demand generally remains comparable to 2020, however, the indigenous gas production declines driven by the significant decline of the conventional natural gas production from 2,750 GWh/d to 2,000 GWh/d. The recent and limited development of renewable and decarbonised gases can hardly compensate (+120 GWh/d between 2020 and 2025).

East → West: As in 2020, the existing gas infrastructure can ensure an efficient price convergence in case of competitive Eastern supply: in case of cheap Russian supply or expensive LNG supply, most European countries can benefit from a cheaper Eastern supply.

West → East: The situation remains like in 2020.

North and South Eastern Europe: The situation remains like in 2020.

National Trends

2030–2040: With the further decline of the indigenous natural gas production in Europe, and the limited uptake of renewable gases, the same infrastructure limitation remains and the convergence of marginal prices in case of West → East gas flows further deteriorates.


Picture courtesy of Gasum

COP21 scenarios

Distributed Energy

2030: The significant development of renewable gases production capacities allows the EU to reach similar levels of indigenous production to 2020, renewables fully compensating for the decline of Natural Gas production. Therefore, the situation remains stable over time and Marginal Price convergence is very similar to 2025. With some limitations West → East.

2040: In 2040, the development of renewables gases reaches significant volumes (3,800 GWh/d), more than compensating for the sharp decline of the natural gas production. Furthermore, the development of electrification and energy efficiency reduces the overall gas demand bringing more flexibility into the gas system.

East → West: Marginal Prices further converge and most of the differences observed between countries reflect the transmission tariffs.

West → East: The same infrastructure limitations remain between Western and Central-Eastern Europe.

North-Eastern Europe: The development of renewable gases allows the Baltic states and Finland to have their Marginal Prices independent from Russia.

Despite the significant increase of the national production, including renewable gases; the assessment shows a significant difference between the Marginal Price in Poland and its neighbouring countries. Infrastructure shows some limitations between Poland and its neighbouring countries not accommodating with the significant increase of the Polish demand, due to the transition away from coal in power and heating, industrial and tertiary sectors.

South-Eastern Europe: The same infrastructure limitations between Greece and Bulgaria are observed.

Global Ambition

2030: The development of renewable gases production compensates for the decline of the conventional Natural Gas production and the overall European Indigenous production remains almost stable between 2025 and 2030. The overall gas demand remains stable as the demand decreases in power and tertiary sector, but at the same time, the more centralised and global development of renewable and decarbonised gases enhance the displacement of carbon intensive fuels by gas, increasing the demand in the transport and industrial sectors.

Therefore, the situation remains stable over time and Marginal Price convergence is very similar to 2025. With some limitations West → East.

2040: The European gas demand decreases slightly thanks to improvement in energy efficiency. Furthermore, the further development of renewable gases allows the overall European indigenous production to reach levels similar to 2020.

East → West: Marginal Prices further converge and most of the differences observed between countries reflect the transmission tariffs.

West → East: The same infrastructure limitations remain between Western and Central-Eastern Europe.

North-Eastern Europe: The development of renewable gases allows the Baltic states – and Finland to a lesser extent – to have their Marginal Prices independent from Russia.

Despite the significant increase of the national production, including renewable gases; the assessment shows a significant difference between the Marginal Price in Poland and its neighbouring countries. Infrastructure shows some limitations between Poland and its neighbouring countries not accommodating with the significant increase of the Polish demand, due to the transition away from coal in power and heating sectors.

South-Eastern Europe: The same infrastructure limitations between Greece and Bulgaria are observed.

5.5.2 LOW INFRASTRUCTURE LEVEL

Low infrastructure level contains list of the project that have FID status granted until the end of 2019 year. Those projects improve situation in Europe by providing new cross border capacities and other improvement of the gas systems in the Europe. Those projects are increasing possibility to follow the same gas price signals and improves convergence.

For the result evaluation it is crucial to remember that demand weighted Reference Marginal Price was calculated for Low infrastructure level separately (for each year and scenario) which means that results cannot be compared with other infrastructure level directly. Important finding from evaluation of the results is observation of convergence – not the difference of the numerical value of Marginal Price calculated for each country.

As the results for Best Estimate 2020 are not changing with the infrastructure level, following results will contain only Gas Before Coal 2025, National Trends 2030 and 2040.

Reference Supply Configuration

In the Reference gas price configuration gas prices over the Europe are not in perfect convergence. However, projects in Low infrastructure level are bringing possibility for better convergence especially in South Europe. Denmark and Sweden are having significant access to gas from national production and at the same time limited possibility to freely transfer gas with neighbouring countries in amount that will interfere with marginal prices. Finland and Estonia are having limited possibility to converge with the rest of the Europe as Baltic states are isolated.

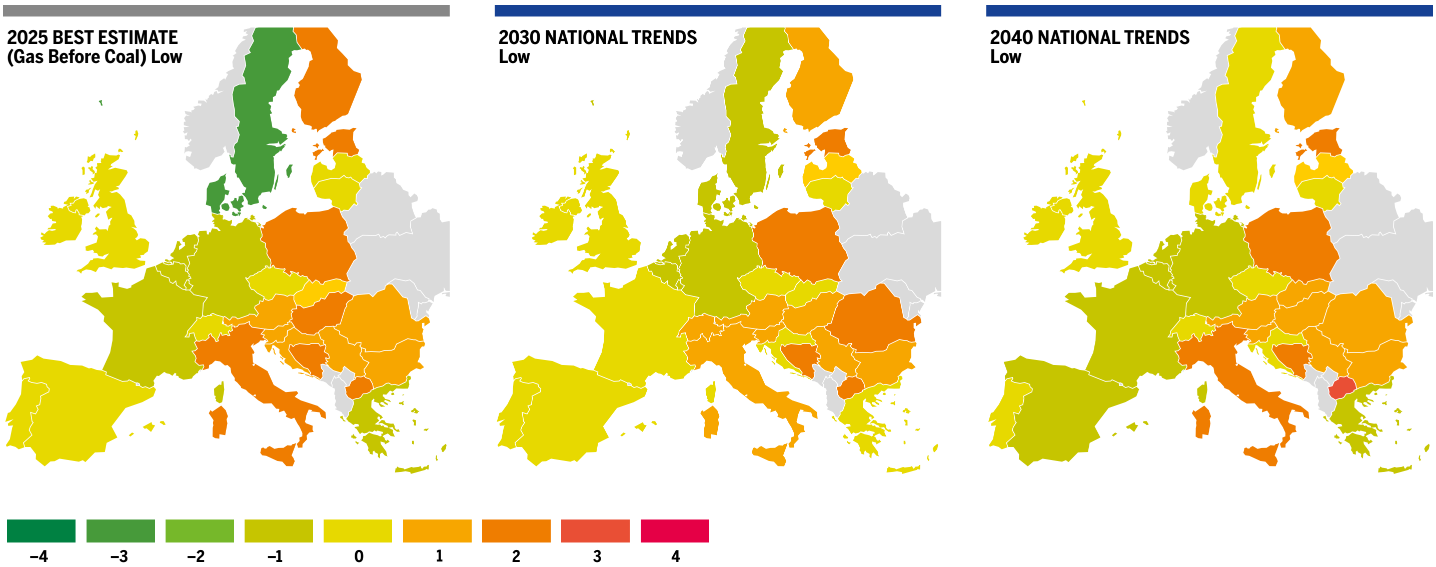


Figure 5.86 MP delta (EUR/MWh) – Low infrastructure level, Reference supply price configuration

LNG Max

There is limited convergence (slight improvement comparing the Reference supply price configuration) observed between Central-Eastern Europe and South Europe with Western markets in case when LNG gas price is significantly cheaper than other sources.

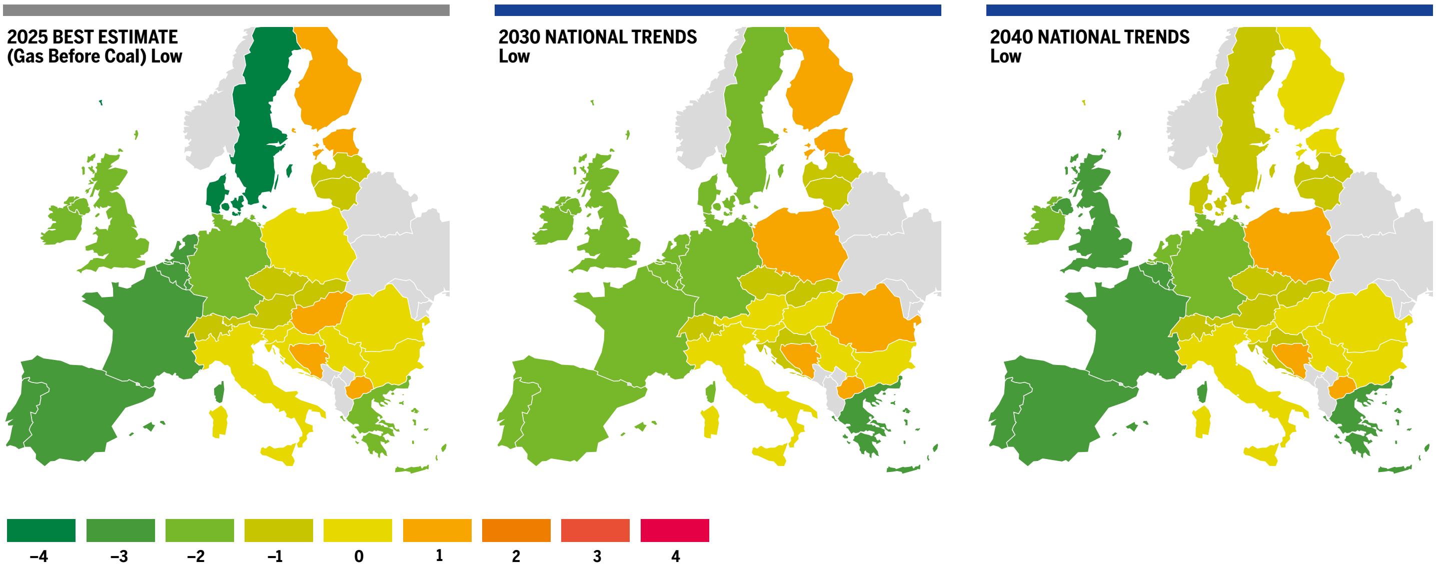


Figure 5.87 MP delta (EUR/MWh) – Low infrastructure level, LNG Max supply configuration

LNG Min

Limited convergence is observed. Denmark and Sweden are having significant access to gas from national production and at the same time limited possibility to freely transfer gas with neighbouring countries in amount that will interfere with marginal prices. Finland and Estonia are having limited possibility to converge with the rest of the Europe as Baltic states are isolated.

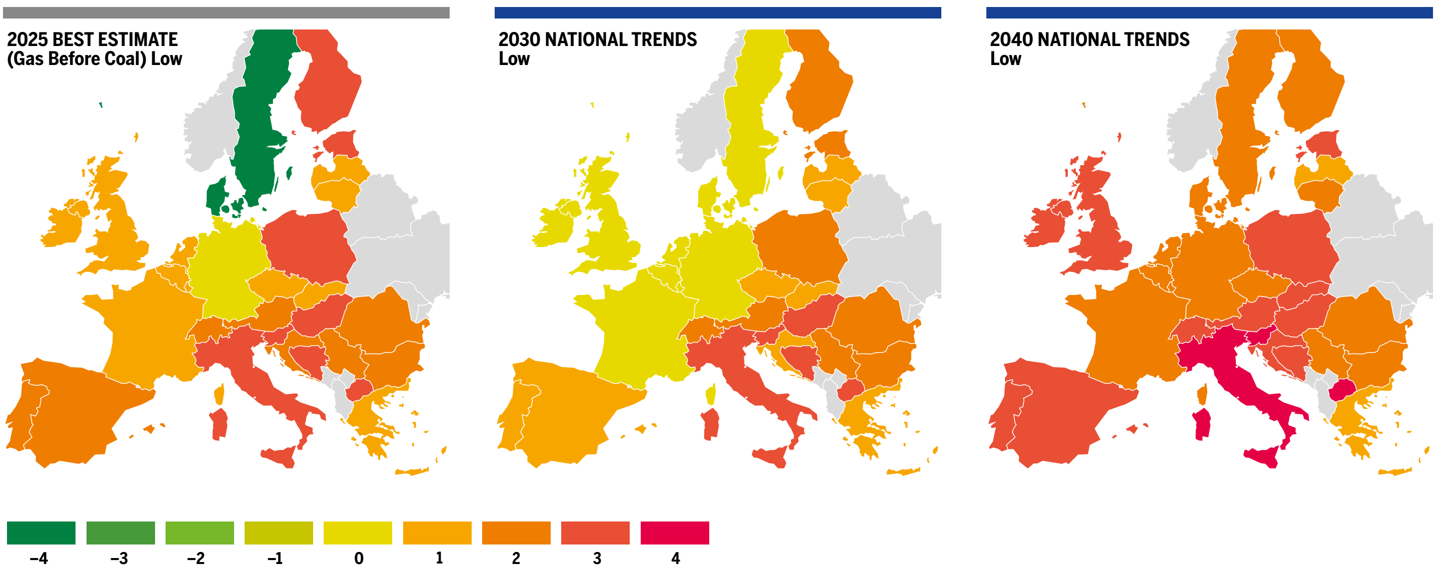


Figure 5.88 MP delta (EUR/MWh) – Low infrastructure level, LNG Min supply configuration

RU Max

The Low infrastructure level allows most of the Western and Central-Eastern and South countries to benefit of attractive prices on the same basis as countries directly supplied by Russia in National Trends 2030 and 2040.

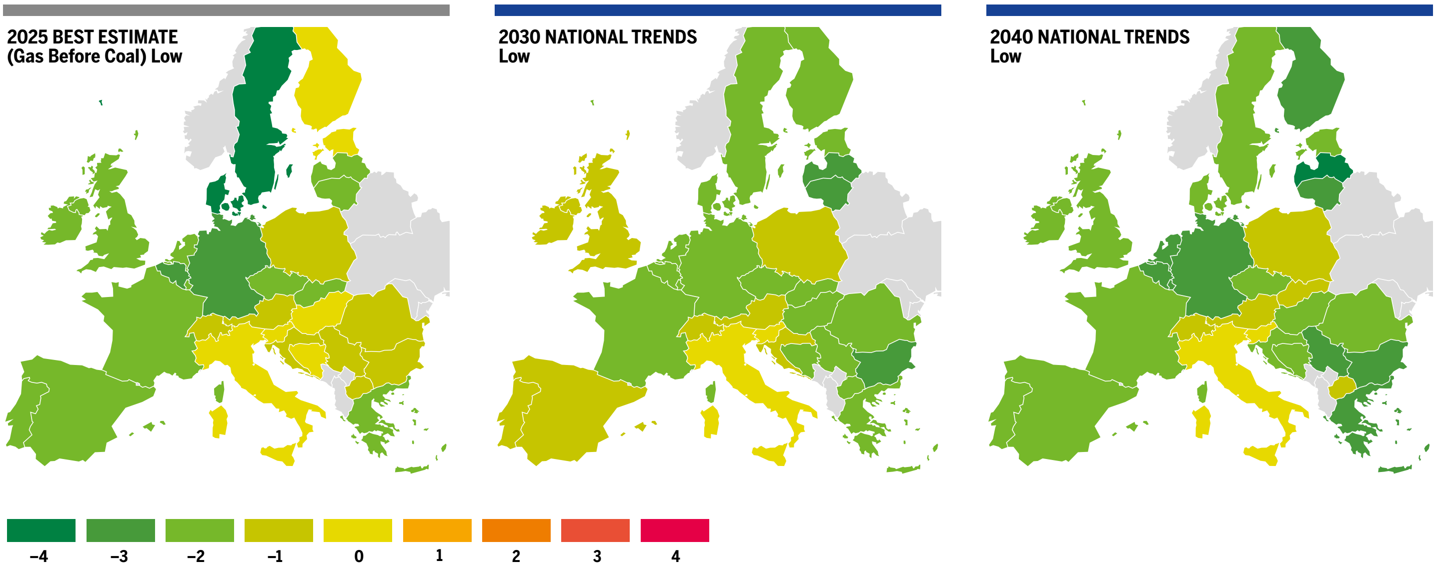


Figure 5.89 MP delta (EUR/MWh) – Low infrastructure level, RU Max supply configuration

RU Min

There is a limitation in convergence between Central-Eastern and South Europe together with Baltic states versus Western Europe. Denmark and Sweden are having significant access to gas from national production and at the same time limited possibility to freely transfer gas with neighbouring countries in amount that will interfere with marginal prices. Within regions, convergence signals are observed.

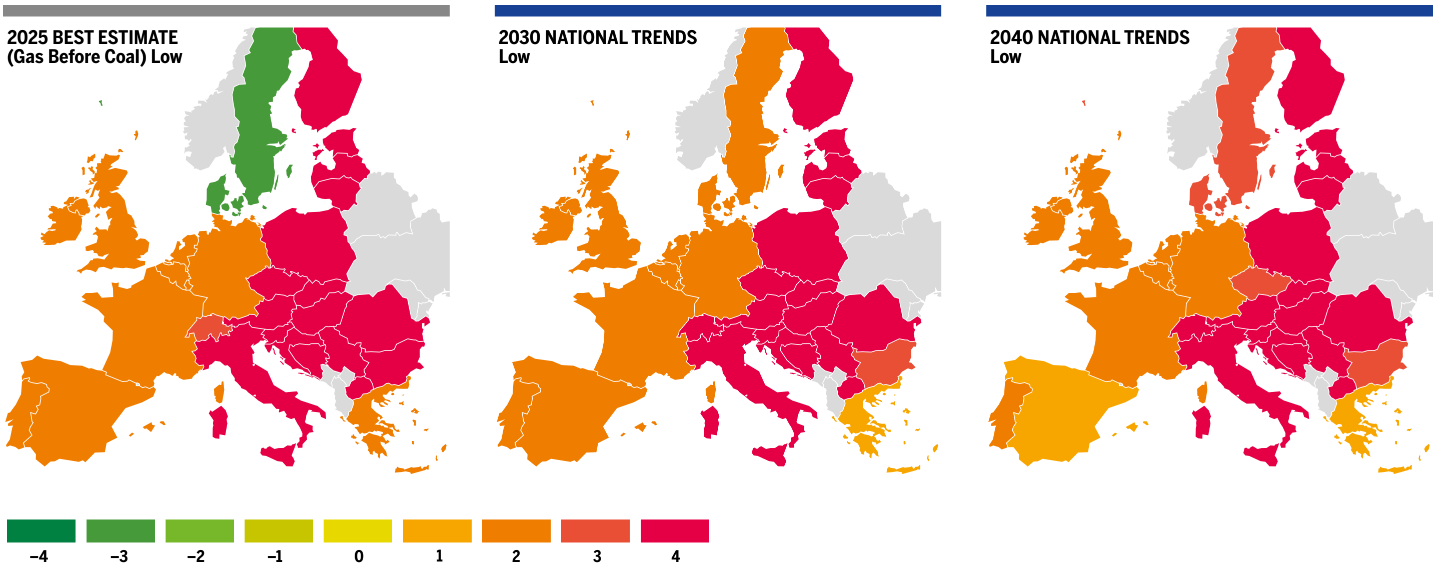


Figure 5.90 MP delta (EUR/MWh) – Low infrastructure level, RU Min supply configuration

South Max

This supply configuration is not influencing Marginal prices in Europe in context of convergence changes.

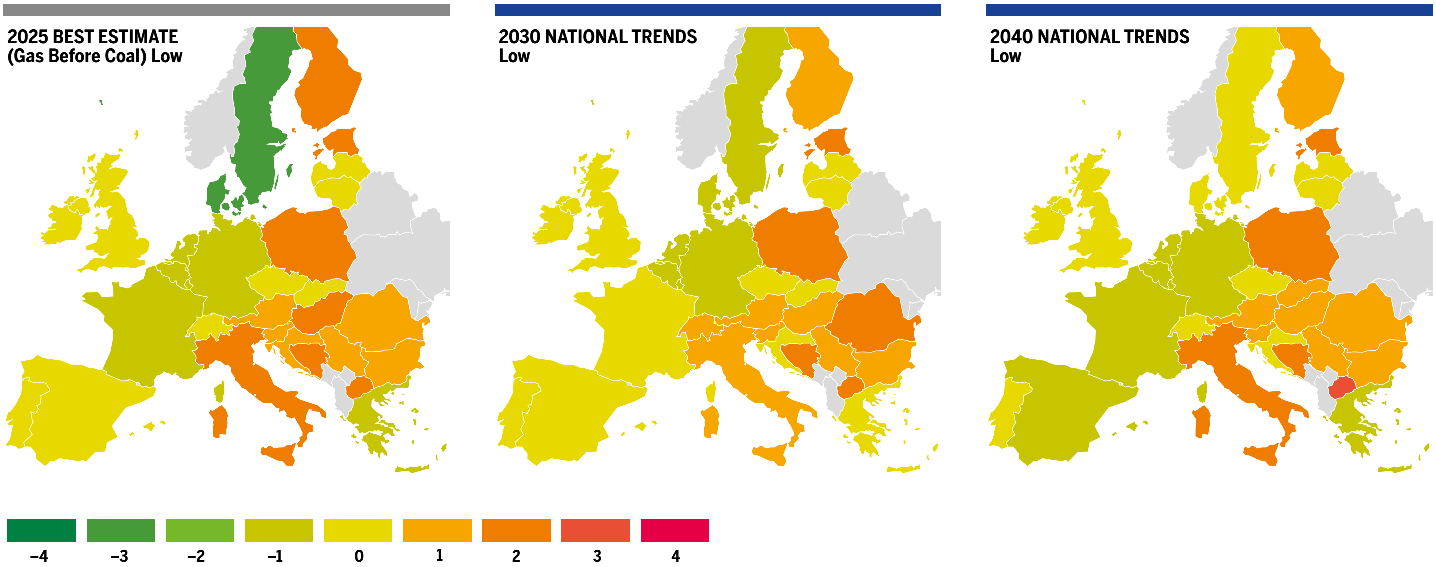


Figure 5.91 MP delta (EUR/MWh) – Low infrastructure level, South Max supply configuration

South Min

Signs of convergence are to be observed but Central-Eastern and South of Europe together with Baltic states are not converging with Western Europe.

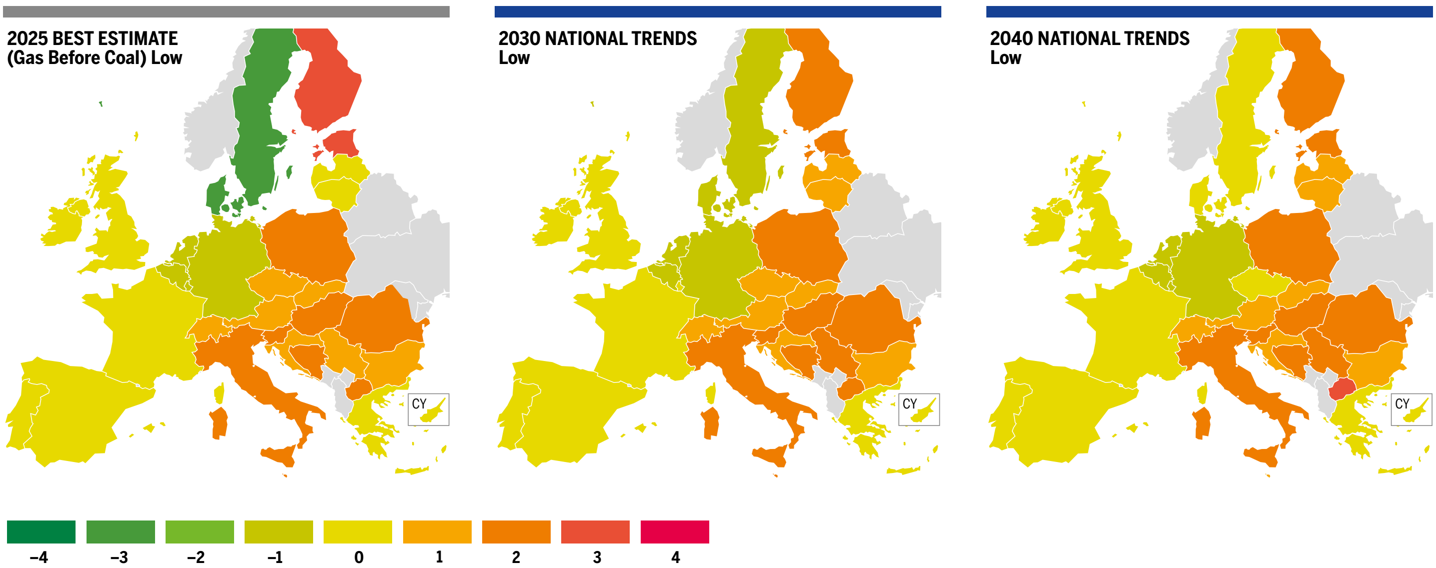


Figure 5.92 MP delta (EUR/MWh) – Low infrastructure level, South Min supply configuration

CONCLUSION

2025

FID projects further enhance the Marginal Price convergence between Central-Eastern Europe and the Baltic states.

However, in case of expensive Russian supply or low LNG price, the decommissioning project at the Danish-German border deteriorates the Marginal Price convergence between Denmark and Germany.

National Trends

2030–2040

East → West: FID projects generally enhance the Marginal Price convergence in Europe, especially between Central-Eastern Europe and the Baltic states, and in the Balkan region between Bulgaria and Serbia-Bosnia.

West → East: FID projects generally improve the price convergence in Eastern Europe, especially with the Baltic states. However, the main infrastructure limitations between Germany and Poland or Austria remain, with a limited improvement in 2040.

COP 21 scenarios

Distributed Energy

2030–2040

East → West: FID projects generally enhance the Marginal Price convergence in Europe, especially between Central-Eastern Europe and the Baltic states, and in the Balkan region between Bulgaria and Serbia-Bosnia.

West → East: FID projects generally improve the price convergence in Eastern Europe, especially with the Baltic states. The infrastructure limitations between Germany and Austria are mitigated and Marginal Prices converge between Germany, Czech Republic and Austria. However, infrastructure limitation between Germany and Poland remain, and marginal price differences between Austria-Czech Republic and Slovakia-Hungary reveal some remaining infrastructure limitations.

South-Eastern Europe: FID projects generally improve marginal price convergence in the region, however, they do not mitigate the infrastructure limitation between Greece and Bulgaria.

Global Ambition

2030–2040

East → West: FID projects generally enhance the Marginal Price convergence in Europe, especially between Central-Eastern Europe and the Baltic states, and in the Balkan region between Bulgaria and Serbia-Bosnia.

West → East: FID projects generally improve the price convergence in Eastern Europe, especially with the Baltic states. The infrastructure limitations between Germany and Austria are partially mitigated in 2030 and Marginal Prices convergence improve. However, other infrastructure limitations remain.

South-Eastern Europe: FID projects generally improve marginal price convergence in the region to a limited extent, however, they do not mitigate the infrastructure limitation between Greece and Bulgaria.

5.5.3 ADVANCED INFRASTRUCTURE LEVEL

Advanced projects are further improving the price convergence. Baltic states are connected to the rest of the Europe and new projects are allowing Denmark and Sweden to follow the same price signals.

For the result evaluation it is crucial to remember that demand weighted Reference Marginal Price was calculated for Advanced infrastructure level separately (for each year and scenario) which means that results cannot be compared with other infrastructure level directly. Important finding from evaluation of the results is observation of convergence – not the difference of the numerical value of Marginal Price calculated for each country.

Reference supply price configuration

In Reference supply price configuration case, the advanced level is improving price convergence for all scenarios, especially in Central Eastern and South European countries.

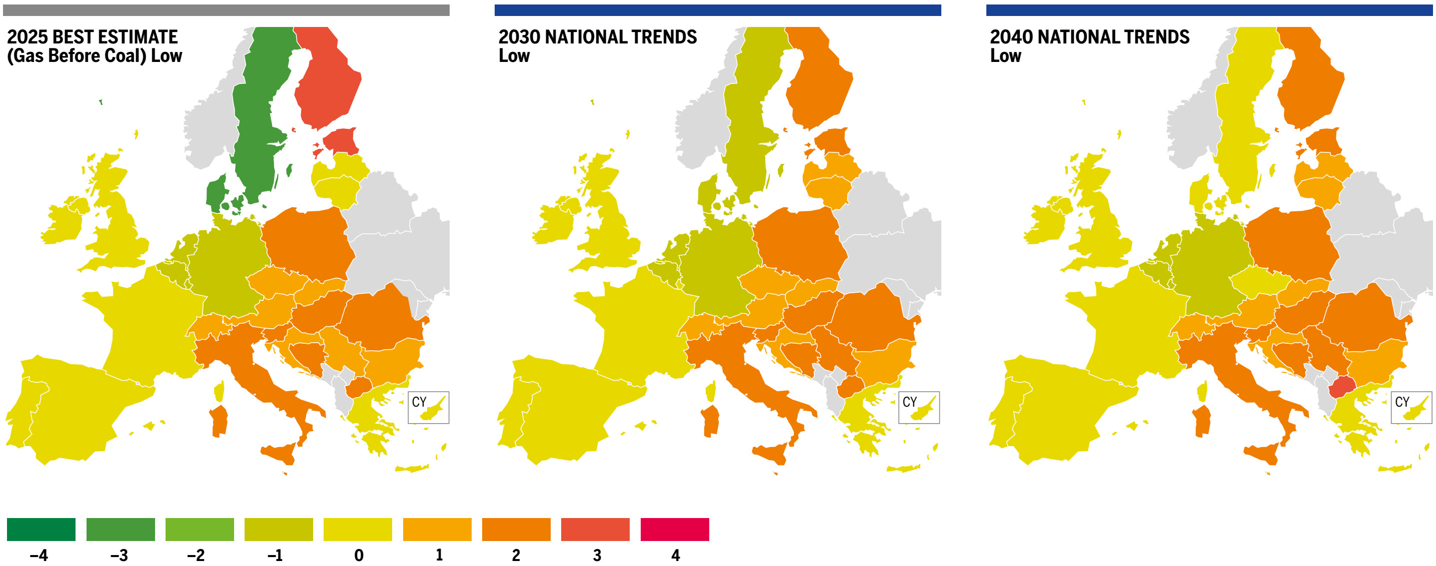


Figure 5.93 MP delta (EUR/MWh) – Advanced infrastructure level, Reference supply price configuration

LNG Max

The Advanced infrastructure level allows most of the Western and Central-Eastern and South countries to benefit of attractive prices of LNG.

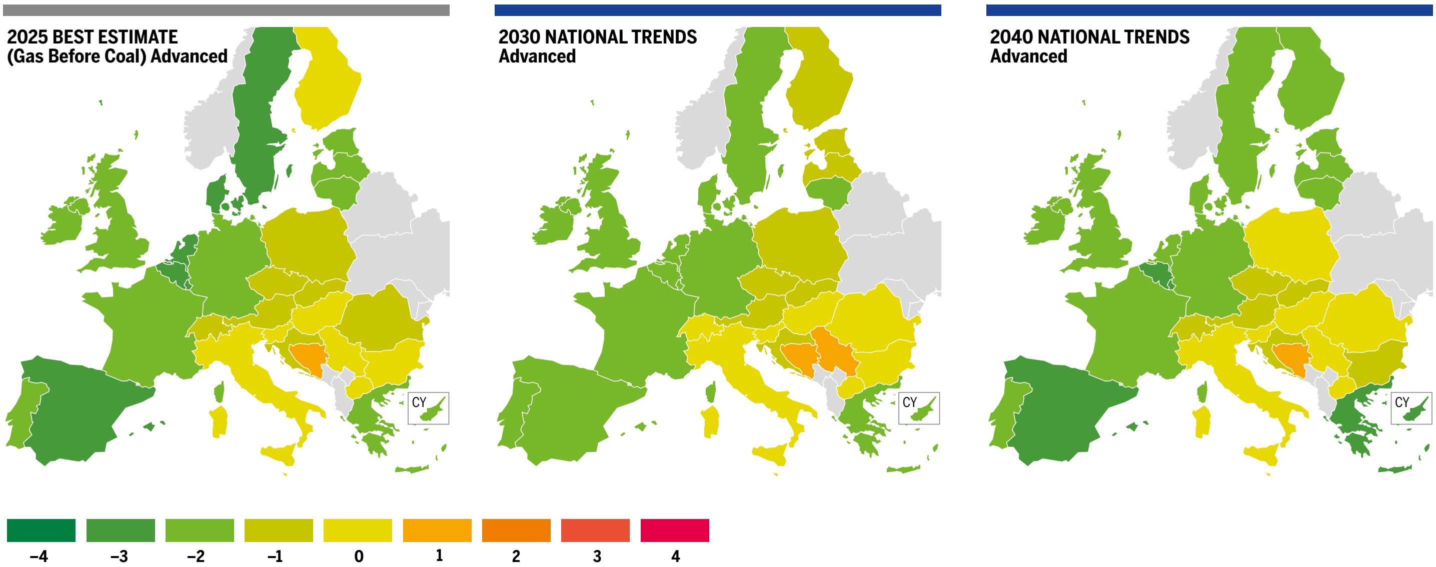


Figure 5.94 MP delta (EUR/MWh) – Advanced infrastructure level, LNG Max supply configuration

LNG Min

Limited convergence is observed in National Trends 2030 and 2040 in case of expensive LNG prices.

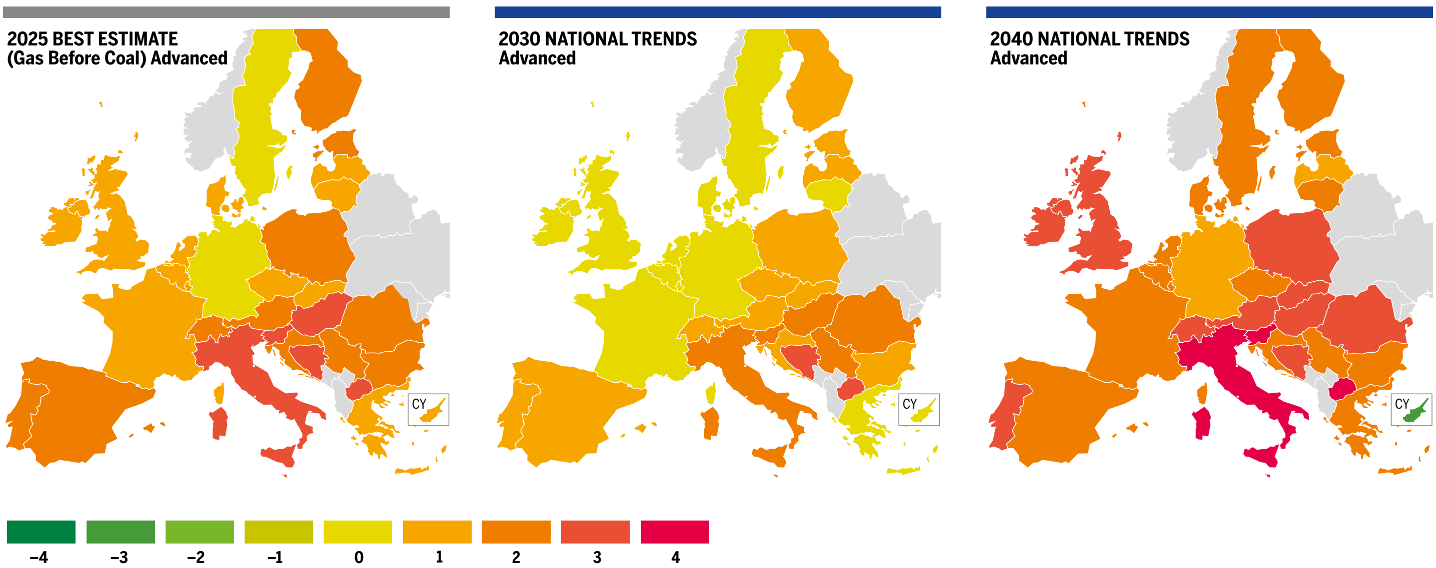


Figure 5.95 MP delta (EUR/MWh) – Advanced infrastructure level, LNG Min supply configuration

RU Max

Advanced infrastructure level allows most of the Western and Central-Eastern and South countries to benefit of attractive prices on the same basis as countries directly supplied by Russia. Differences in between countries are mostly caused by transmission tariffs.

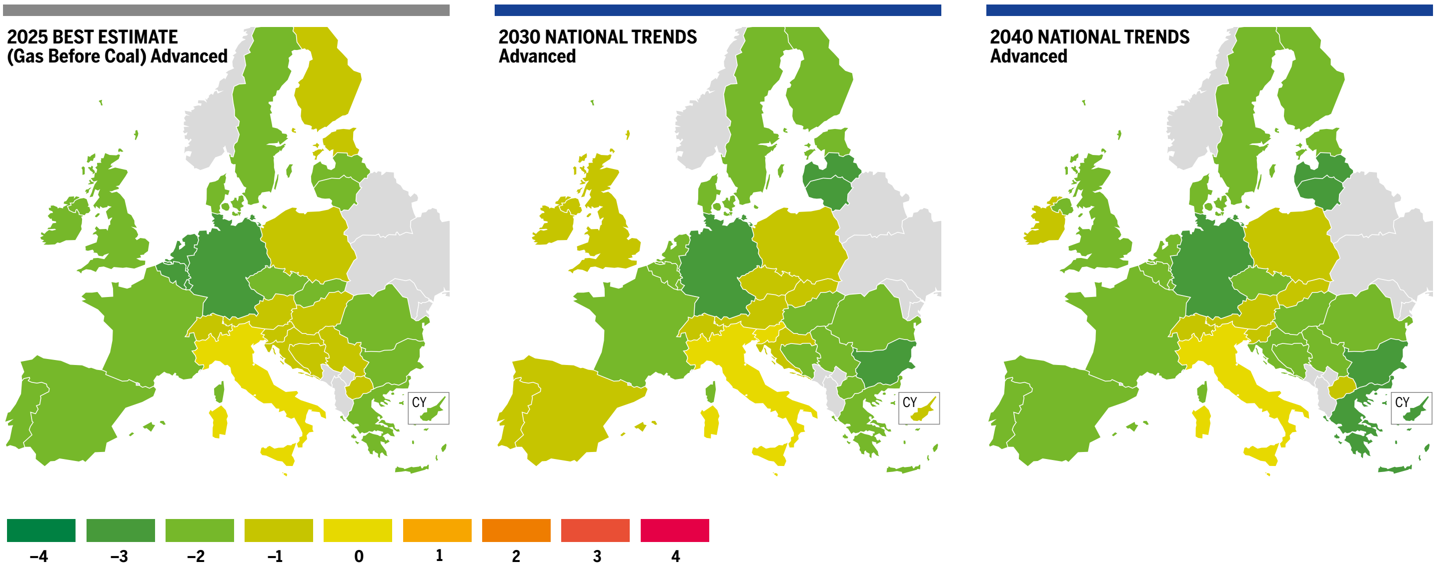


Figure 5.96 MP delta (EUR/MWh) – Advanced infrastructure level, Ru Max supply configuration

RU Min

In case of high prices of gas from Russia, European countries are converging with each other in similar way as in case of cheap gas from Russia.

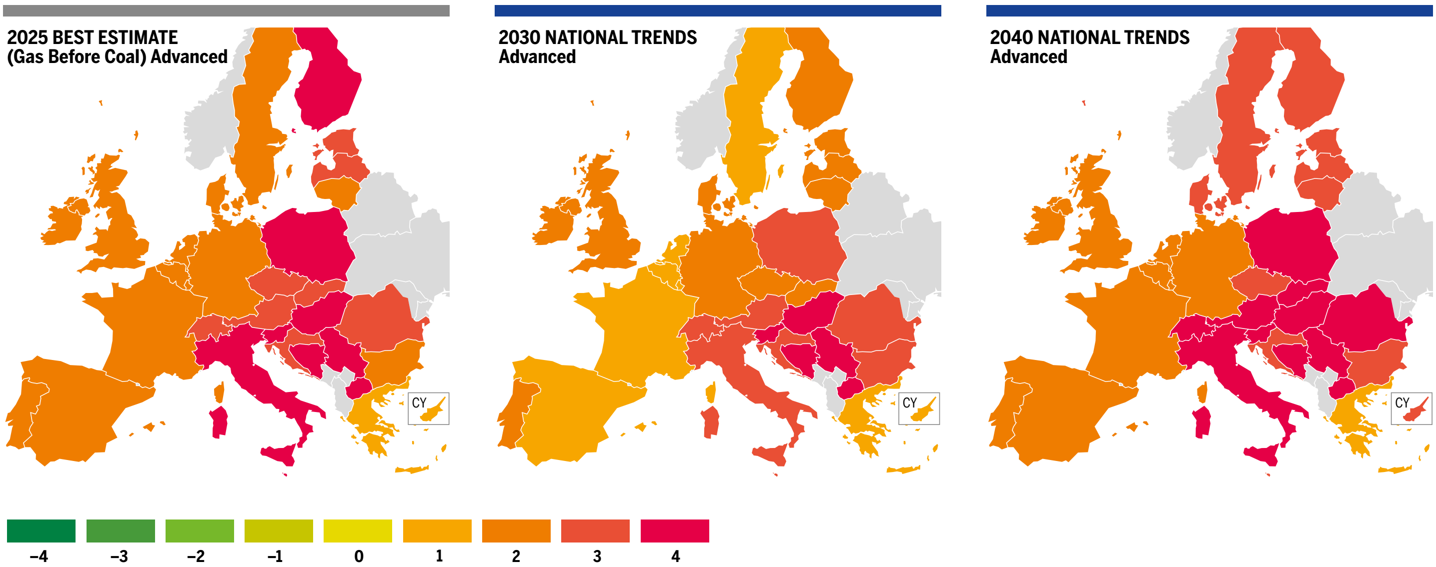


Figure 5.97 MP delta (EUR/MWh) – Advanced infrastructure level, Ru Min supply configuration

South Max

Limited improvement, in terms of convergence, provided by Advanced infrastructure level can be observed in case of preferential gas price from Southern sources.

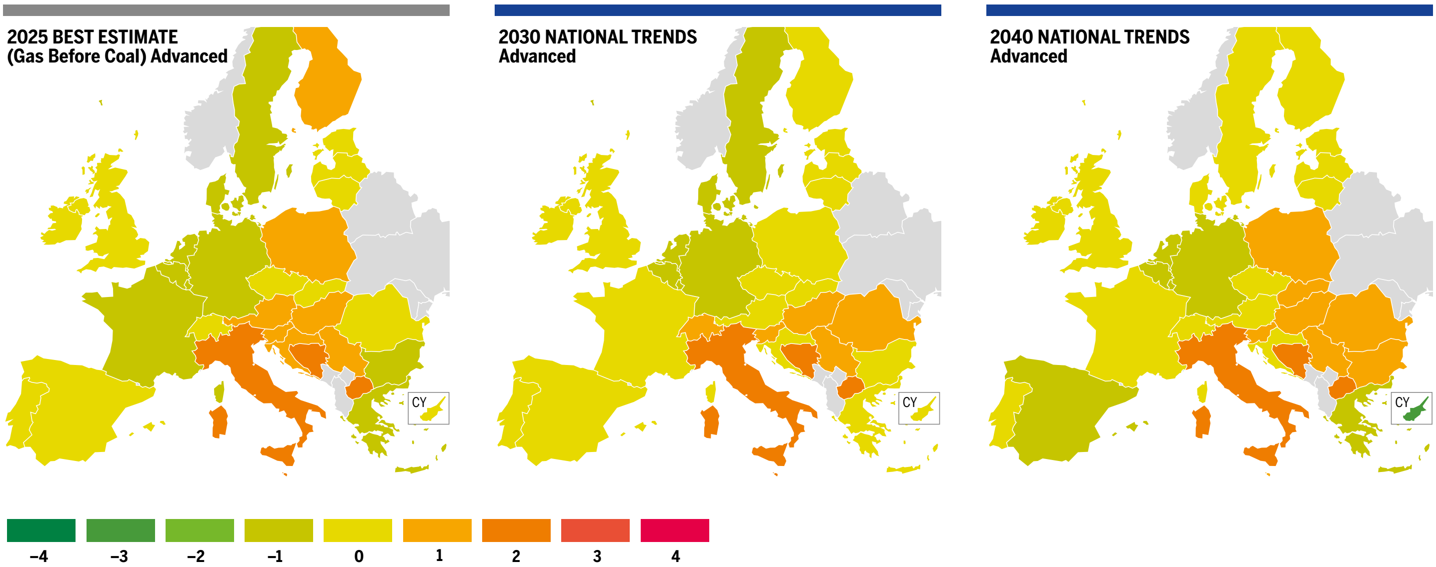


Figure 5.98 MP delta (EUR/MWh) – Advanced infrastructure level, South Max supply configuration

South Min

Central-Eastern and South Europe are showing signs of convergence in the situation of expensive gas from Southern sources, but price is not converging with Western Europe which Marginal Price is not affected by gas from this source.

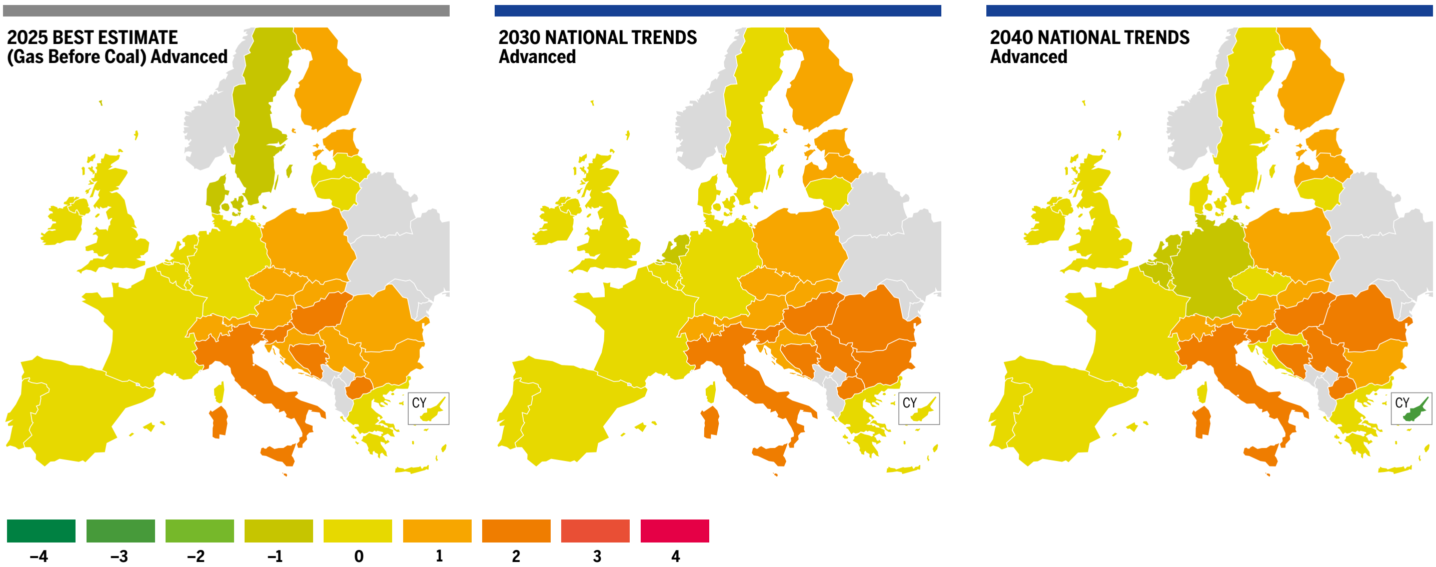


Figure 5.99 MP delta (EUR/MWh) – Advanced infrastructure level, South Min supply configuration

CONCLUSION

2025

Advanced projects further enhance the Marginal Price convergence in Eastern Europe, especially between Central-Eastern Europe and the Baltic states.

However, the main infrastructure limitations East → West and West → East remain.

National Trends

2030–2040

East → West: Advanced projects generally enhance the Marginal Price convergence in Europe.

West → East: Advanced projects significantly improve the price convergence in Europe as of 2030. However, identified limitations between Germany and Poland or Germany and Austria in the Low infrastructure level remain to a certain extent.

South-Eastern Europe: Advanced projects do not mitigate the infrastructure limitations between Greece and Bulgaria.

COP 21 scenarios

Distributed Energy

2030–2040

East → West: Advanced projects generally enhance the Marginal Price convergence in Europe.

West → East: Advanced projects significantly mitigate the West → East infrastructure limitations and improve the price convergence all over Europe.

South-Eastern Europe: Advanced projects generally improve marginal price convergence in the region; however, they do not mitigate the infrastructure limitation between Greece and Bulgaria.

Global Ambition

2030–2040

East → West: Advanced projects enhance the Marginal Price convergence in Europe.

West → East: Advanced projects significantly mitigate infrastructure limitations in Eastern Europe. However, the infrastructure limitations West → East remain and a misalignment of Marginal Prices between Germany and Poland or Austria can still be observed.

South-Eastern Europe: Advanced projects generally improve marginal price convergence in the region to a limited extent, however, they do not mitigate the infrastructure limitation between Greece and Bulgaria.

Picture courtesy of Enagás

5.5.4 PCI INFRASTRUCTURE LEVEL

PCI infrastructure level changes situation over the Europe by introduction of wide list of the projects that are improving convergence. It is worth to mention that this is not only selection of the projects from Advanced infrastructure level with the PCI status but as well list of further projects, less mature on the date of TYNDP publication.

For the result evaluation it is crucial to remember that demand weighted Reference Marginal Price was calculated for PCI infrastructure level separately (for each year and scenario) which means that results cannot be compared with other infrastructure level directly. Important finding from evaluation of the results is observation of convergence – not the difference of the numerical value of Marginal Price calculated for each country.

Reference supply price configuration

In Reference supply price configuration case, the advanced level is improving price convergence for all scenarios, especially in Central Eastern and South European countries.

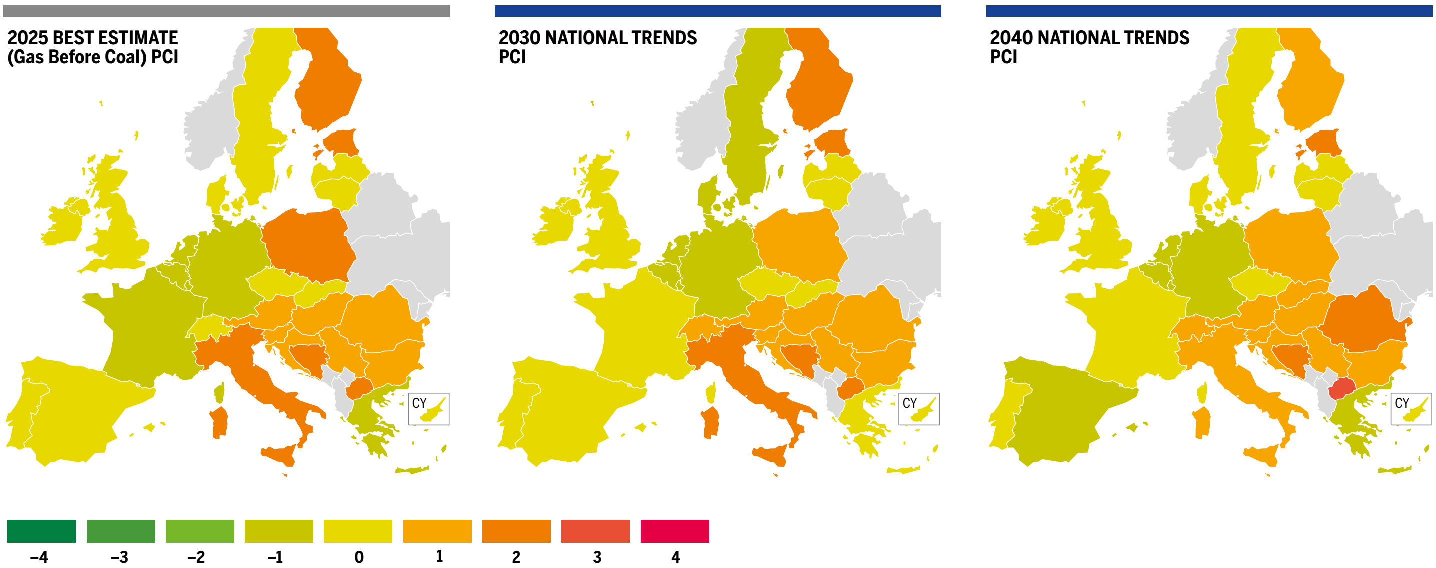


Figure 5.100 MP delta (EUR/MWh) – PCI infrastructure level, Reference supply price configuration

LNG Max

To some extend convergence can be observed between Central-East Europe, South Europe and Western Europe. With the consideration of PCI LNG terminal projects, many countries and neighbouring countries directly benefit from attractive LNG prices.

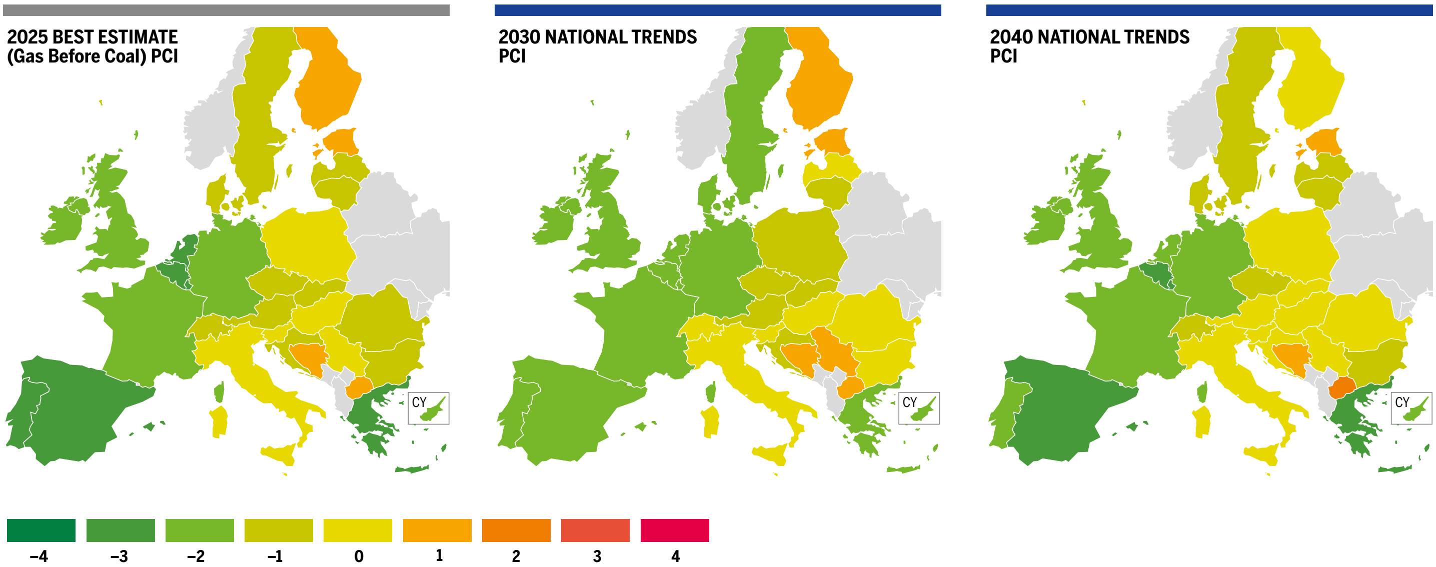


Figure 5.101 MP delta (EUR/MWh) – PCI infrastructure level, LNG Max supply configuration

LNG Min

A high LNG price can influence the marginal price in most of Europe but thanks to new layer of projects, in limited way. Limited convergence is observed in case of expensive LNG prices.

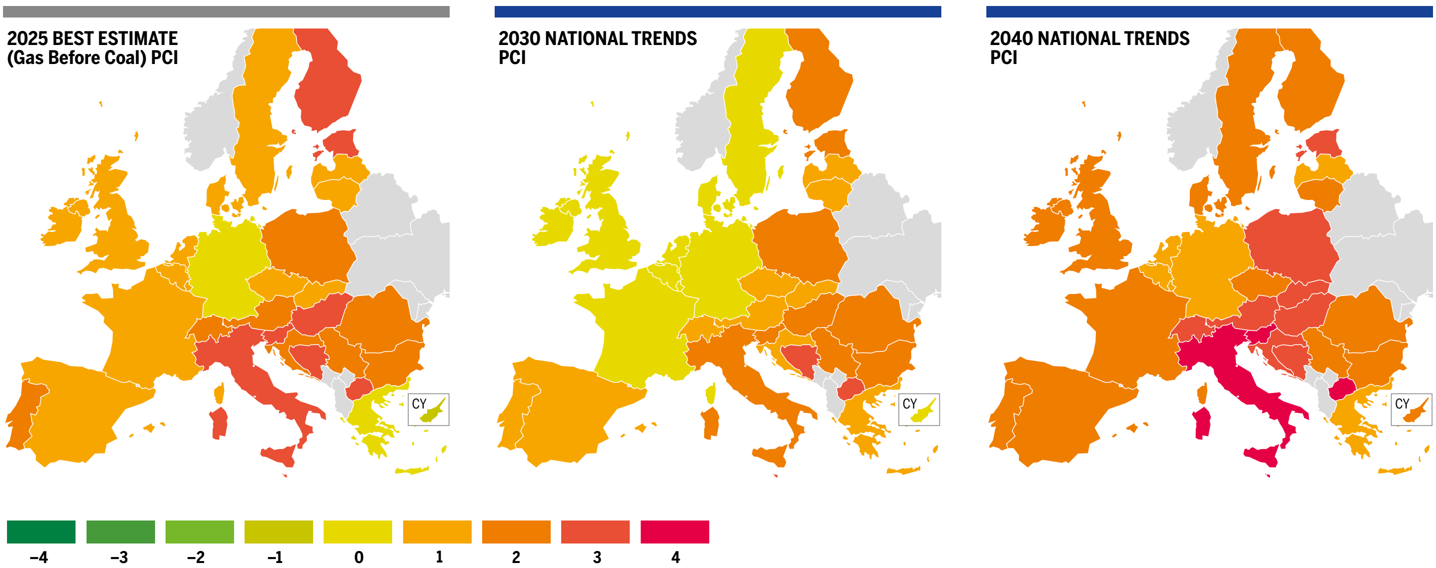


Figure 5.102 MP delta (EUR/MWh) – PCI infrastructure level, LNG Min supply configuration

RU Max

PCI infrastructure level allows most of the Western and Central-Eastern and South countries to benefit of attractive prices on the same basis as countries directly supplied by Russia. Differences in between countries are mostly caused by transmission tariffs.

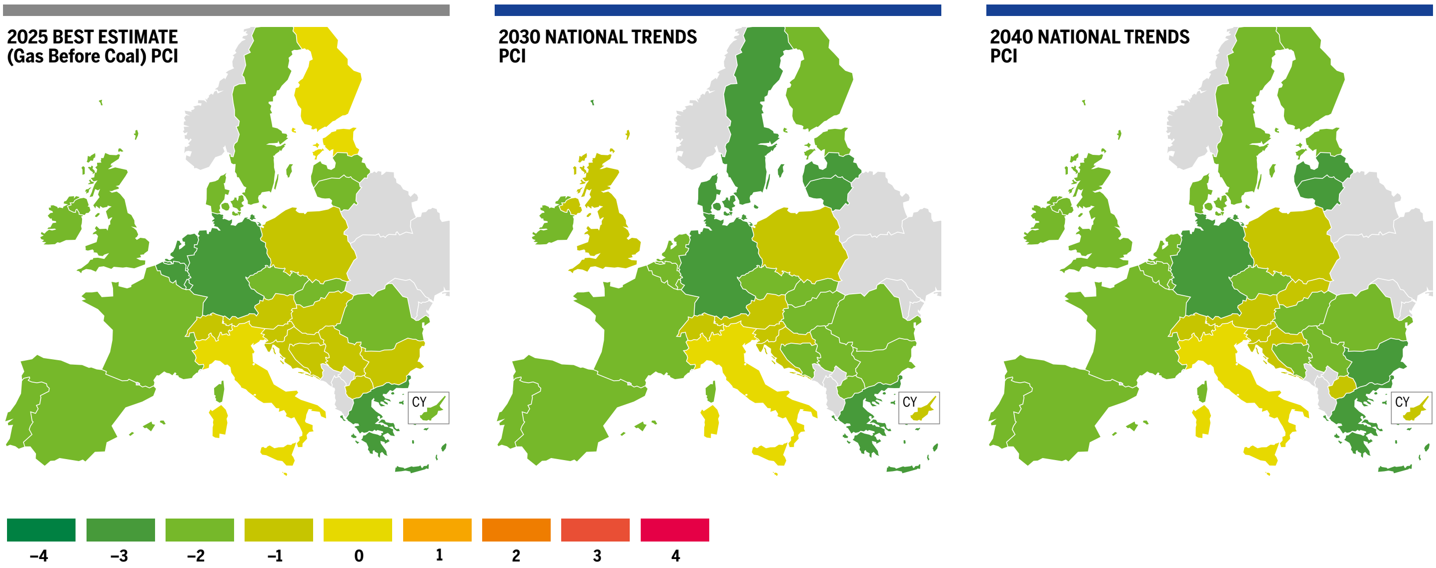


Figure 5.103 MP delta (EUR/MWh) – PCI infrastructure level, RU Max supply configuration

RU Min

In case of high prices of gas from Russia countries, Marginal Prices in countries shows similar trends as in case of cheap gas from Russia and is showing convergence.

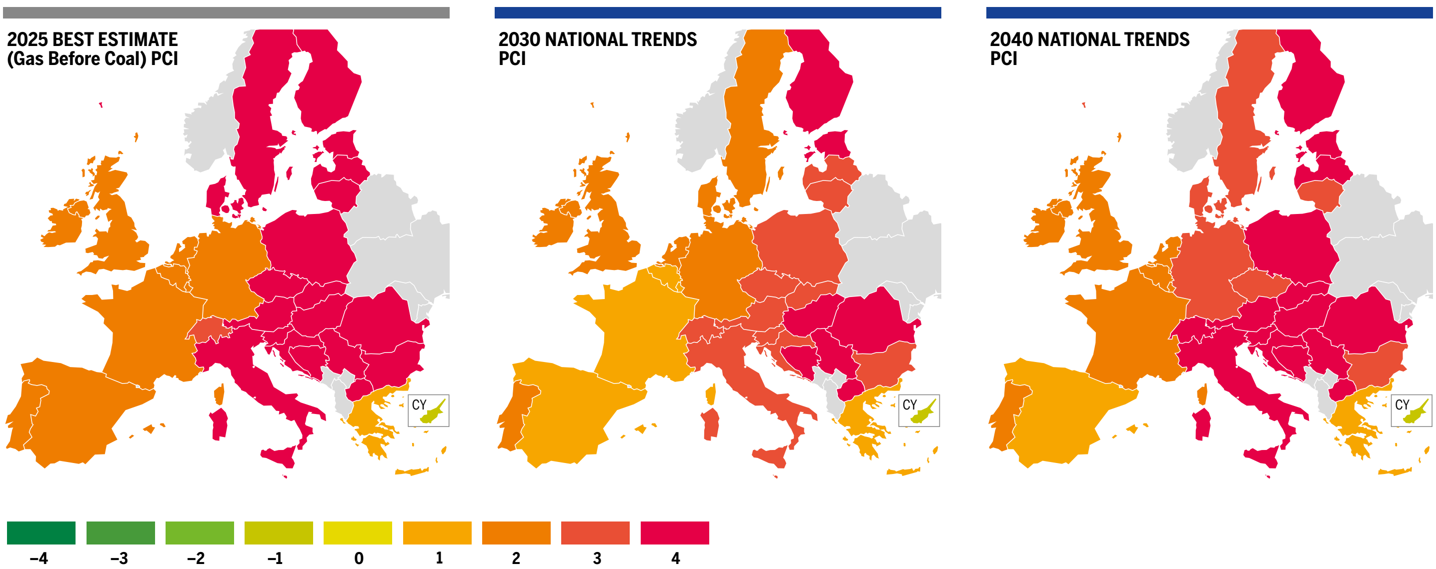


Figure 5.104 MP delta (EUR/MWh) – PCI infrastructure level, RU Min supply configuration

South Max

No significant changes observed in terms of convergence comparing to reference supply case.

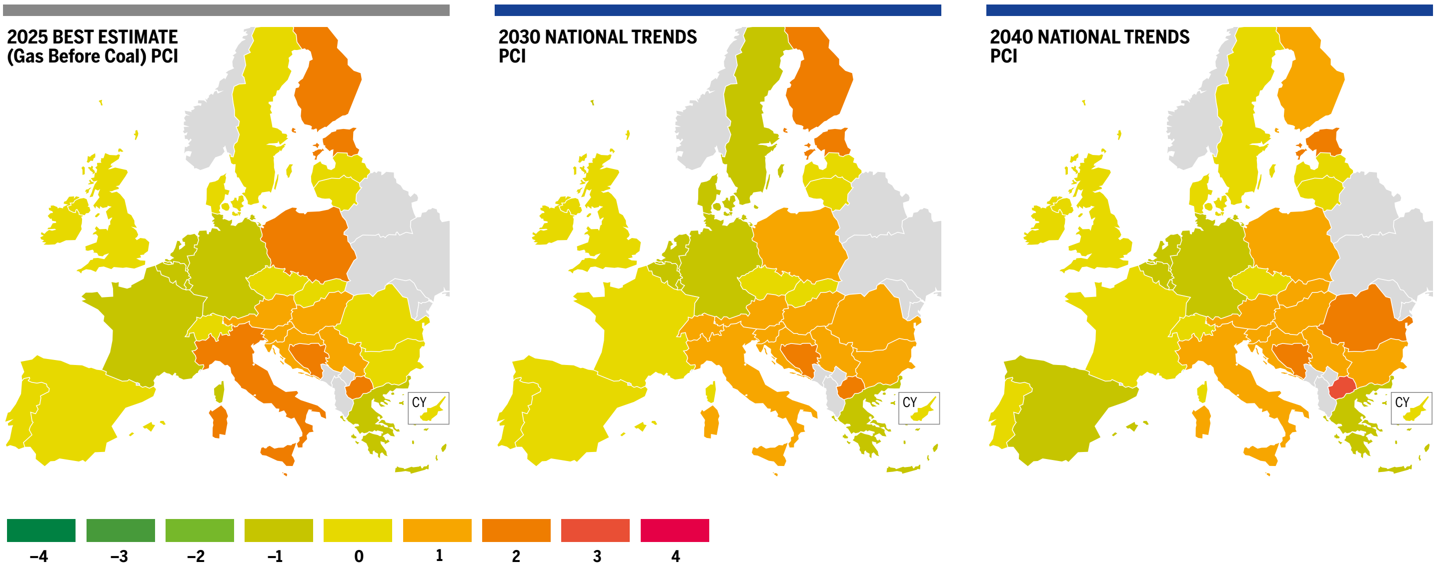


Figure 5.105 MP delta (EUR/MWh) – PCI infrastructure level, South Max supply configuration

South Min

Central-Eastern and South Europe are showing signs of convergence in the situation of expensive gas from Southern sources, but price is not converging with Western Europe which Marginal Price is not affected by gas from this source.

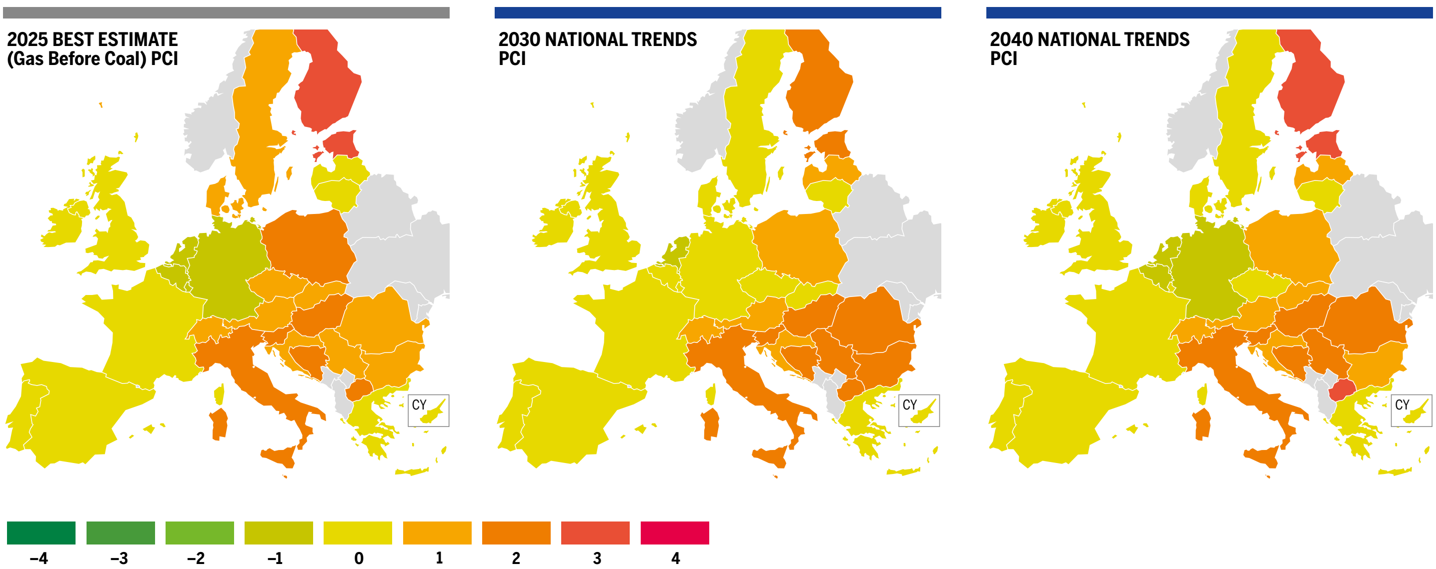


Figure 5.106 MP delta (EUR/MWh) – PCI infrastructure level, South Min supply configuration

CONCLUSION

2025

PCI infrastructure level projects further enhance the Marginal Price convergence in Eastern Europe.

However, the main infrastructure limitations East → West and West → East remain.

National Trends

2030–2040

East → West: PCI infrastructure level projects generally enhance the Marginal Price convergence in Europe.

West → East: PCI infrastructure level projects significantly improve the price convergence in Europe as of 2030. However, identified limitations between Germany and Poland or Germany and Austria in the Low infrastructure level remain to a certain extent.

South-Eastern Europe: PCI infrastructure level projects do not mitigate the infrastructure limitations between Greece and Bulgaria.

COP 21 scenarios

Distributed Energy

2030–2040

East → West: PCI infrastructure level projects generally enhance the Marginal Price convergence in Europe.

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Global Ambition

2030–2040

East → West: PCI infrastructure level projects generally enhance the Marginal Price convergence in Europe.

West → East: PCI infrastructure level projects significantly mitigate infrastructure limitations in Eastern Europe. However, the infrastructure limitations West → East remain and a misalignment of Marginal Prices between Germany and Poland or Austria can still be observed.

South-Eastern Europe: PCI infrastructure level projects generally improve marginal price convergence in the region to a limited extent, however, they do not mitigate the infrastructure limitation between Greece and Bulgaria.

5.5.5 WEIGHTED MARGINAL PRICE DEVIATION

Apart of the maps with presentation how Marginal Price in each country is different than Reference Marginal Price, Weighted Marginal Price Deviation was introduced. It is an average deviation calculated for each specific scenario, year and infrastructure level. Reference price was the same as used for Marginal price results interpretation, which allows to observe and compare increase of convergence between different infrastructure level. For the same reason, this indicator is calculated only for Reference supply price configuration where no specific gas source is significantly cheaper or more expensive than other.

For the results interpretation it is important to remember that demand weighted average deviation is used to measure dispersion between Marginal Prices in European countries and Reference value. Together with additional layer of infrastructure there is possibility to observe how new projects eliminating bottlenecks, creating new capacities between two countries or increasing existing capacity are improving situation. Results of WCF is impacted by the scenarios assumptions such as total demand in EU, demand in specific countries and national production – this is as well influencing different dispersion in comparison of different year and scenario.

The Weighted Marginal Price Deviation measures the dispersion of Marginal Price deltas. The lower Marginal Prices deltas are, the better the Marginal Price convergence. This indicator allows to see direct impact of the infrastructure level, with no interference due to transmission tariffs.

Weighted Marginal Price Deviation results show that successive layers of infrastructure projects (aggregated in infrastructure levels Low, Advanced and PCI) are improving convergence comparing to Existing infrastructure level. New infrastructure projects are decreasing dispersion of Marginal Price deltas (decreasing value of the indicator) around the Europe which is a sign of convergence improvement.

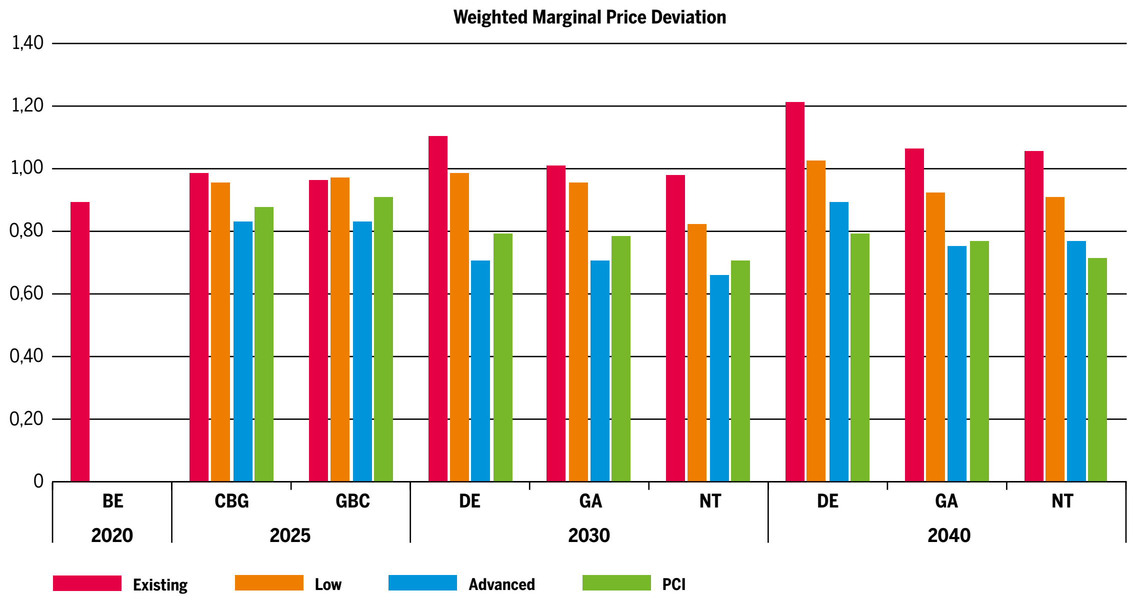

Figure 5.107 Weighted Marginal Price Deviation

5.5.6 CONCLUSION

The gas infrastructure is key to enable an efficient and competitive gas market. Gas prices generally observed in the EU confirm the efficiency of the European gas infrastructure to ensure price convergence. However, when the European supply flow pattern is oriented from the West to the East or South to North, some regions still experience some misalignment in their marginal price with their neighbouring market areas which are not only reflecting the infrastructure tariffs, but also resulting from infrastructure limitations.

However, the assessment of the different infrastructure level confirm that FID and Advanced projects can further enhance the gas price convergence throughout Europe up to 35 % in Distributed Energy in 2030. The PCI infrastructure projects can improve the convergence of the European gas prices too, however to a lesser extent than the Advanced infrastructure projects.

LIST OF **FIGURES**

LIST OF **TABLES**

Picture courtesy of FGSZ

LIST OF **ABBREVIATIONS**

ACER	Agency for the Cooperation of Energy Regulators
Bcm/Bcma	Billion cubic meters/Billion cubic meters per annum
CAM NC	Capacity Allocation Mechanism Network Code
CAPEX	Capital expenditure
CBA	Cost-Benefit Analysis
CIS	Commonwealth of Independent States
DIR-73	Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.
EBP	European Border Price
EC	European Commission
EIA	Energy Information Administration
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ETS	European Trading Scheme
EU	European Union
FEED	Front End Engineering Design
FID	Final Investment Decision
GCV	Gross Calorific Value
GIE	Gas Infrastructure Europe
GHG	Greenhouse Gases
GLE	Gas LNG Europe
GRIP	Gas Regional Investment Plan
GSE	Gas Storage Europe
GWh	Gigawatt hour
e-GWh	Gigawatt hour electrical
GQO	Gas Quality Outlook
HHI	Herfindahl-Hirschman-Index
H-gas	High calorific gas
HDV	Heavy duty vehicles
HGV	Heavy goods vehicles
IEA	International Energy Agency
IP	Interconnection Point
ktoe	A thousand tonnes of oil equivalent. Where gas demand figures have been calculated in TWh (based on GCV) from gas data expressed in ktoe, this was done on the basis of NCV and it was assumed that the NCV is 10 % less than GCV.
L-gas	Low calorific gas
LDV	Light Duty Vehicles
LNG	Liquefied Natural Gas

mcm	Million cubic meters
MMBTU	Million British Thermal Unit
MS	Member State
MTPA	Million Tonnes Per Annum
mtoe	A million tonnes of oil equivalents. Where gas demand figures have been calculated in TWh (based on GCV) from gas data expressed in mtoe, this was done on the basis of NCV and it was assumed that the NCV is 10 % less than GCV.
MWh	Megawatt hour
e-MWh	Megawatt hour electrical
NCV	Net Calorific Value
NERAP	National Energy Renewable Action Plans
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operational expenditure
PCI	Project of Common Interest
P2G	Power-to-Gas
REG-703	REGULATION (EU) 2015/703 of 30 April 2015 establishing a network code on interoperability and data exchange rules
REG-347	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	Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks.
REG-SoS	Regulation (EU) No 994/2010 of the European Parliament and of the Council of 20 October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC.
RES	Renewable Energy Sources
SIF/SWF	Seasonal Injection Factor/Seasonal Withdrawal Factor
SLI	Single Largest Infrastructure
SLID	Single Largest Infrastructure Disruption
SoS	Security of Supply
Tcm	Tera cubic meter
TSO	Transmission System Operator
TWh	Terawatt hour
e-TWh	Terawatt hour electrical
TYNDP	Ten-Year Network Development Plan
UGS	Underground Gas Storage (facility)
WI	Wobbe Index

COUNTRY CODES (ISO)

AL	Albania
AT	Austria
AZ	Azerbaijan
BA	Bosnia and Herzegovina
BE	Belgium
BG	Bulgaria
BY	Belarus
CH	Switzerland
CY	Cyprus
CZ	Czech Republic
DE	Germany
DK	Denmark
DZ	Algeria
EE	Estonia
ES	Spain
FI	Finland
FR	France
GR	Greece
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LT	Lithuania
LU	Luxembourg
LV	Latvia
LY	Libya
MA	Morocco
ME	Montenegro
MK	FYROM
MT	Malta
NL	Netherlands, the
NO	Norway
PL	Poland
PT	Portugal
RO	Romania
RS	Serbia
RU	Russia
SE	Sweden
SI	Slovenia
SK	Slovakia
TM	Turkmenistan
TN	Tunisia
TR	Turkey
UA	Ukraine
UK	United Kingdom

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