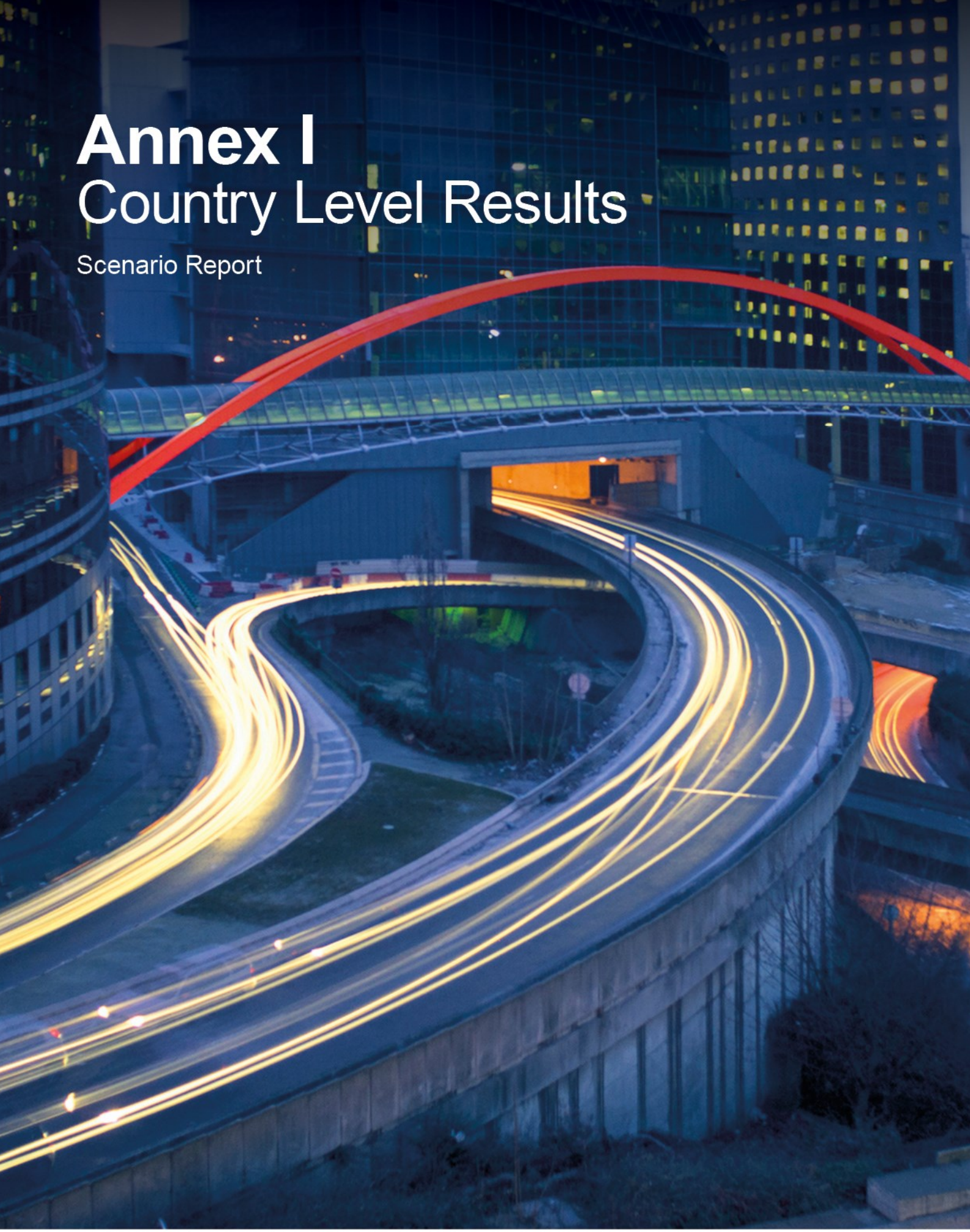
Annex I
Country Level Results

Scenario Report



entsog
european network of transmission system operators for gas

entsoe
Reliable Sustainable Connected

1. Country Level Results

1.1. Demand

1.1.1. Electricity Demand

Figure 1: Electricity annual demand on a country level (DE, ES, FR, GB, IT, PL, TR)

Figure 2: Electricity annual demand on a country level (AT, BE, BG, CH, CZ, DK, FI, GR)

Figure 3: Electricity annual demand on a country level (HR, HU, IE, IS, NL, NO, PT, RO)

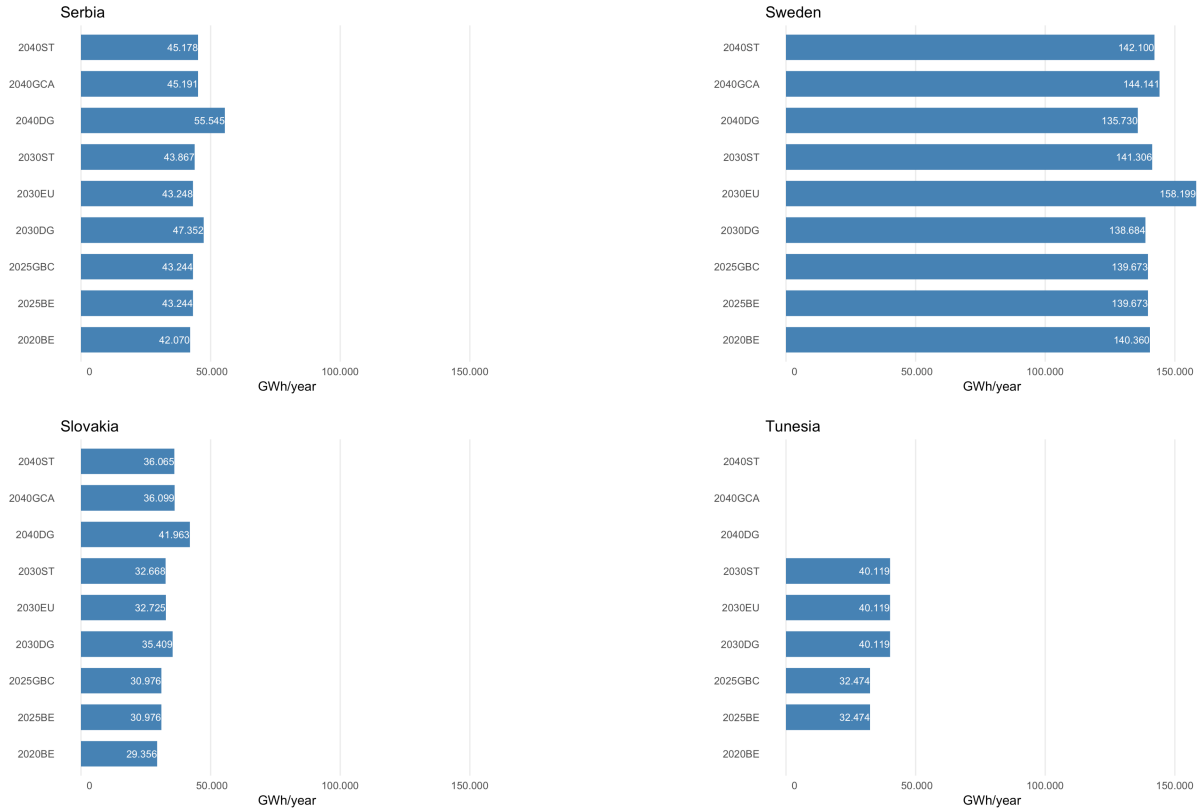


Figure 4: Electricity annual demand on a country level (RS, SE, SK, TU)

Figure 5: Electricity annual demand on a country level (AL, BA, CY, EE, IS, LT, LU, LV)

Figure 6: Electricity annual demand on a country level (ME, MK, MT, NI, SI)

1.1.2. Gas Demand

1.1.2.1. Country level sectoral split The following maps display the annual gas demand on a country level basis. The size of the pie chart is representative of the volume of demand, with the sectoral share displayed as well as an indication if this volume is an increase or decrease when compared to the historic average (calculated from 2010 to 2016).

2020—Best Estimate

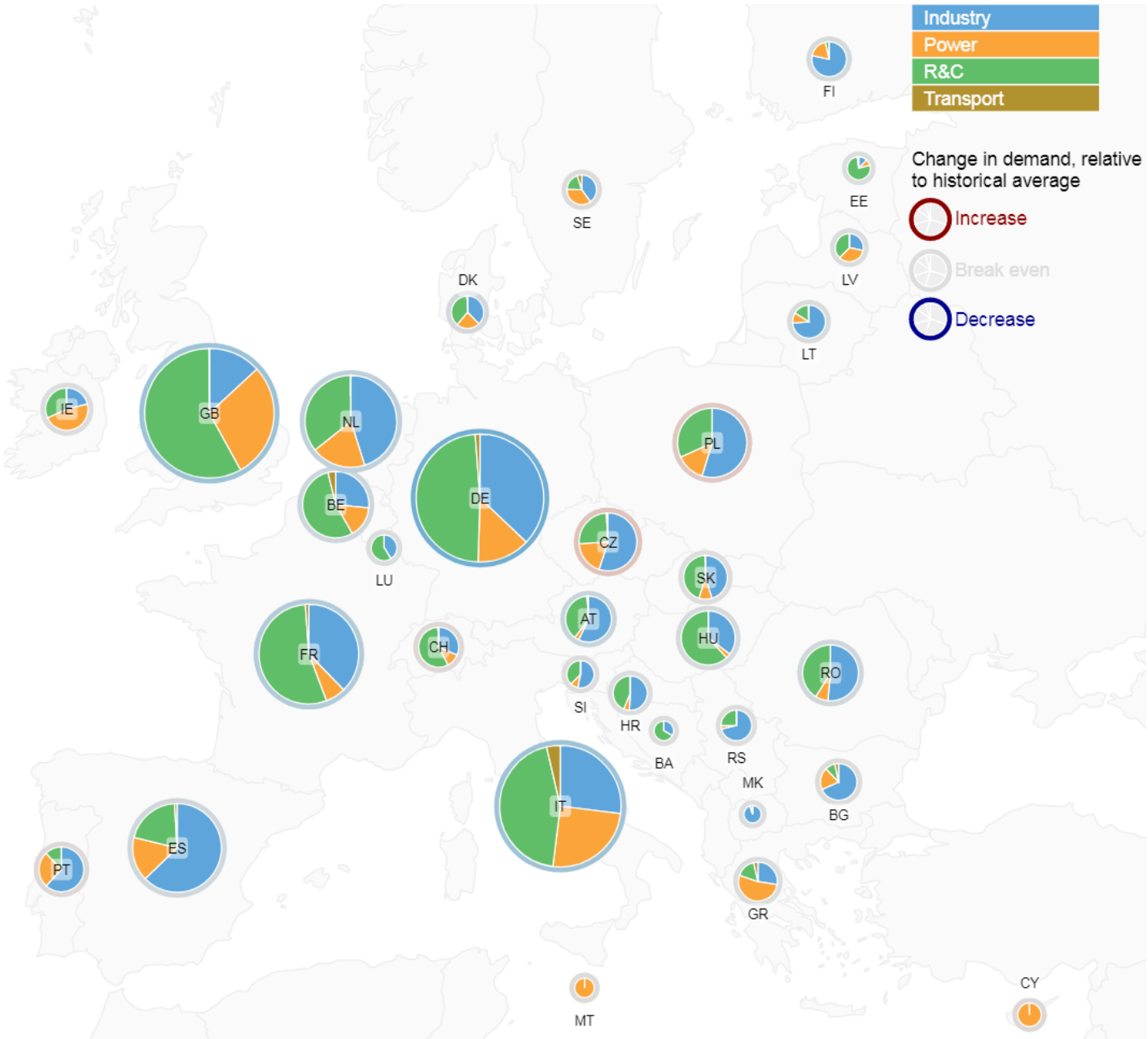


Figure 7: 2020 Best Estimate: Country level gas demand with sectoral split, with relative change to historic average

2025—Best Estimate

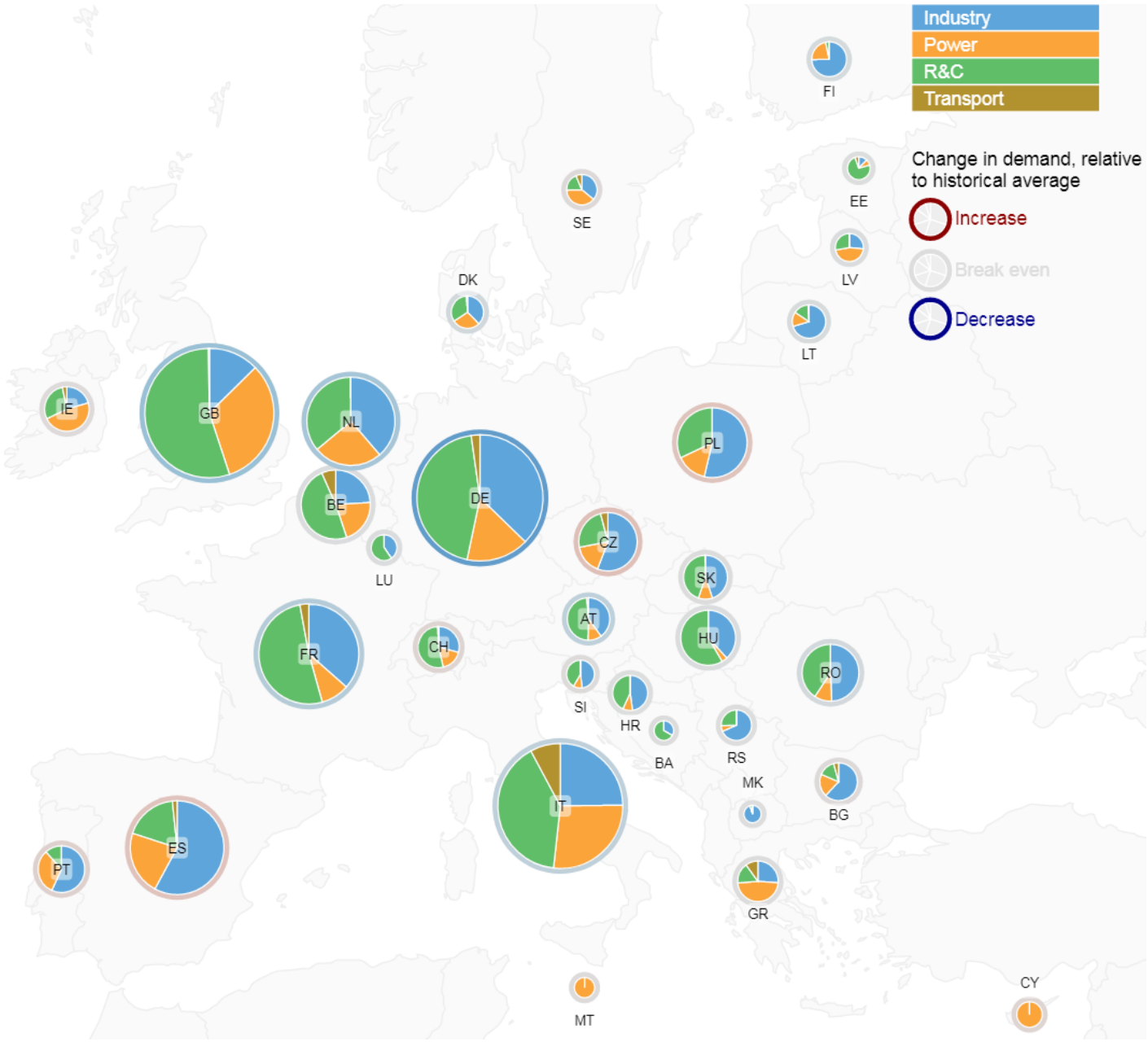


Figure 8: 2025 Best Estimate: Country level gas demand with sectoral split, with relative change to historic average

2025 Gas before Coal

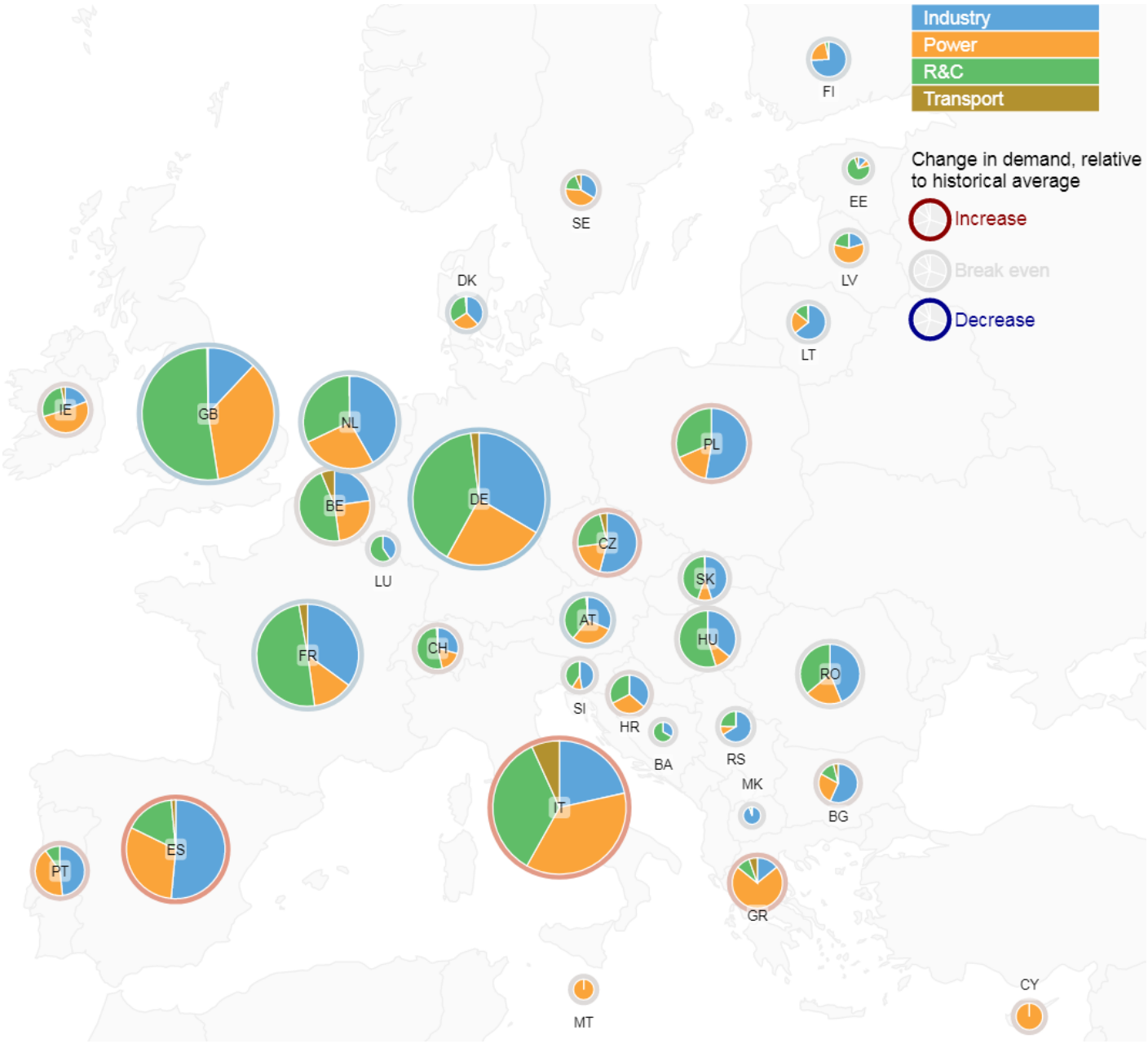


Figure 7: 2025 Gas before Coal: Country level gas demand with sectoral split, with relative change to historic average

2030 Distributed Generation

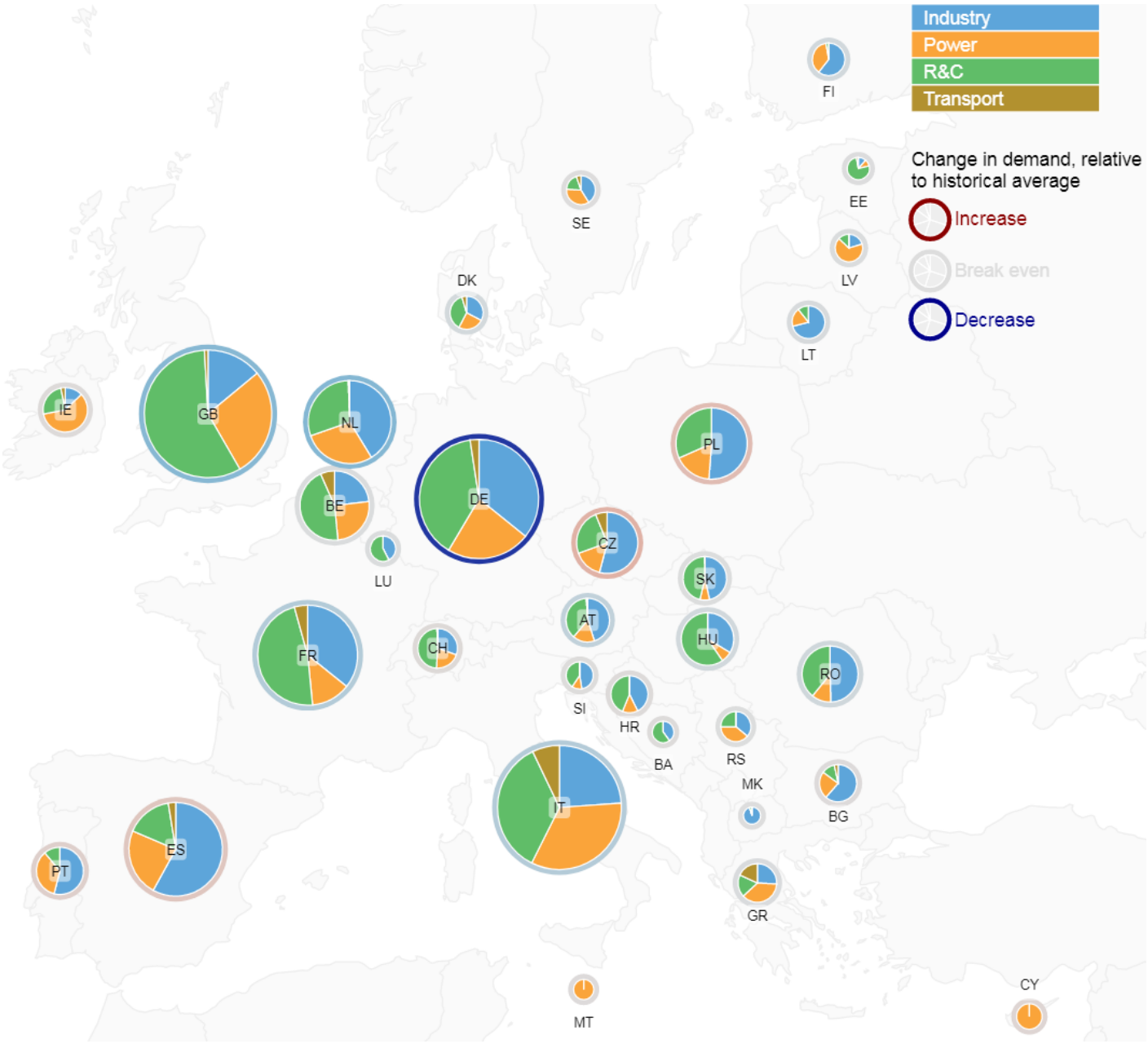


Figure 9: 2030 Distributed Generation: Country level gas demand with sectoral split, with relative change to historic average

2040 Distributed Generation

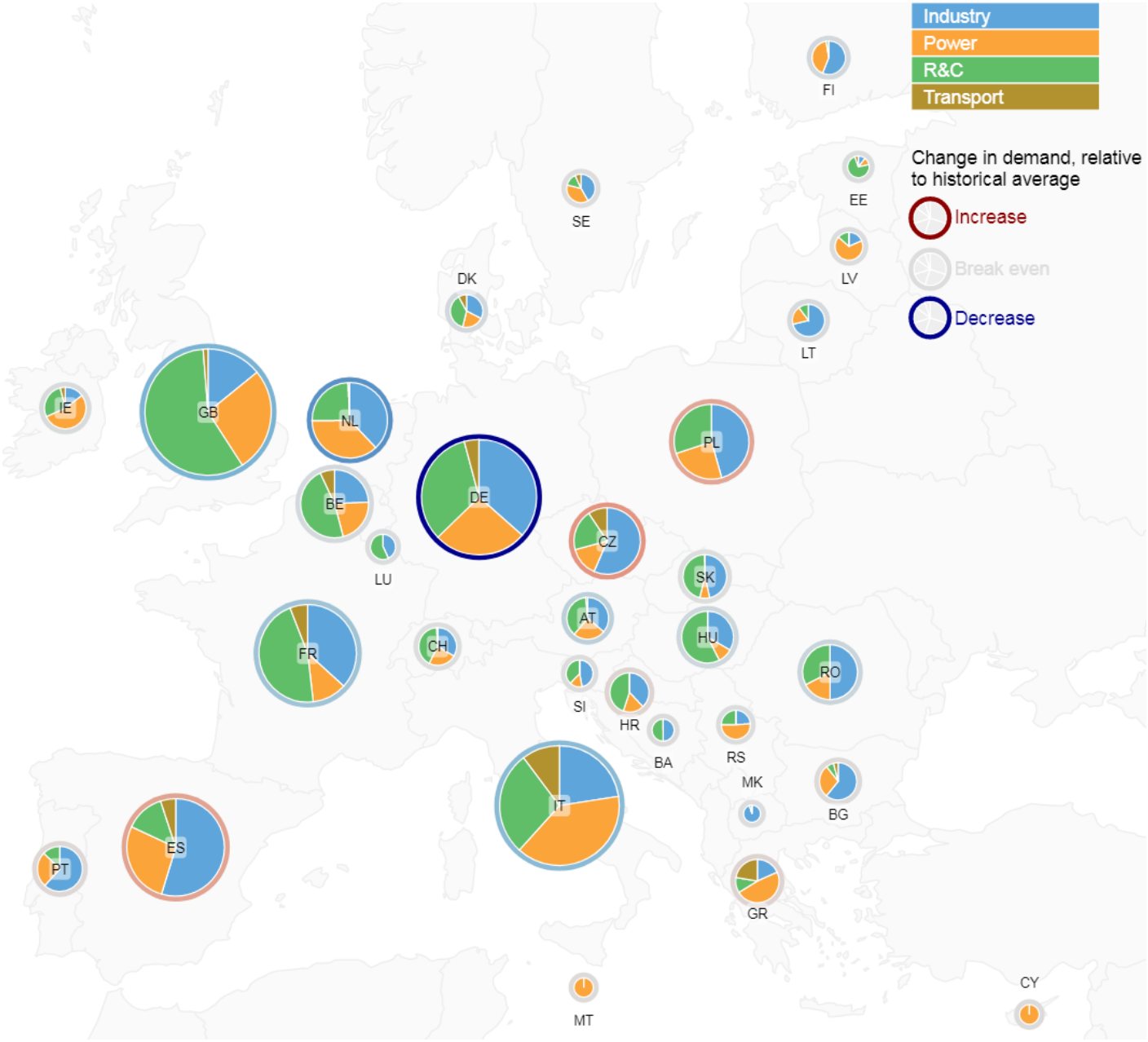


Figure 10: 2040 Distributed Generation: Country level gas demand with sectoral split, with relative change to historic average

2030 EUCO

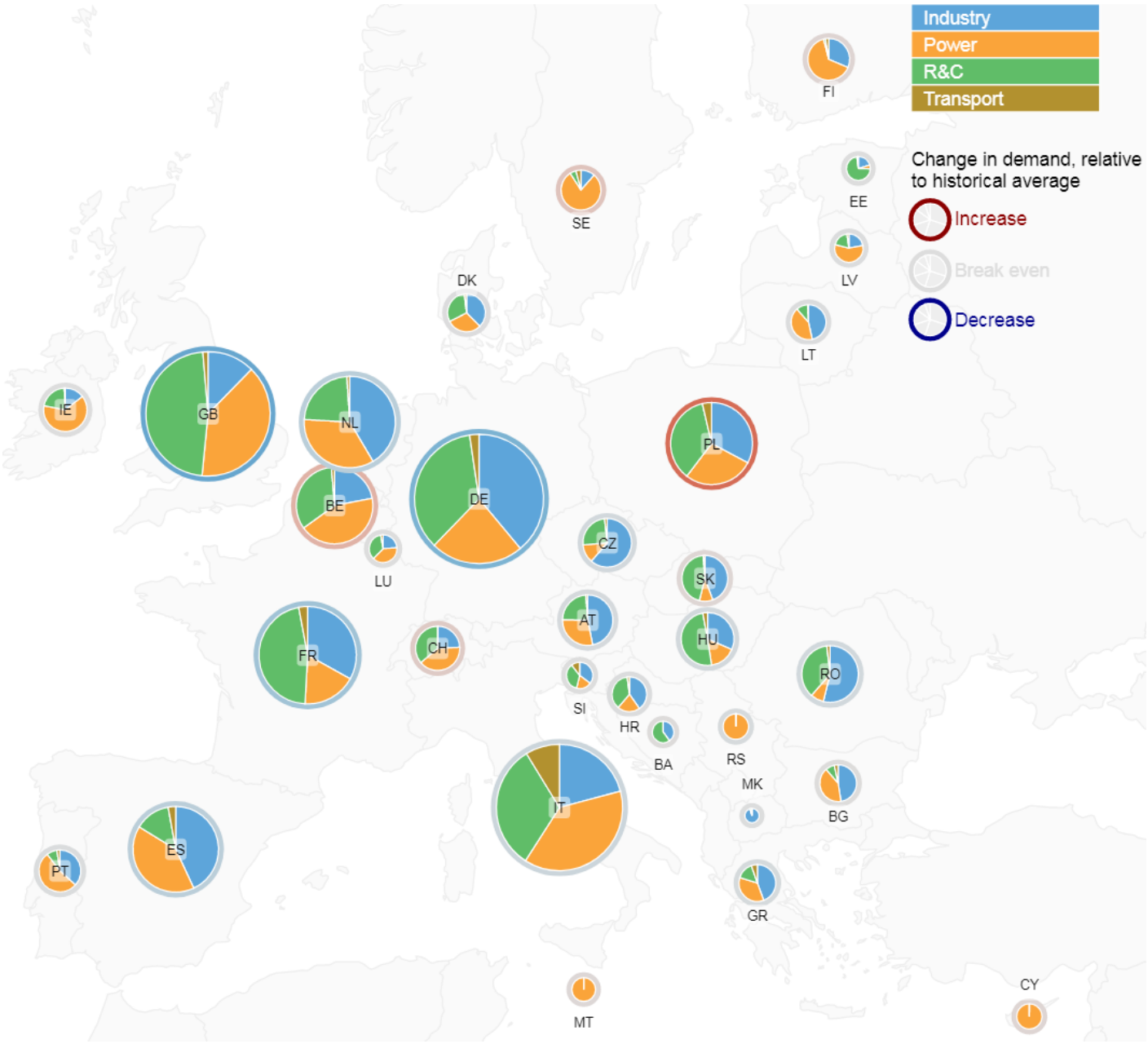


Figure 7: 2030 EUCO: Country level gas demand with sectoral split, with relative change to historic average

2040 Global Climate Action

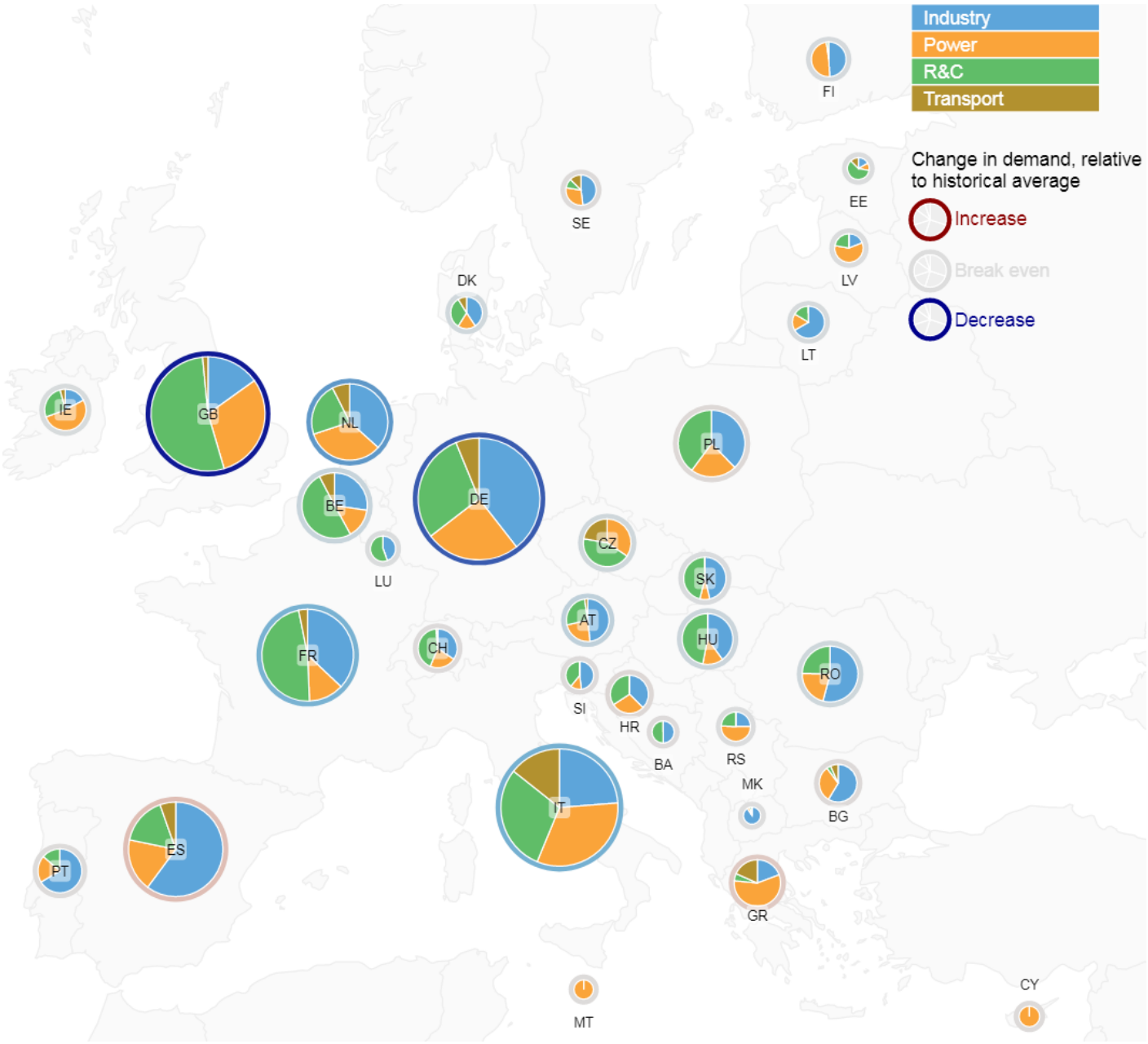


Figure 7: 2040 Global Climate Action: Country level gas demand with sectoral split, with relative change to historic average

2030 Sustainable Transition

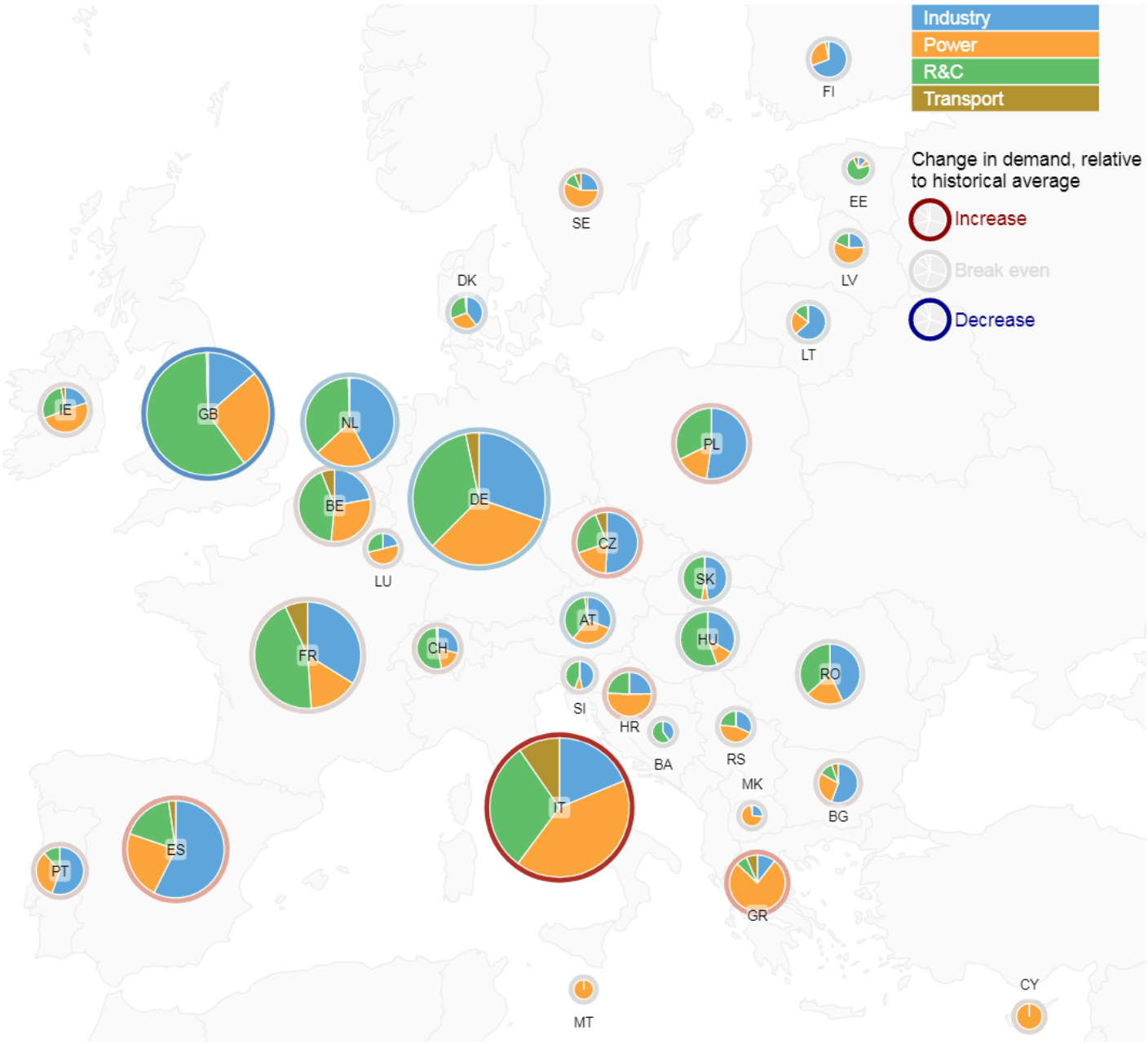


Figure 7: 2030 Sustainable Transition: Country level gas demand with sectoral split, with relative change to historic average

2040 Sustainable Transition

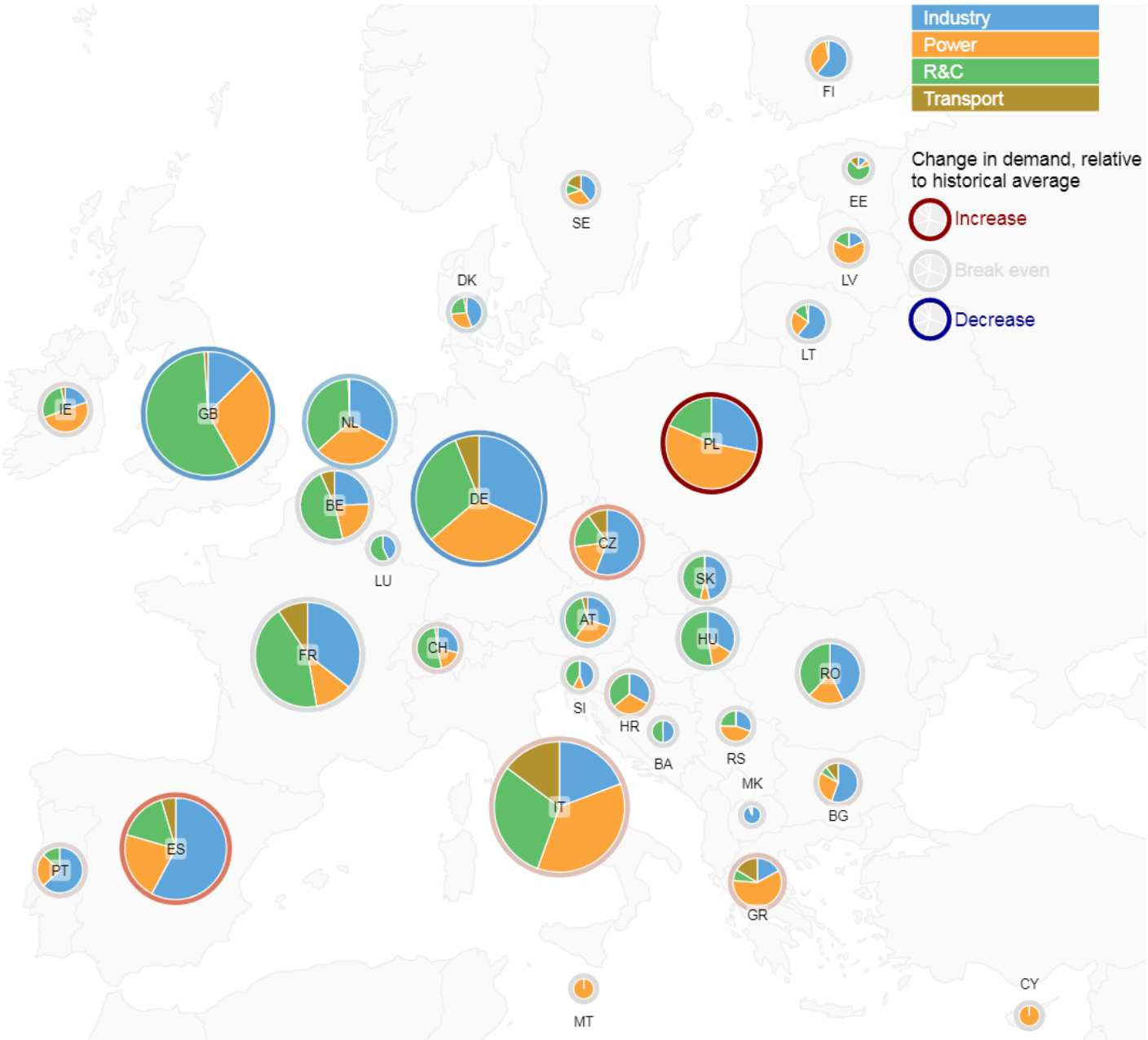


Figure 7: 2040 Sustainable Transition: Country level gas demand with sectoral split, with relative change to historic average

1.1.2.2. Gas High Demand Cases

The following charts show the high demand cases displayed by the 2 week and peak1 requirements, on a country level basis.

2020—Best Estimate

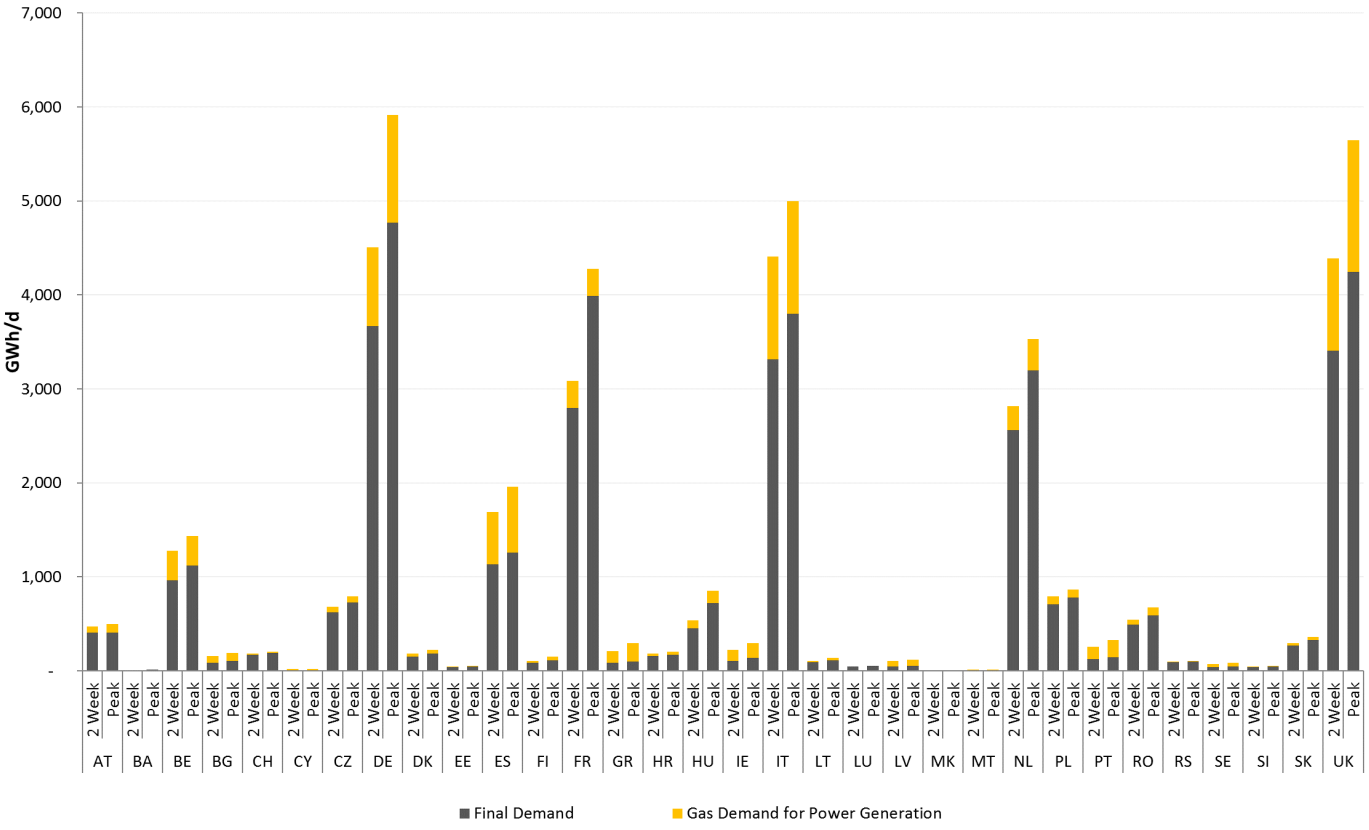


Figure 16: Gas high demand cases – 2020 Best Estimate

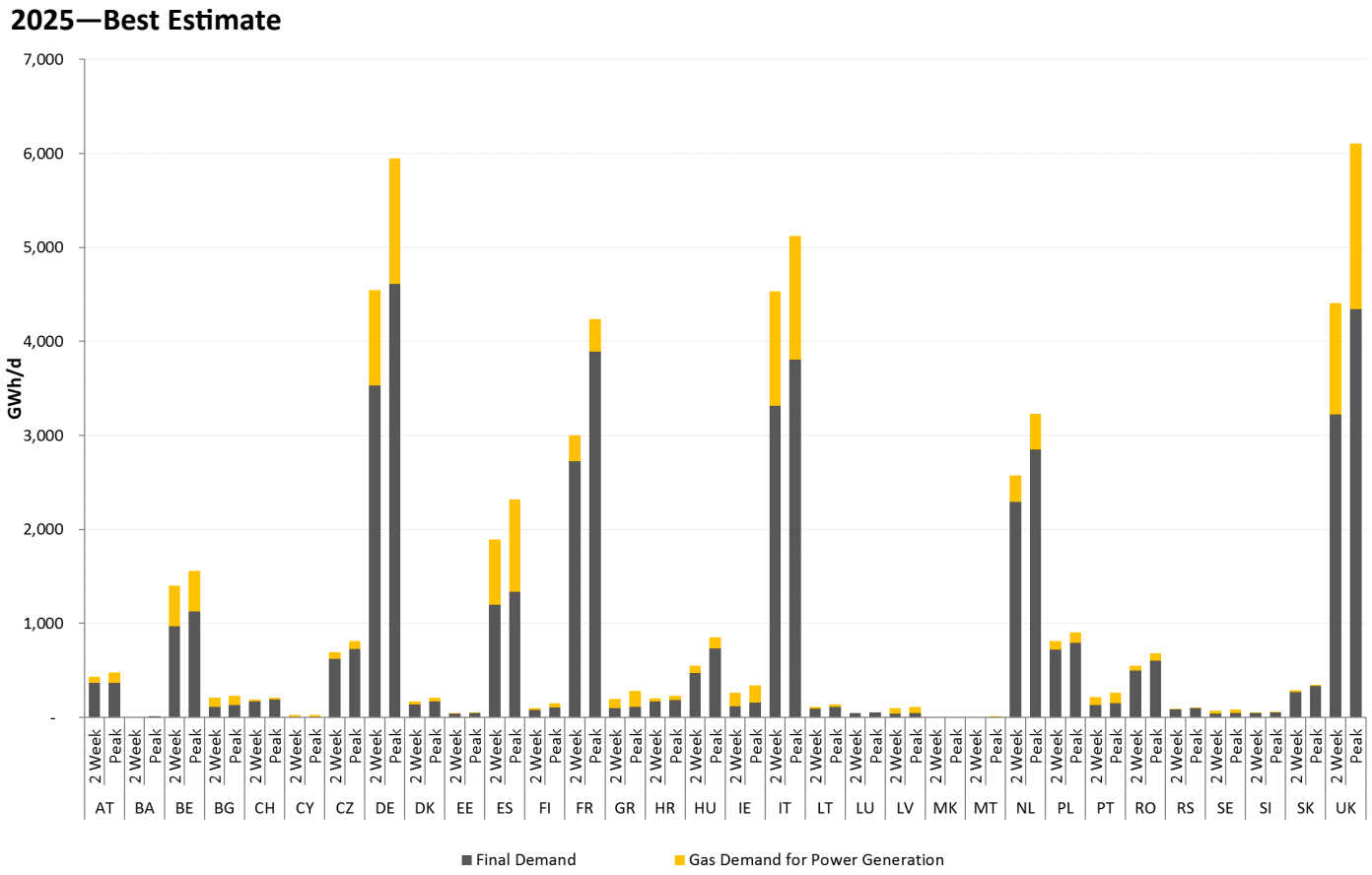


Figure 17: Gas high demand cases – 2025 Best Estimate

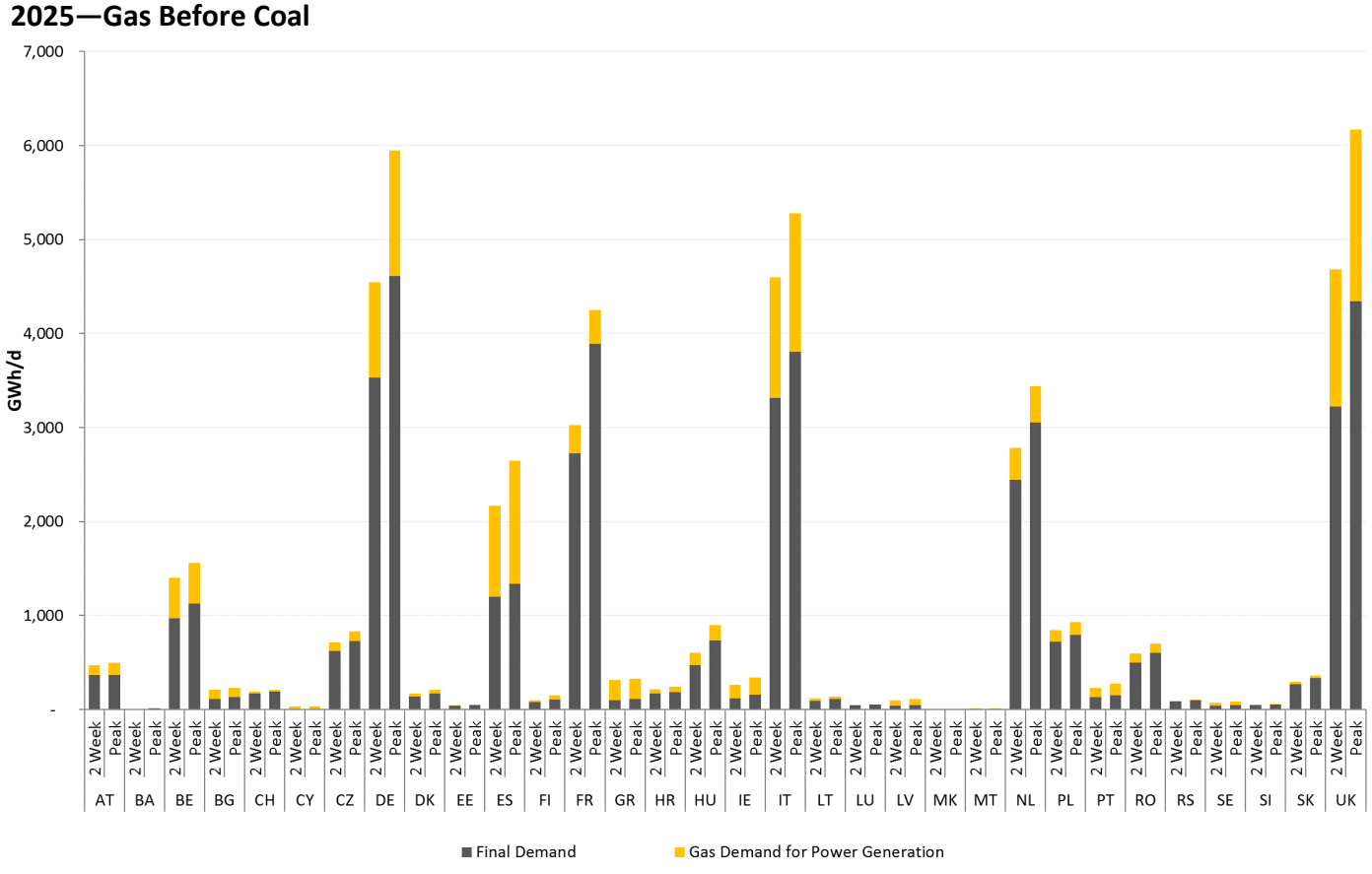


Figure 18: Gas high demand cases – 2025 Gas Before Coal

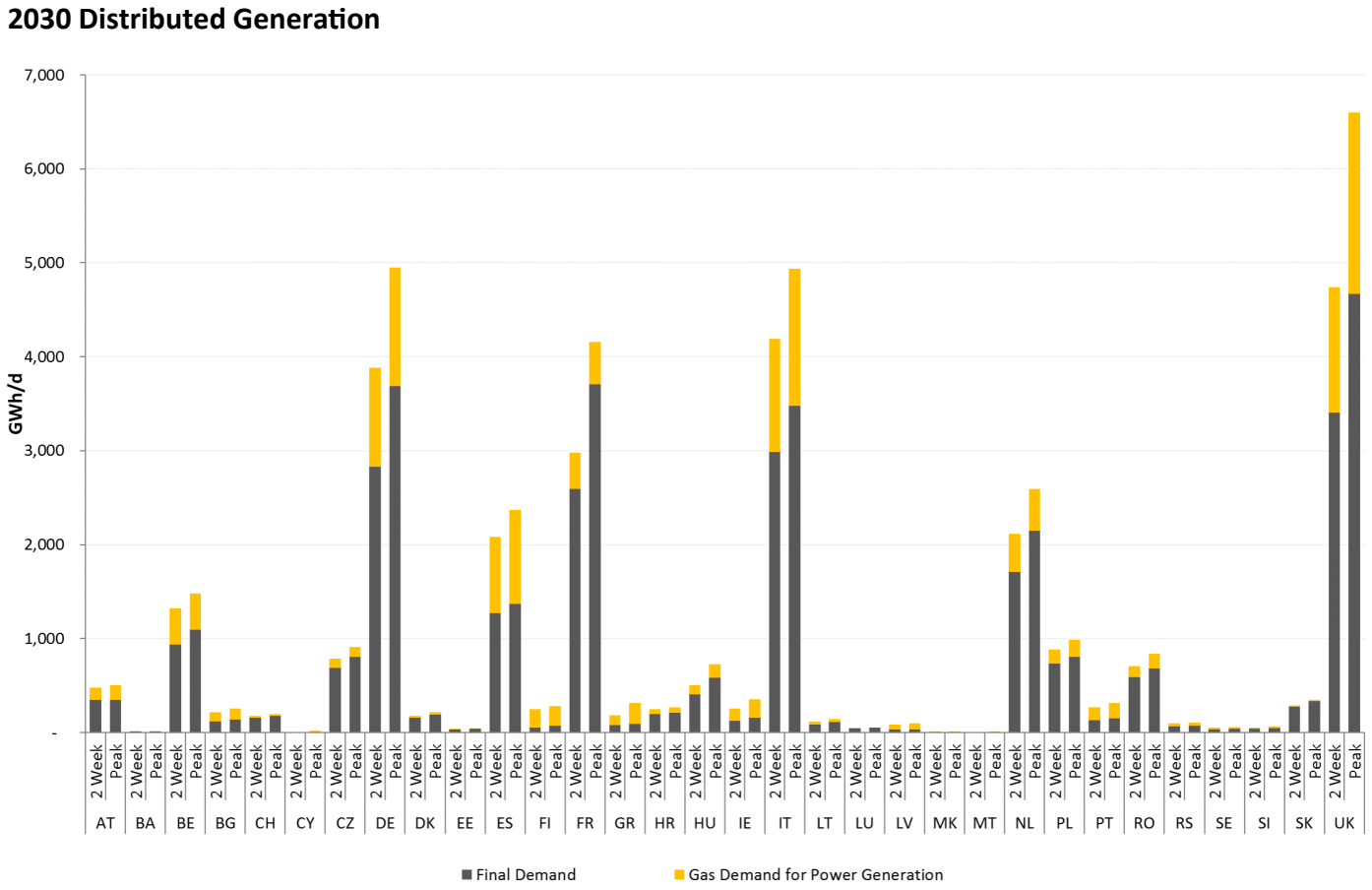


Figure 19: Gas high demand cases – 2030 Distributed Generation

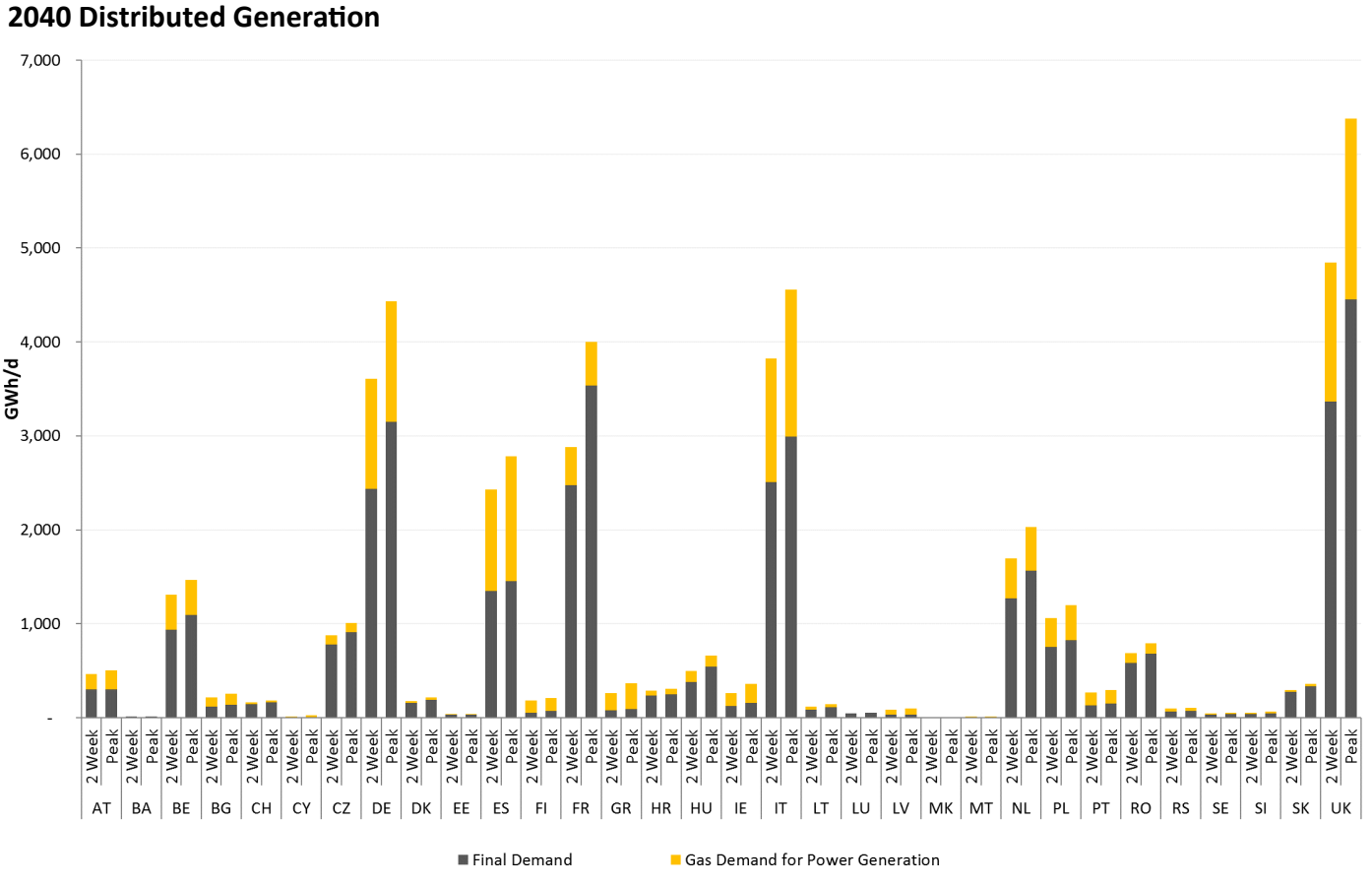


Figure 20: Gas high demand cases – 2040 Distributed Generation

2030 Sustainable Transition

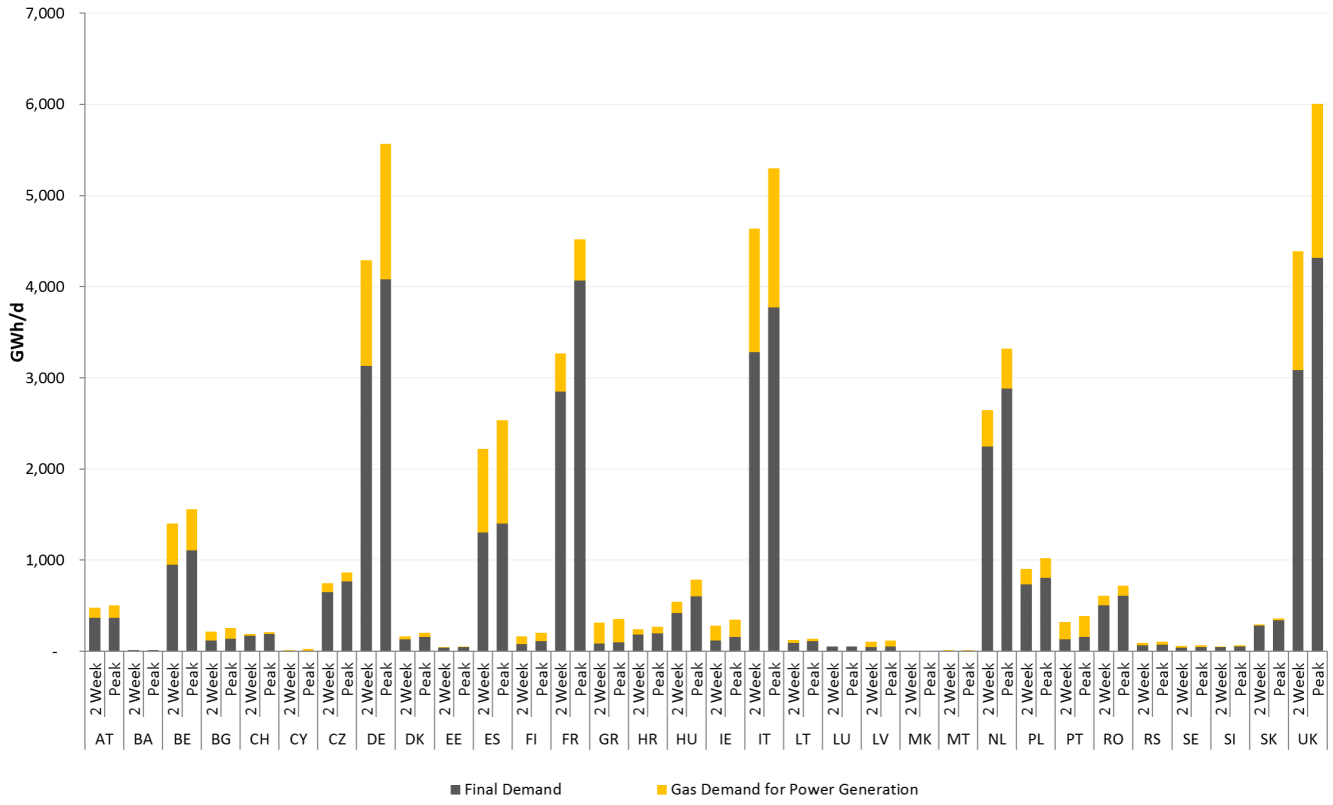


Figure 21: Gas high demand cases – 2030 Sustainable Transition

2040 Sustainable Transition

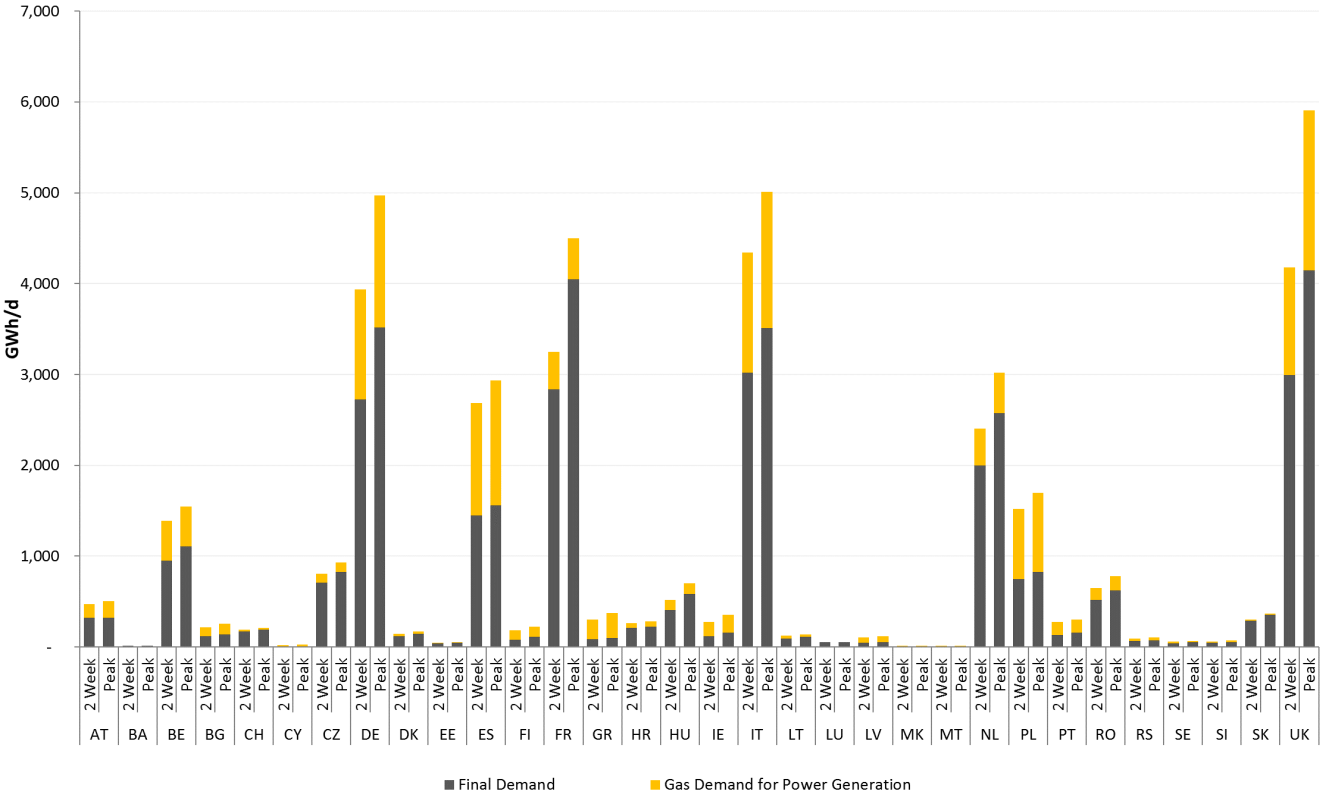


Figure 22: Gas high demand cases – 2040 Sustainable Transition

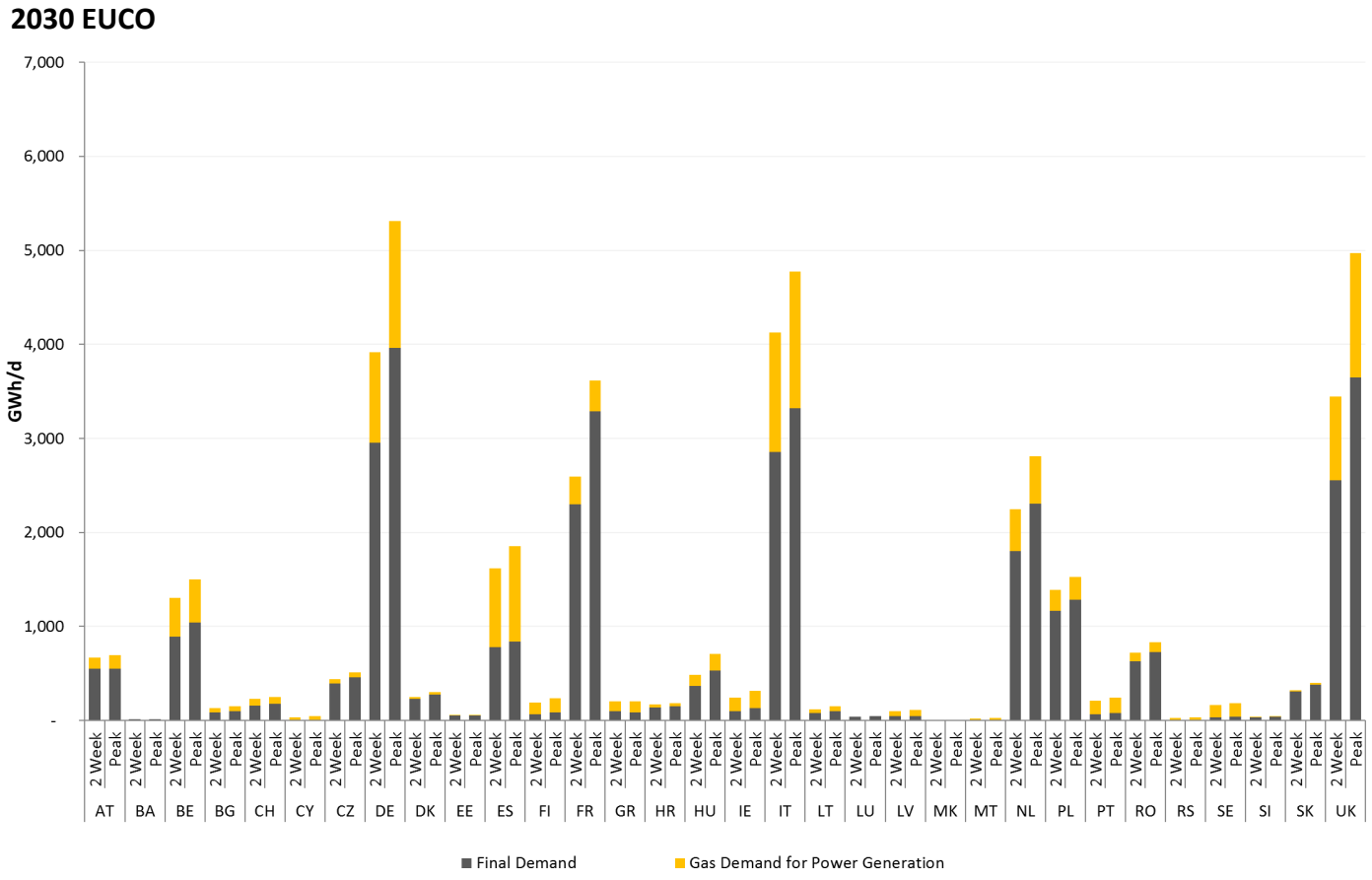


Figure 23: Gas high demand cases – 2030 EUCO

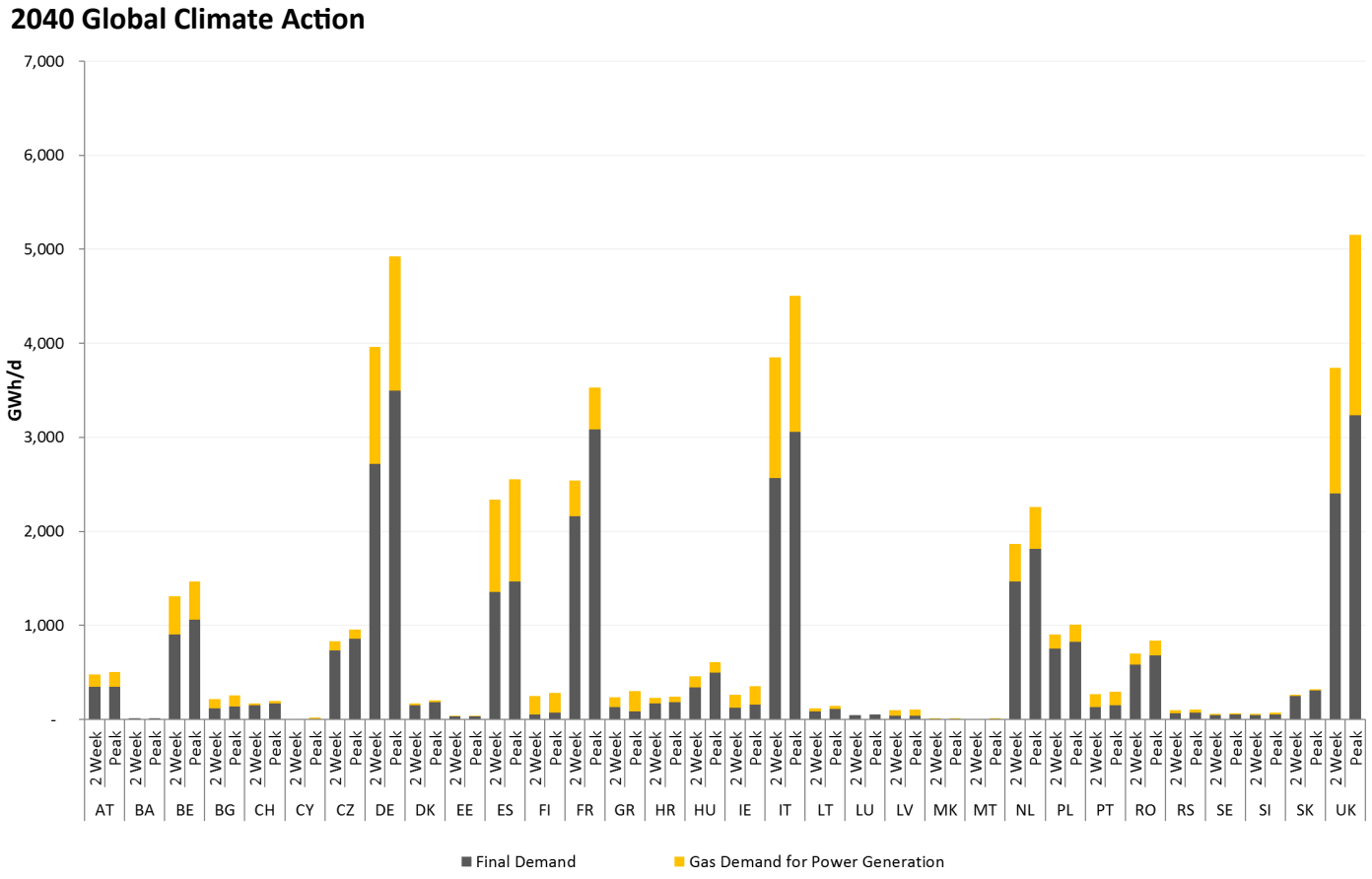


Figure 24: Gas high demand cases – 2040 Global Climate Action

1.2.2. Electricity generation mixes

1.1.2.1. Country level sectoral split The following maps display the annual Power Generation on a country level basis. The size of the pie chart is representative of the volume of generation, with the generation type displayed in segmentations of the charts.

2020 Best Estimate

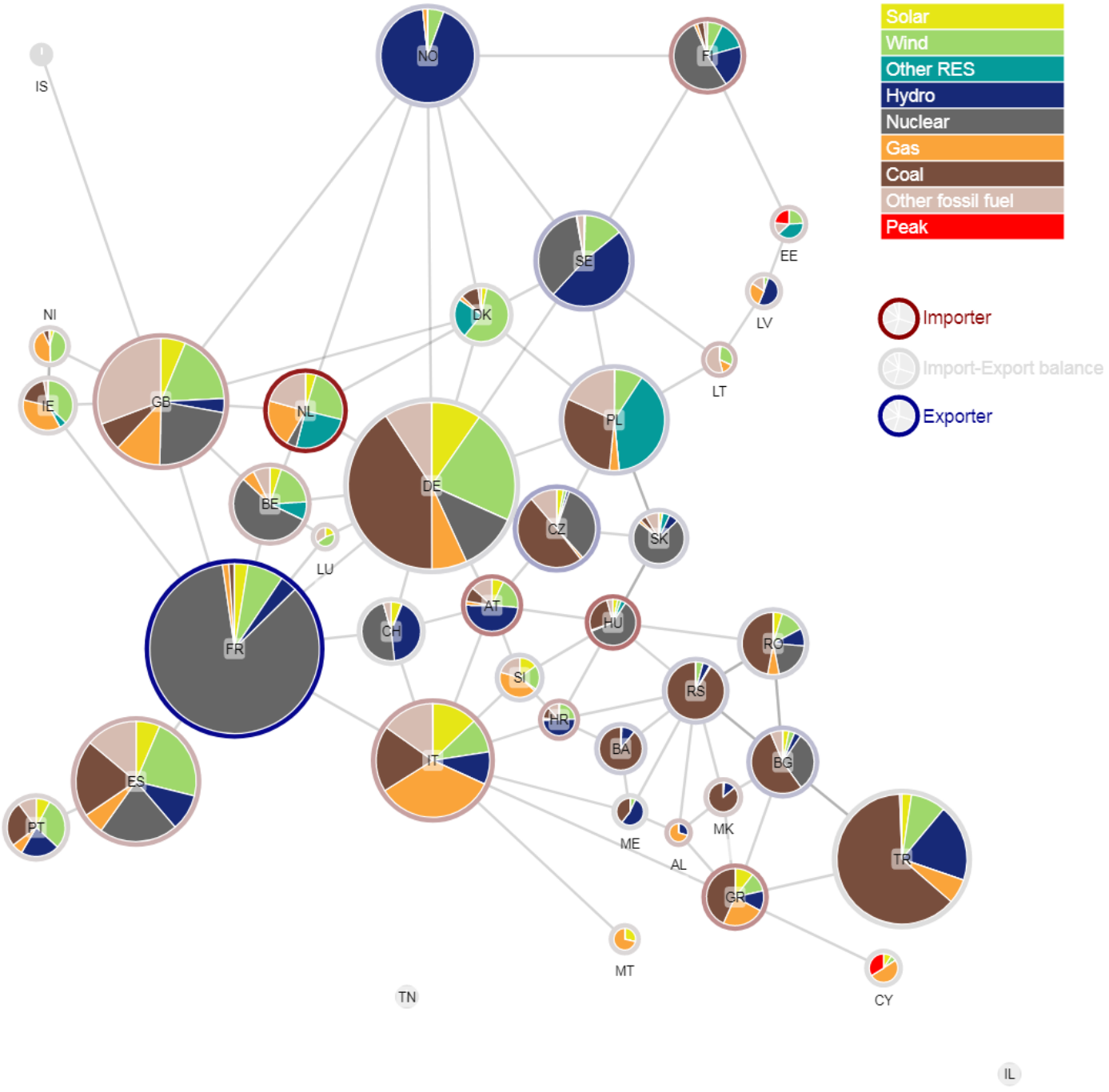


Figure 25: 2020 Best Estimate: Electricity generation mix and import/export balance

2025 Best Estimate

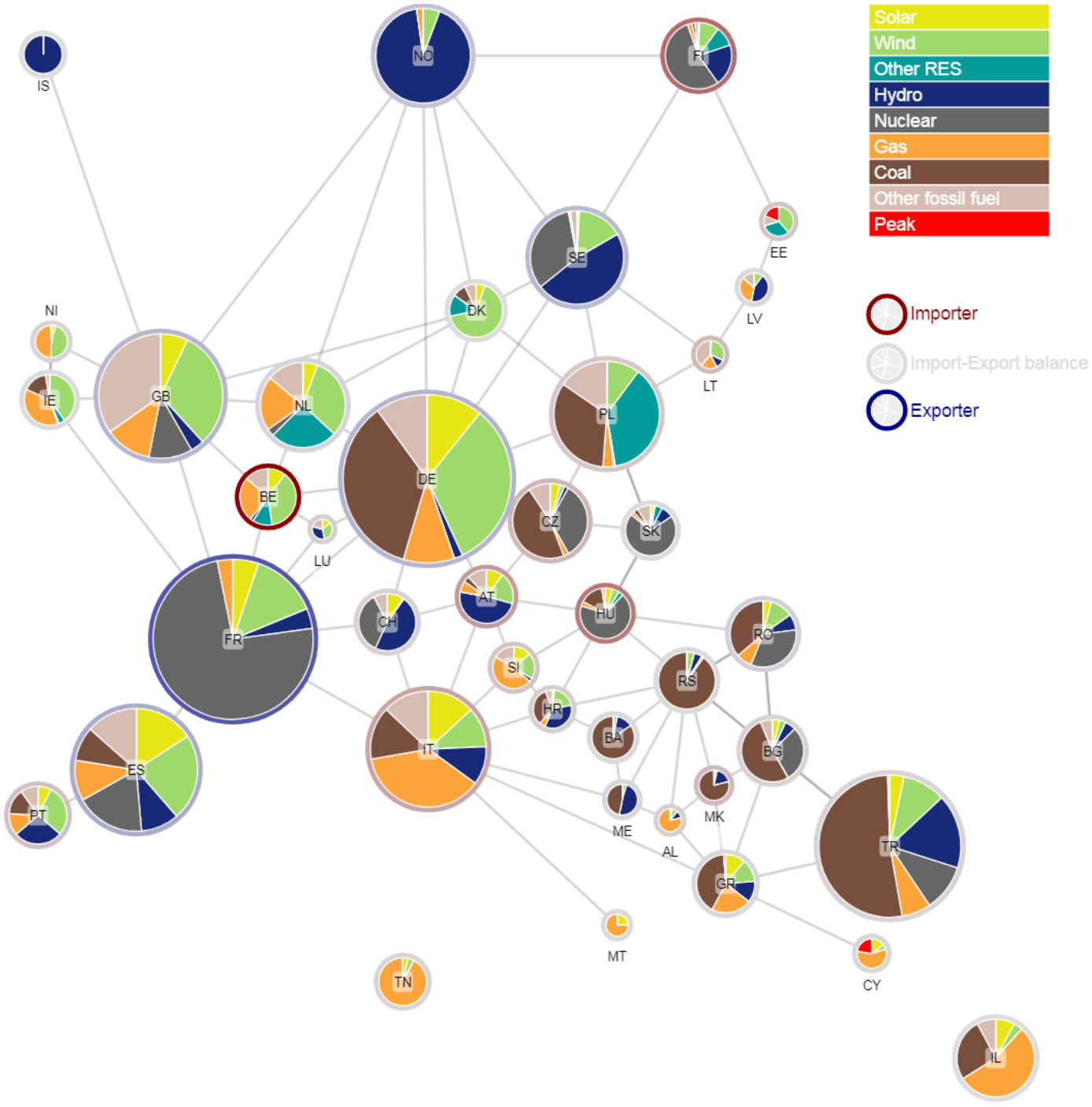


Figure 31: 2025 Best Estimate: Electricity generation mix and import/export balance

2025 Gas Before Coal

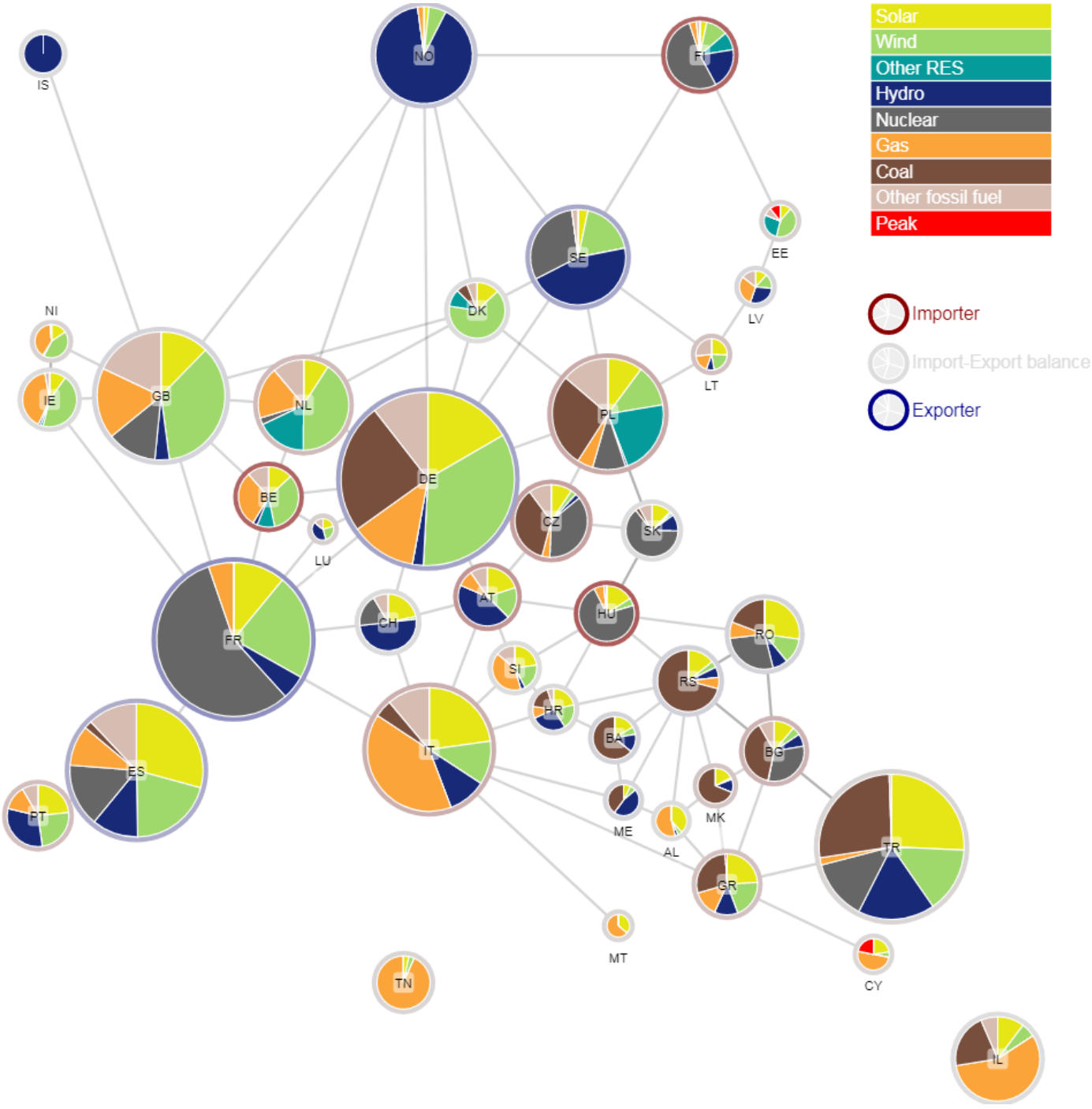


Figure 26: 2025 Gas Before Coal: Electricity generation mix and import/export balance

2040 Distributed Generation

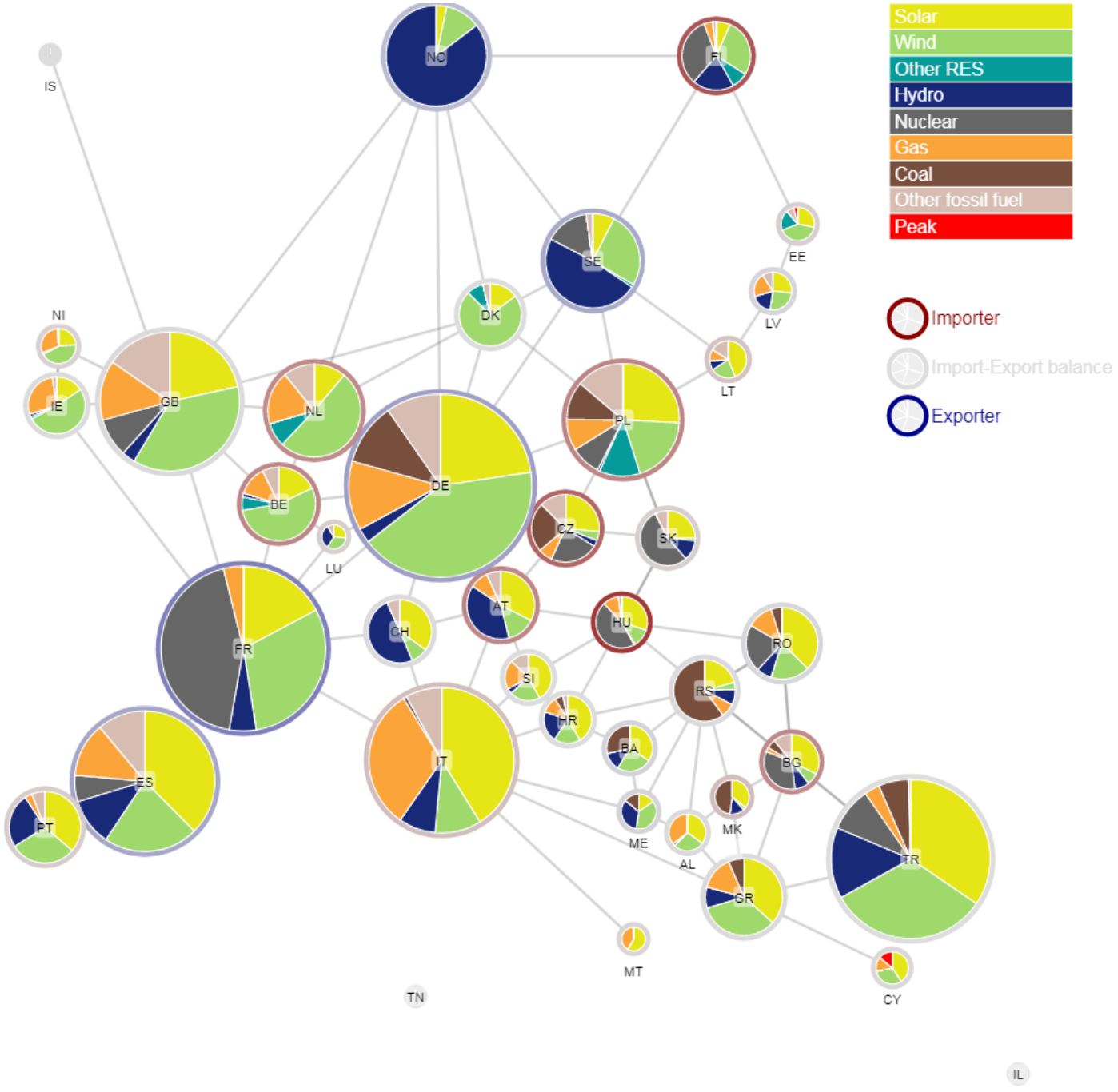


Figure 31: 2040 Distributed Generation: Electricity generation mix and import/export balance

2030 EUCO

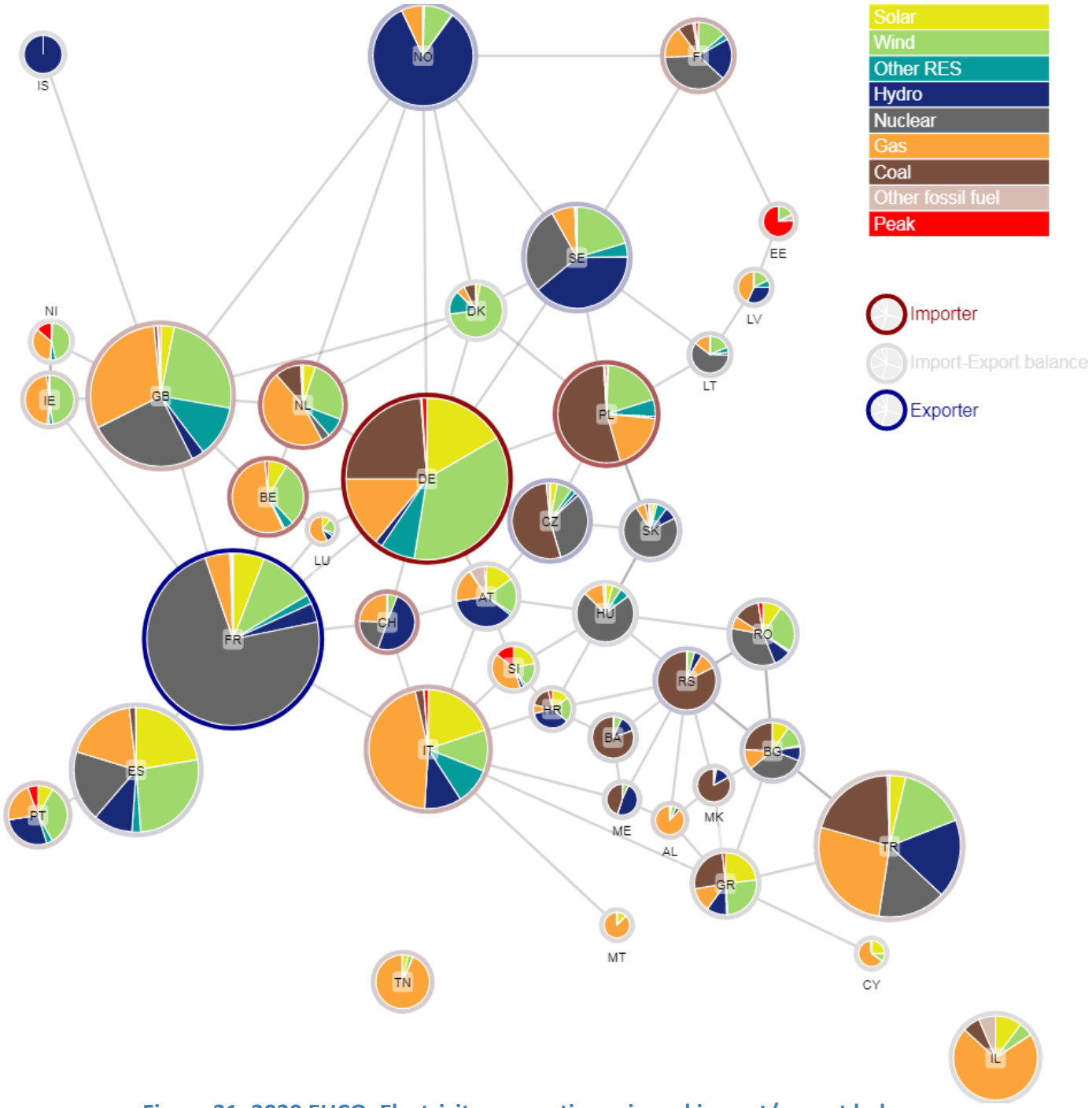


Figure 31: 2030 EUCO: Electricity generation mix and import/export balance

2025 Gas Before Coal

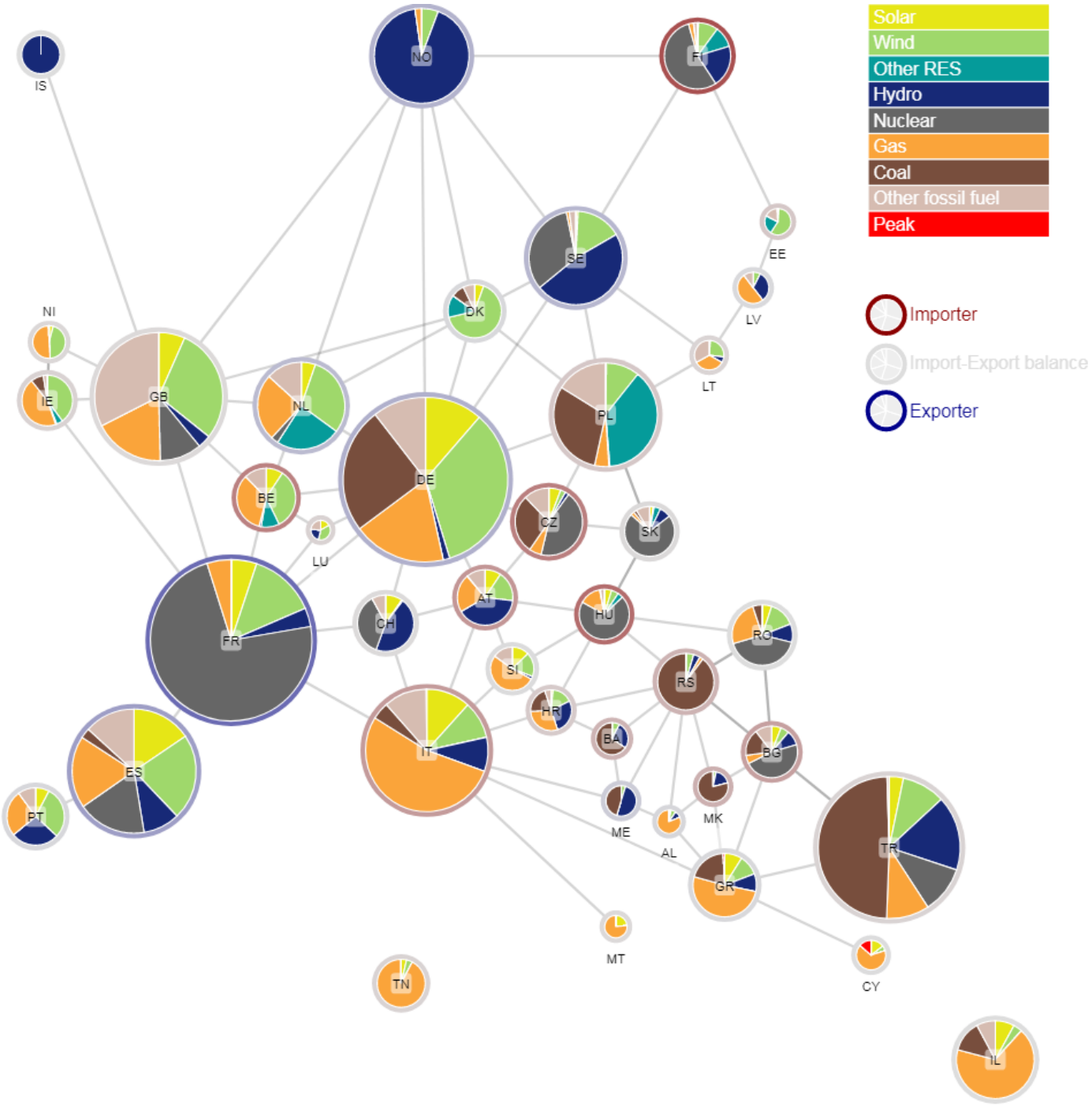


Figure 31: 2025 Gas Before Coal: Electricity generation mix and import/export balance

2040 Global Climate Action

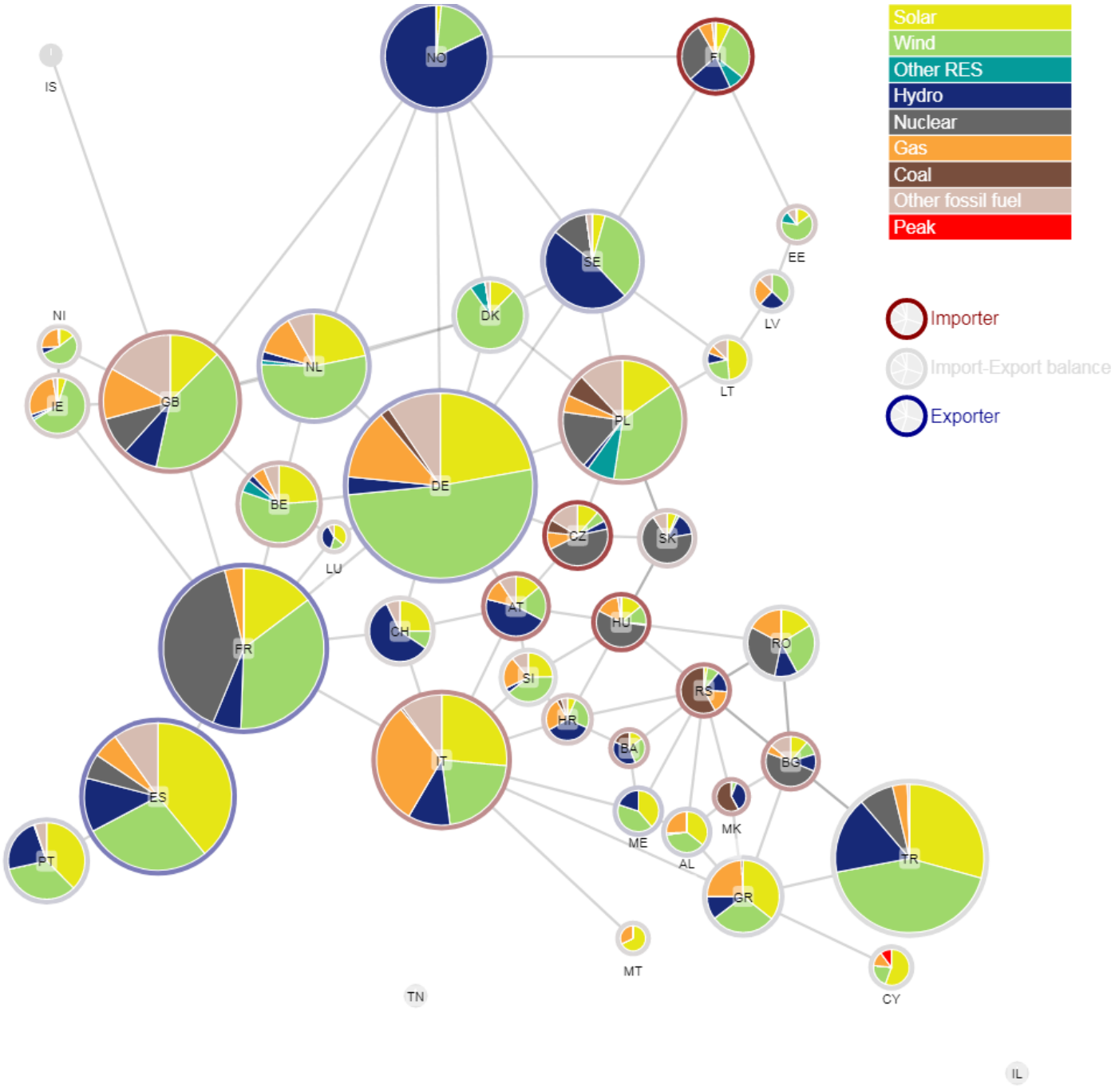


Figure 31: 2040 Global Climate Action: Electricity generation mix and import/export balance

2030 Sustainable Transition

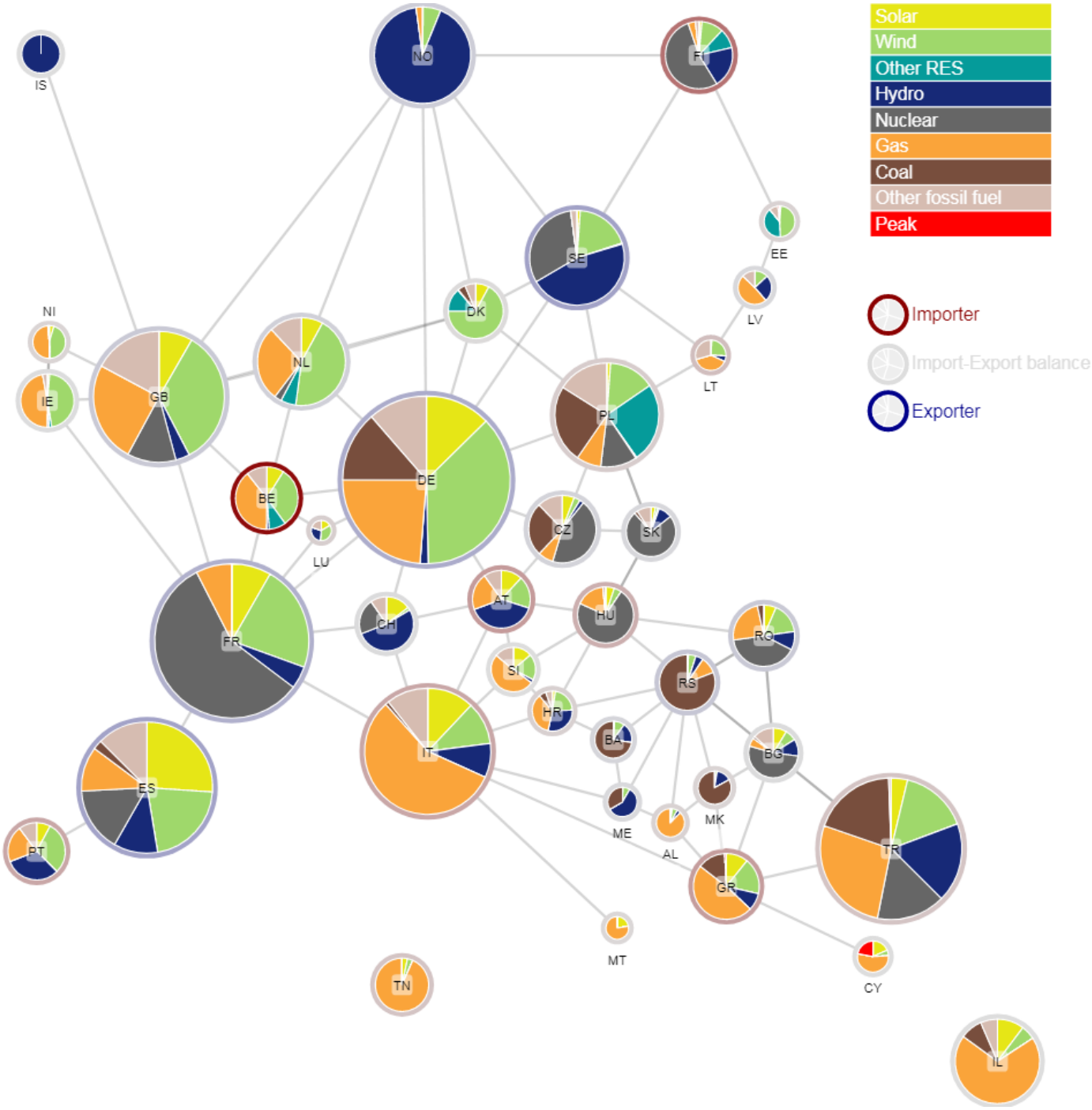


Figure 31: 2030 Sustainable Transition: Electricity generation mix and import/export balance

2040 Sustainable Transition

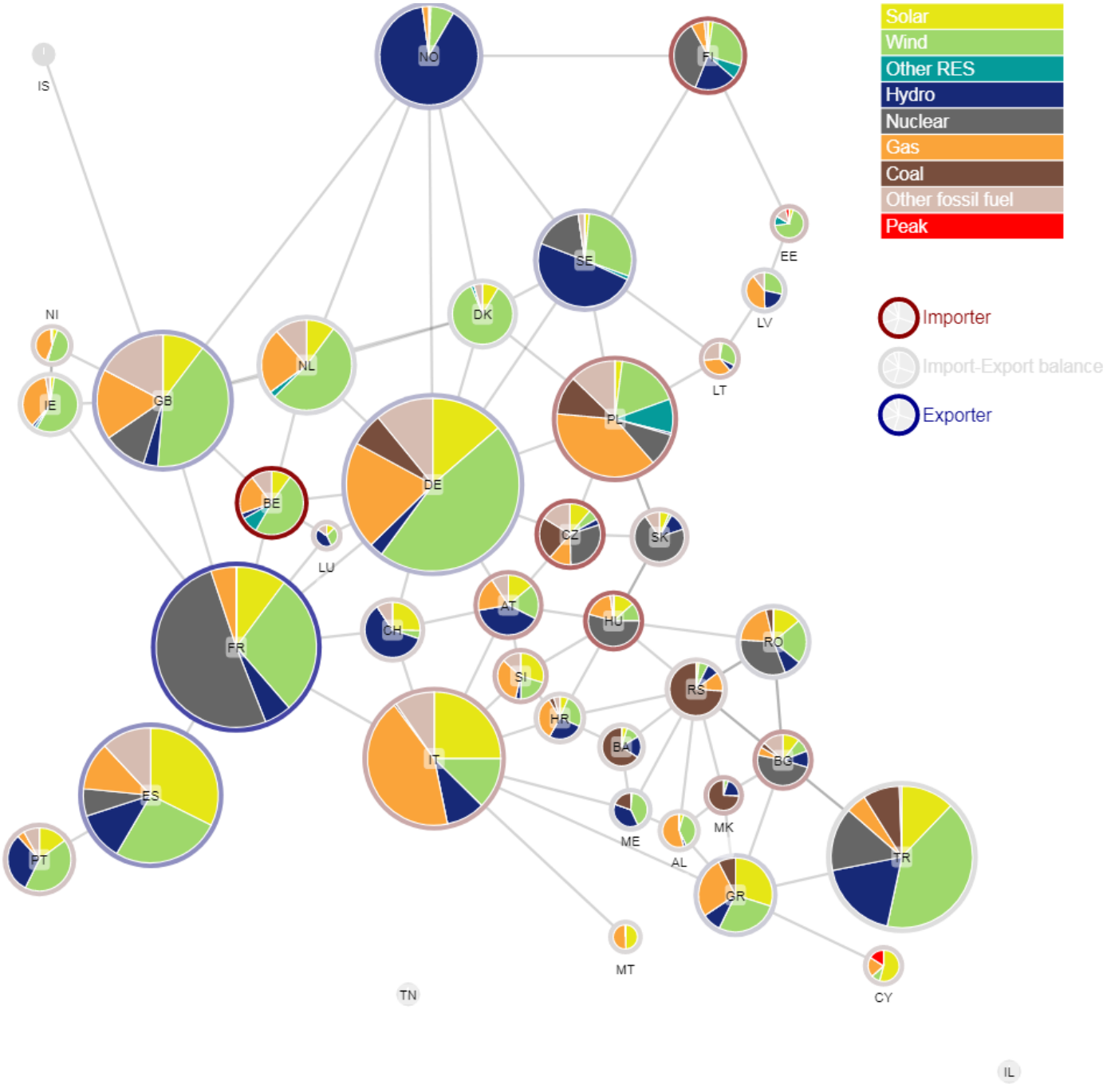


Figure 31: 2040 Sustainable Transition: Electricity generation mix and import/export balance

1.2. Supply

1.2.1. Installed Capacity - Installed capacity on a country level, grouped by aggregate size of installed capacity.

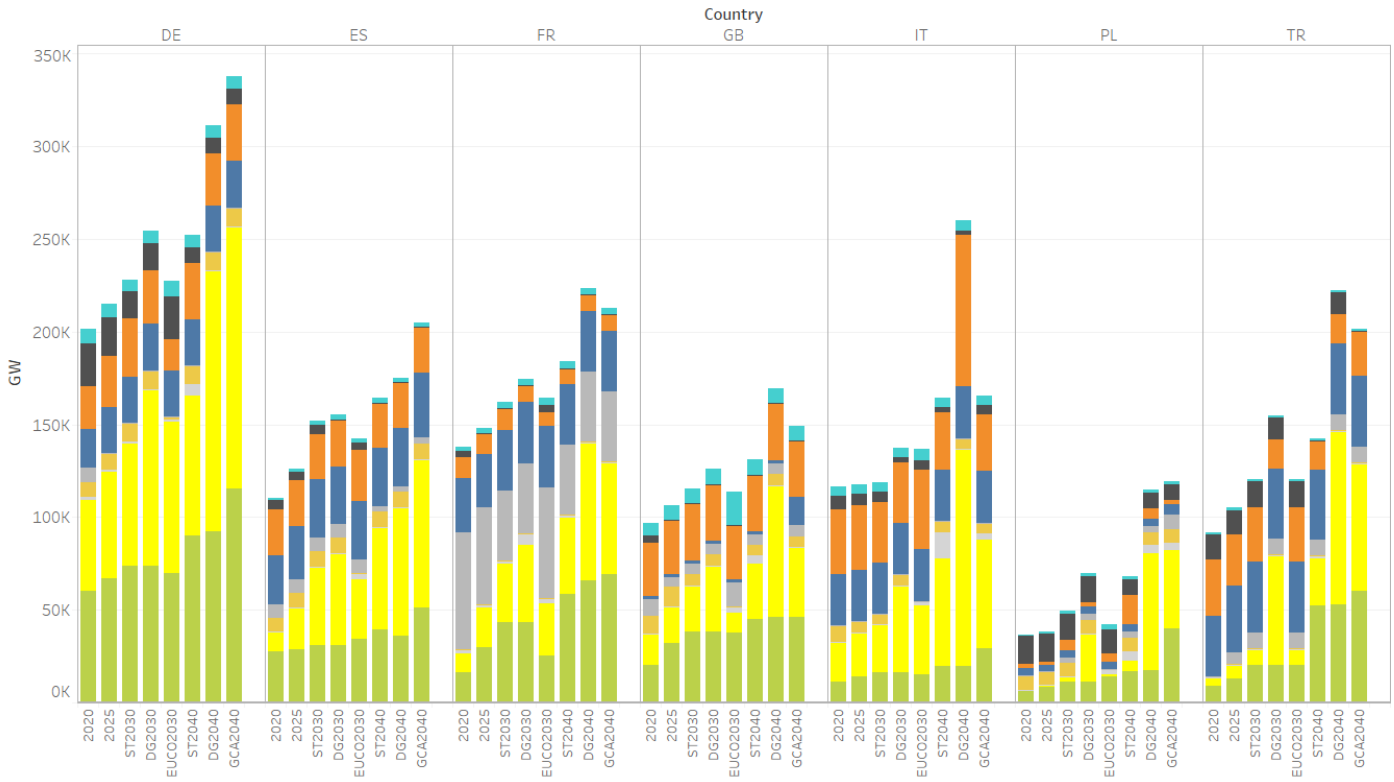


Figure 25: Country level installed capacity by scenario (DE, ES, FR, GB, IT, PL, TR)

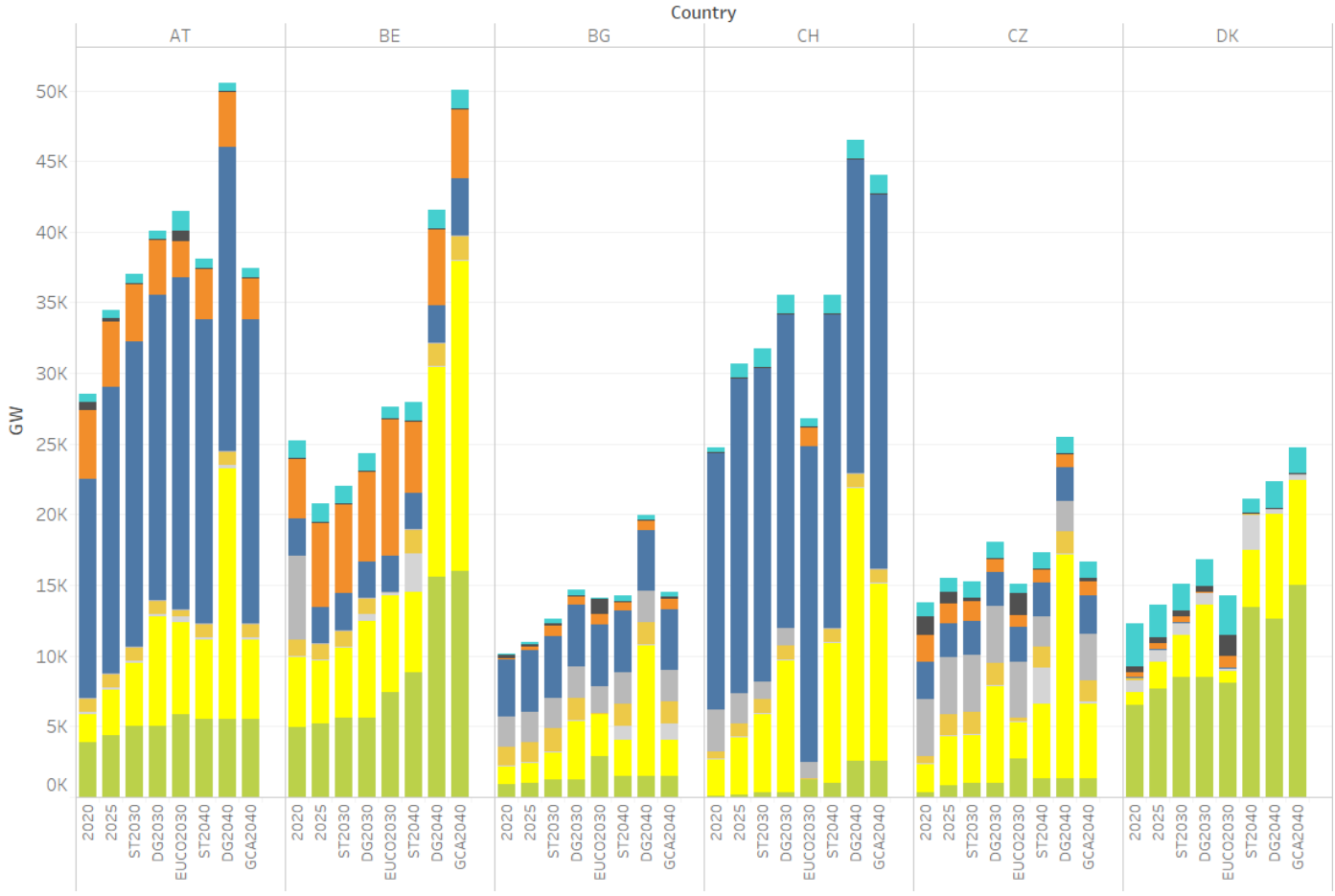


Figure 26: Country level installed capacity by scenario (AT, BE, BG, CH, CZ, DK)

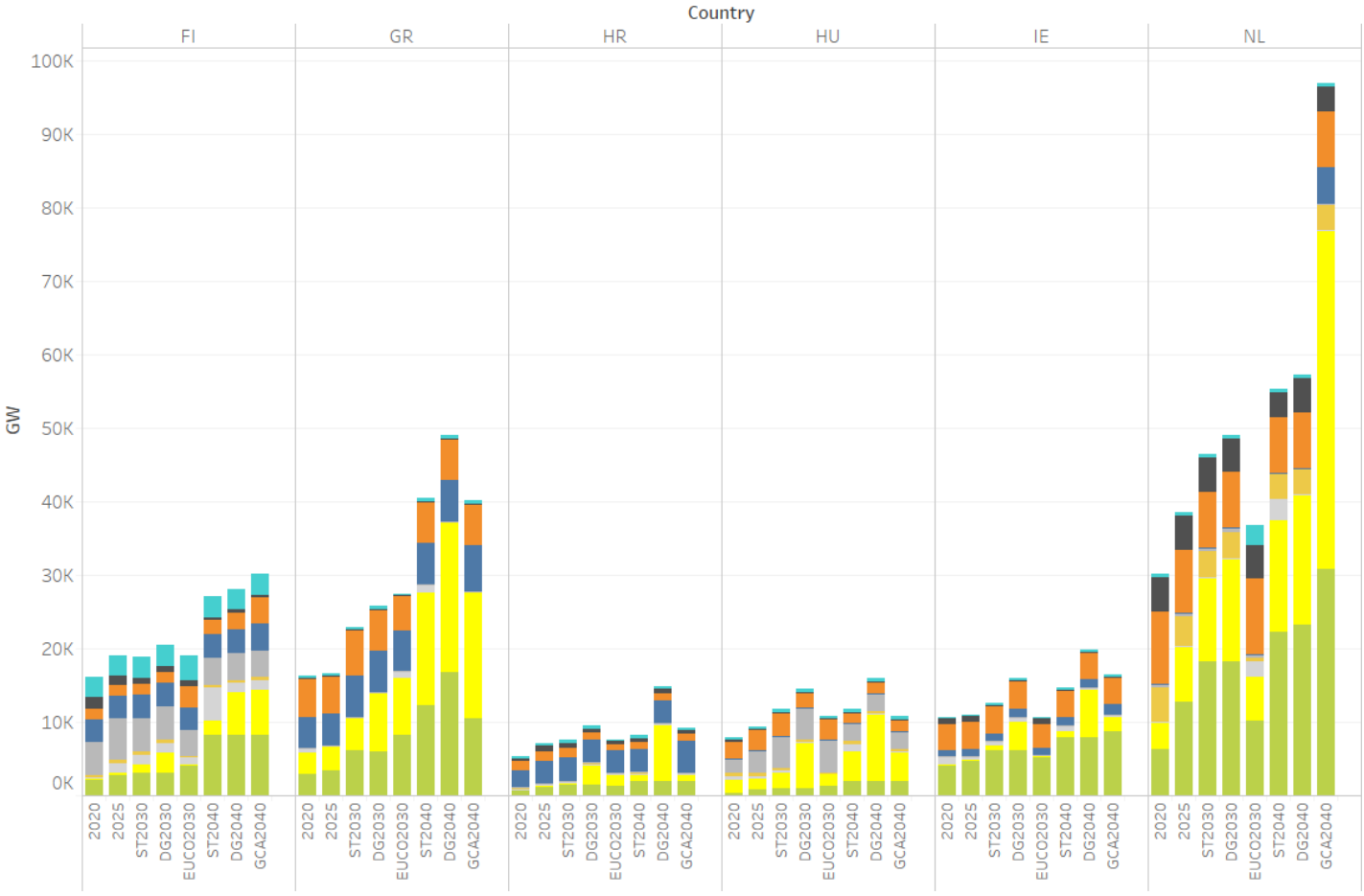


Figure 27: Country level installed capacity by scenario (FI, GR, HR, HU, IE, NL)

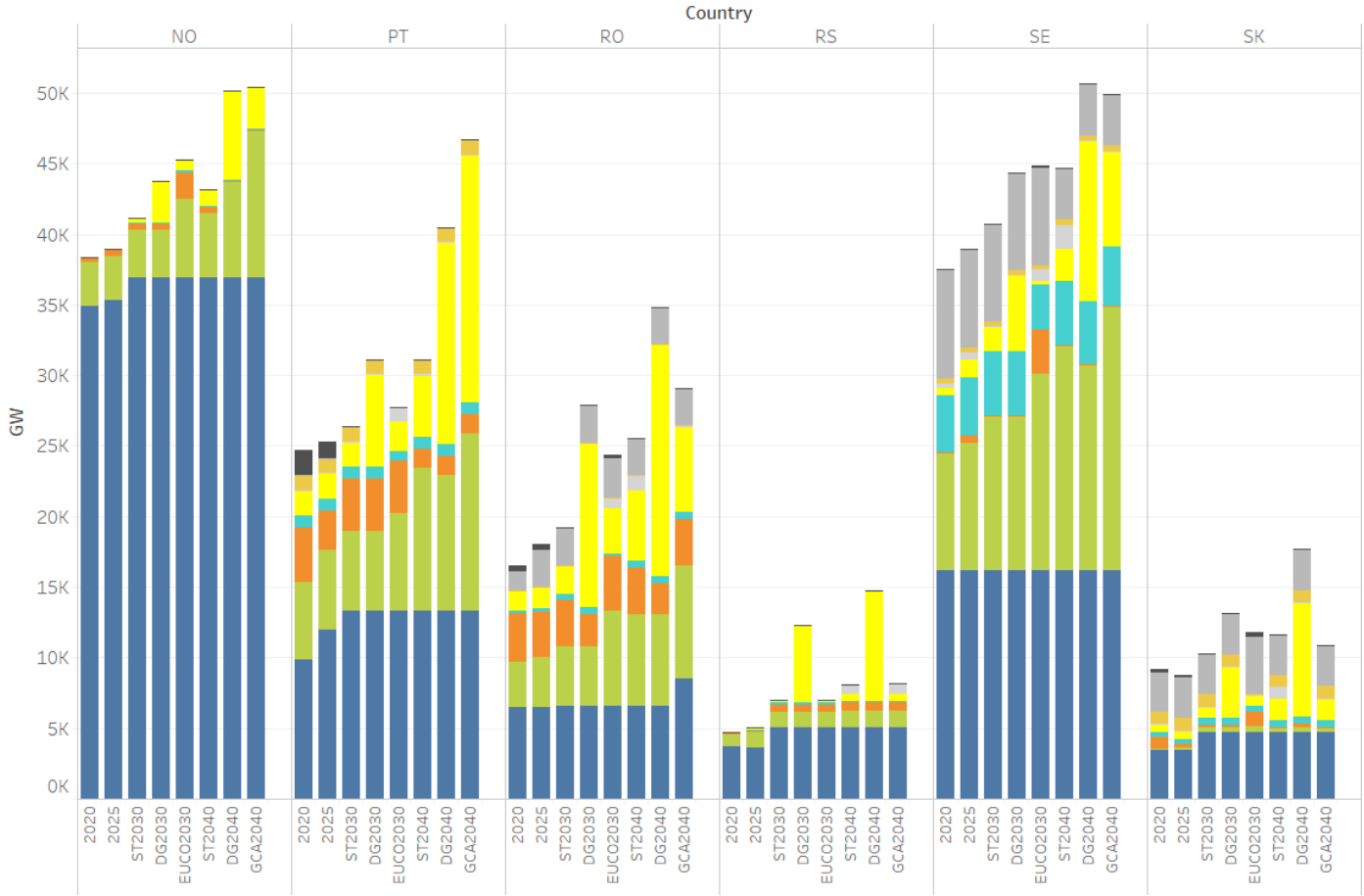


Figure 28: Country level installed capacity by scenario (NO, PT, RO, RS, SE, SK)

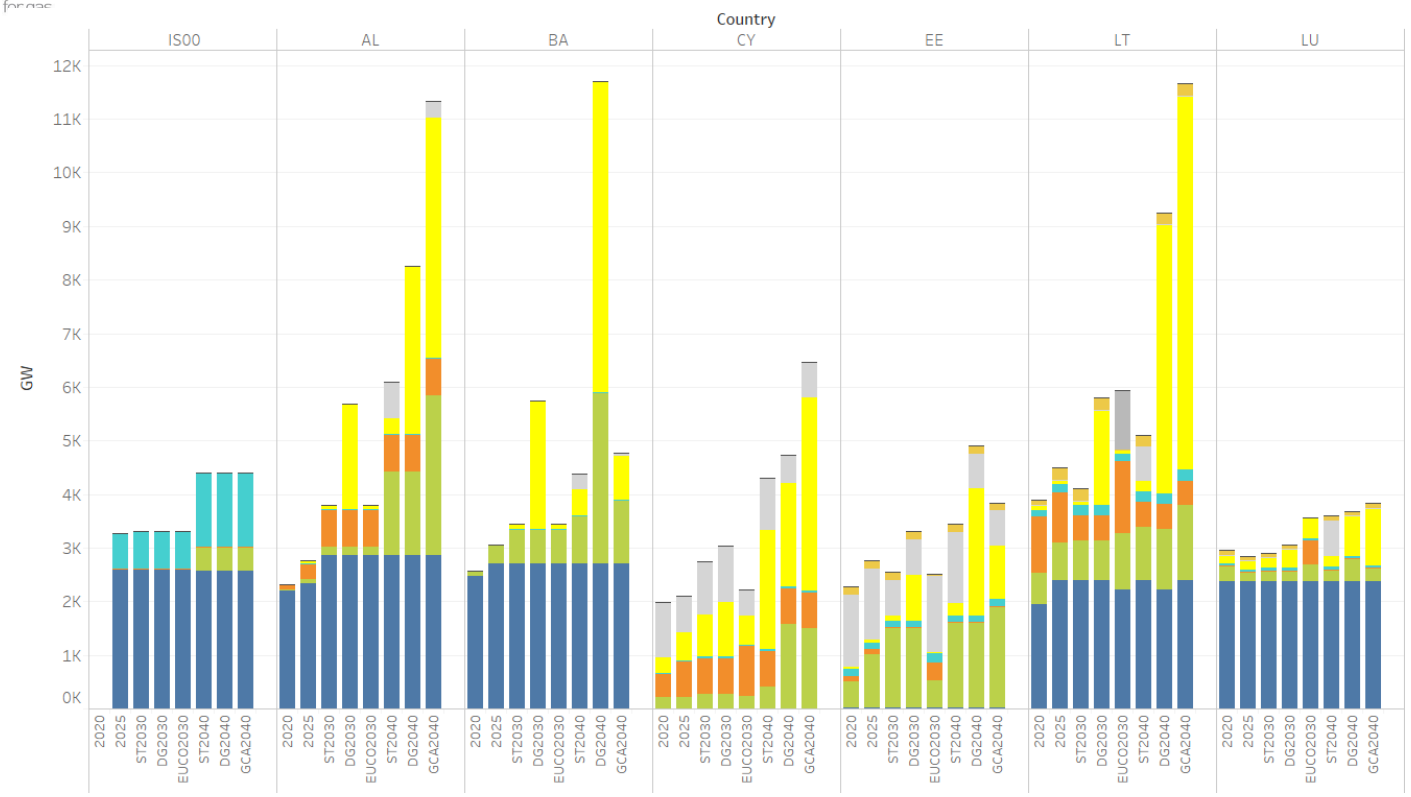


Figure 29: Country level installed capacity by scenario (AL, BA, CY, EE, IS, LT, LU)

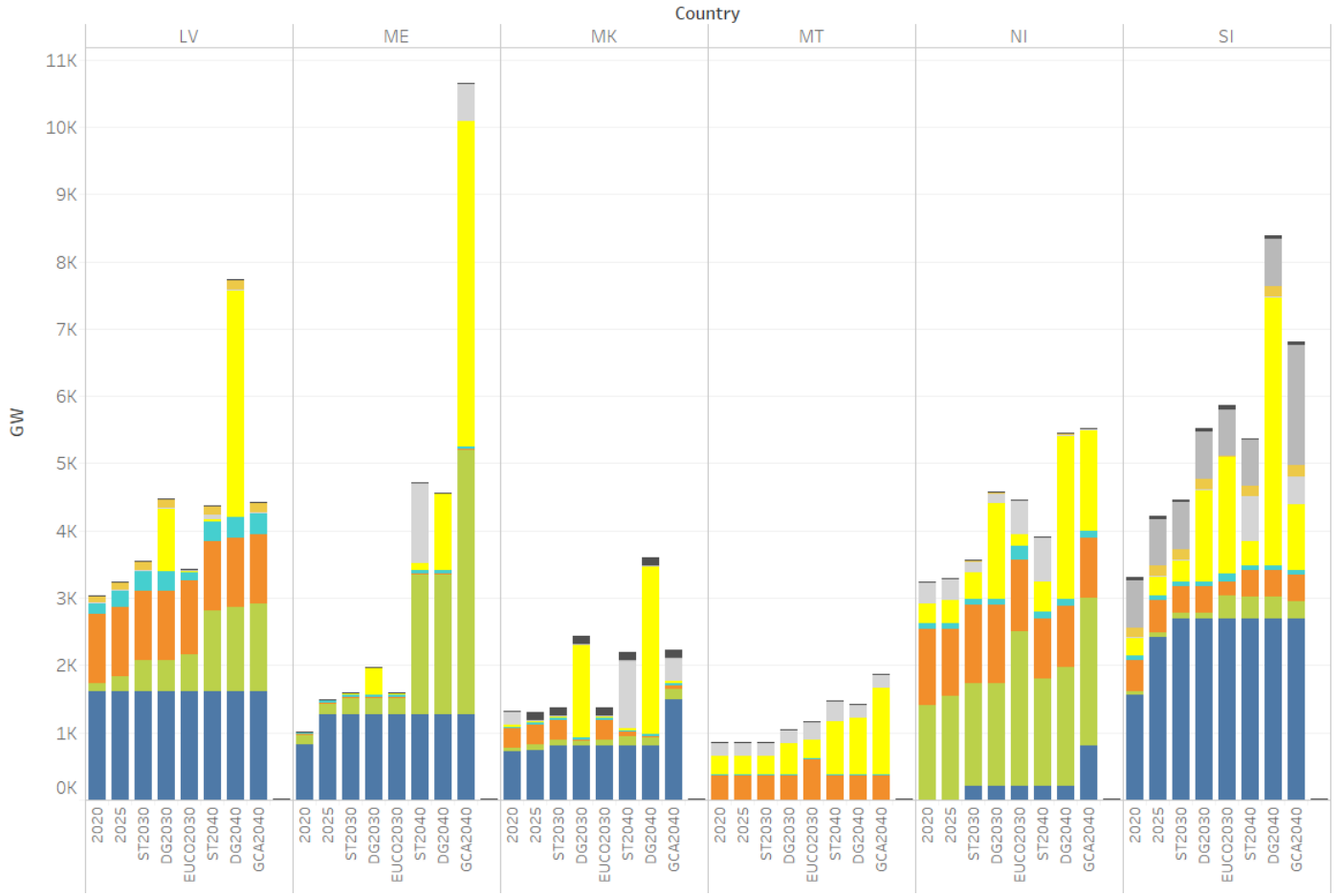


Figure 30: Country level installed capacity by scenario (LV, ME, MK, MT, NI, SI)

1.2.3. Gas supply potentials

1.2.3.1. Indigenous production

Indigenous production covers supplies from inside EU coming from conventional national production and other non -fossil sources like biomethane and power-to-gas (P2G). Scenarios consider the role green gases will take in the European supply mix directly linked to the storylines.

The information on EU conventional production has been collected from TSOs and it is expected to decrease significantly over the next 20 years. ENTSOG has likewise used TSOs estimates on biomethane injection evolving differently for the three scenarios. Power-to-gas has been also considered in two out of three scenarios following the assumptions for P2G, Global Climate Action and Distributed Generation have been built out of a top-down methodology.

Taking into account the scenarios chosen based on stakeholder feedback and that no inputs were shown by gas TSOs during the data collection process, no shale gas from inside EU has been taking into account at all during the whole-time horizon of this report.

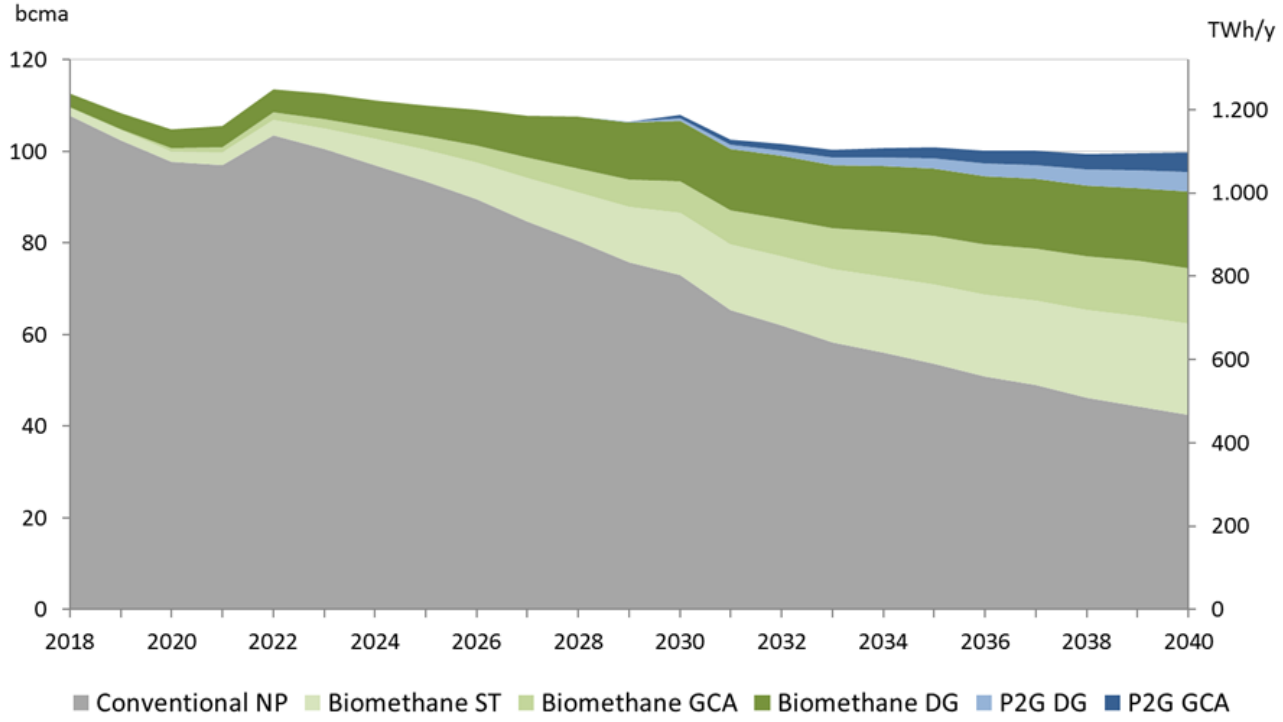


Figure 40: Potential EU indigenous and green gases production 2018-2040

bcma	2020	2025	2030	2035	2040
National Production *	98	93	73	54	42
Biomethane GCA	3	10	20	28	32
P2G GCA	0	0	1	5	9
Biomethane DG	7	17	34	43	49
P2G DG	0	0	1	2	4
Biomethane ST	2	7	13	17	20
P2G ST	-	-	-	-	-

Table 1: Potential EU indigenous and green gases production 2020-2040

*National Production developments related to Groningen's situation will be taken into account, as far as possible, for the TYNDP assessment.

Extra-EU Supply Potentials

Supply potentials have been developed for the purpose of this Scenario Building Report as the reasonable prospective supplies coming from current and realistic new sources known until today. The word “potential” means that these gas supplies cannot be considered as forecasts of future flows. In order to capture the uncertainty in the development of supplies, ranges have been defined for each source to assume their minimum and maximum as the lower and upper limits for the imports. Where historical ranges are shown, this is based on data available from 2009 to 2016, unless otherwise stated.

The development of the supply potentials is based on publicly available information, reports and recent news. These potentials cover supplies from outside EU coming from Russia, Norway, Algeria, Libya, Turkey, Azerbaijan, LNG and other new potential sources like Turkmenistan. Each supply potential is developed independently, and no specific likelihood is defined. For those sources exporting gas, both as pipeline-bounded gas and LNG, the potential supplies have been treated separately in order to avoid double counting.

It is important to highlight that all potential gas supplies from outside EU are independent to the main scenarios. Supply potentials provide ranges to the assessment model where the supply mixes are assessed during the TYNDP simulations stage to then obtain the final supply mixes results.

Russian pipeline supply potentials

These supply potentials define a possible range of Russian gas exports to Europe via pipeline. Although some sources report that Russia has the potential to increase both production and gas exports to Europe by around 100 bcm, this potential would lead to figures exceeding 250 bcm meaning to the overall EU demand a share of Russian gas in the European supply of over 50% which is currently not seen as realistic. The potential range of Russian pipeline supply has been estimated as follows:

Maximum Russian pipeline gas potential:

Own methodology based on Russian Production IEA World Energy Outlook 2017 - New Policies Scenarios - multiplied by the historical maximum share (29%) exported to EU (source BP Statistical).

Minimum Russian pipeline gas potential:

This minimum potential has been determined based on the presentation "European Gas Demand and Sources of Gas Supply" by Gazprom, source "Long Term Natural Gas Supply Contracts by pipelines in EU28", Cedigaz LT Contracts Database.

Russian also exports in the form of LNG but these volumes are part of the LNG analysis.

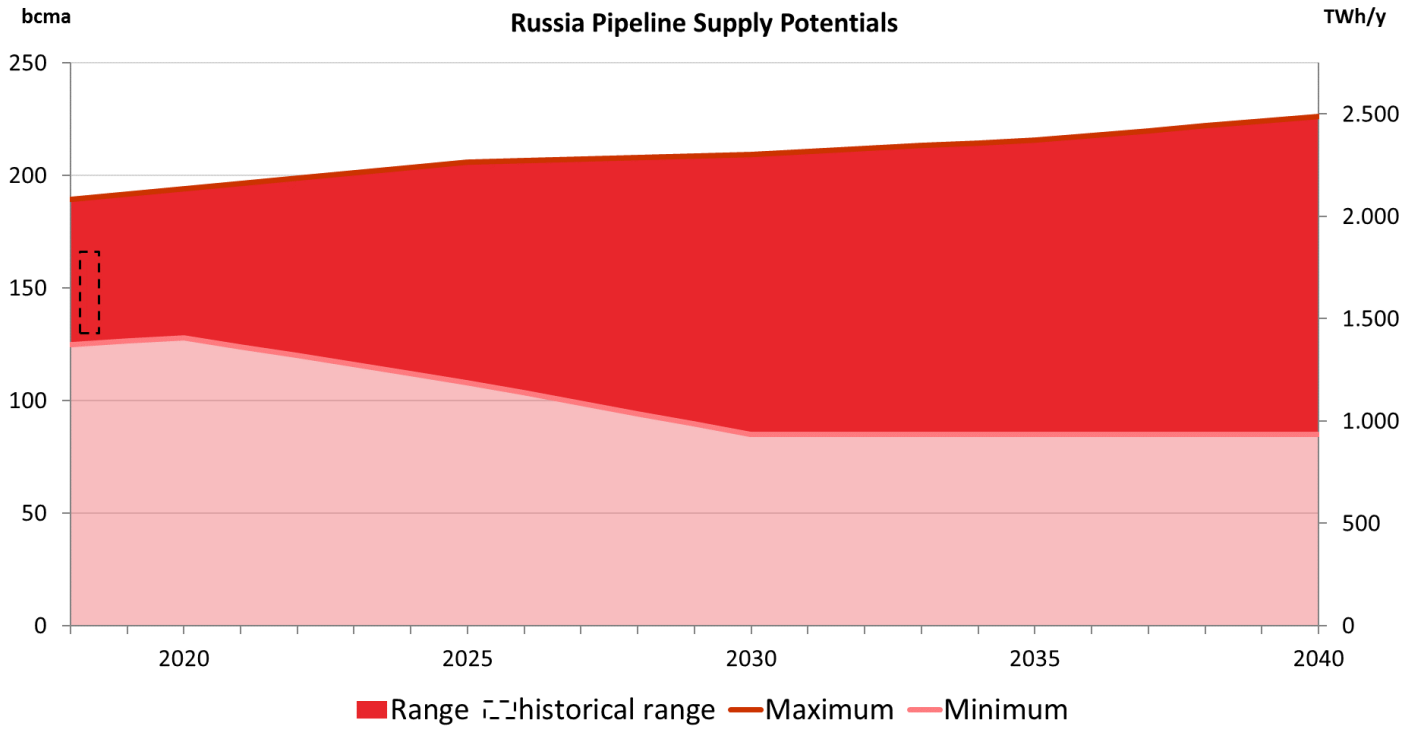


Figure 41: Potential pipeline gas potentials from Russia

Pipeline Gas Supply Potential for Russia				
bcma	**2020**	**2025**	**2030**	**2040**
Max	194	206	210	226
Min	128	108	85	85

Table 2: Potential pipeline gas potentials from Russia (bcma)

Norwegian pipeline supply potentials

These supply potentials define a possible range of Norwegian gas exports to Europe via pipeline. The Norwegian supply potentials are based on data coming from the Norwegian Petroleum Directorate (NPD) / Ministry of Petroleum and Energy (MPE) as provided by GASSCO. The potential range of Norwegian supply has been estimated as follows:

Maximum Norwegian pipeline gas potential:

This potential represents the exports from Norway where the maximum level is the development of annual exports as estimated on the maximum scenario (from the Norwegian Petroleum Directorate) including existing fields, discoveries and yet to find fields, extrapolated from 2035 to 2040.

Minimum Norwegian pipeline gas potentials:

This potential takes the lowest of the minimum imports of 2009-2016 (93 bcma) interpolated to the production sales forecast in 2025 of resources in existing fields (Norwegian Petroleum Directorate), extrapolated between 2035 and 2040.

Norwegian LNG exports are part of the LNG potentials featured later in this report.

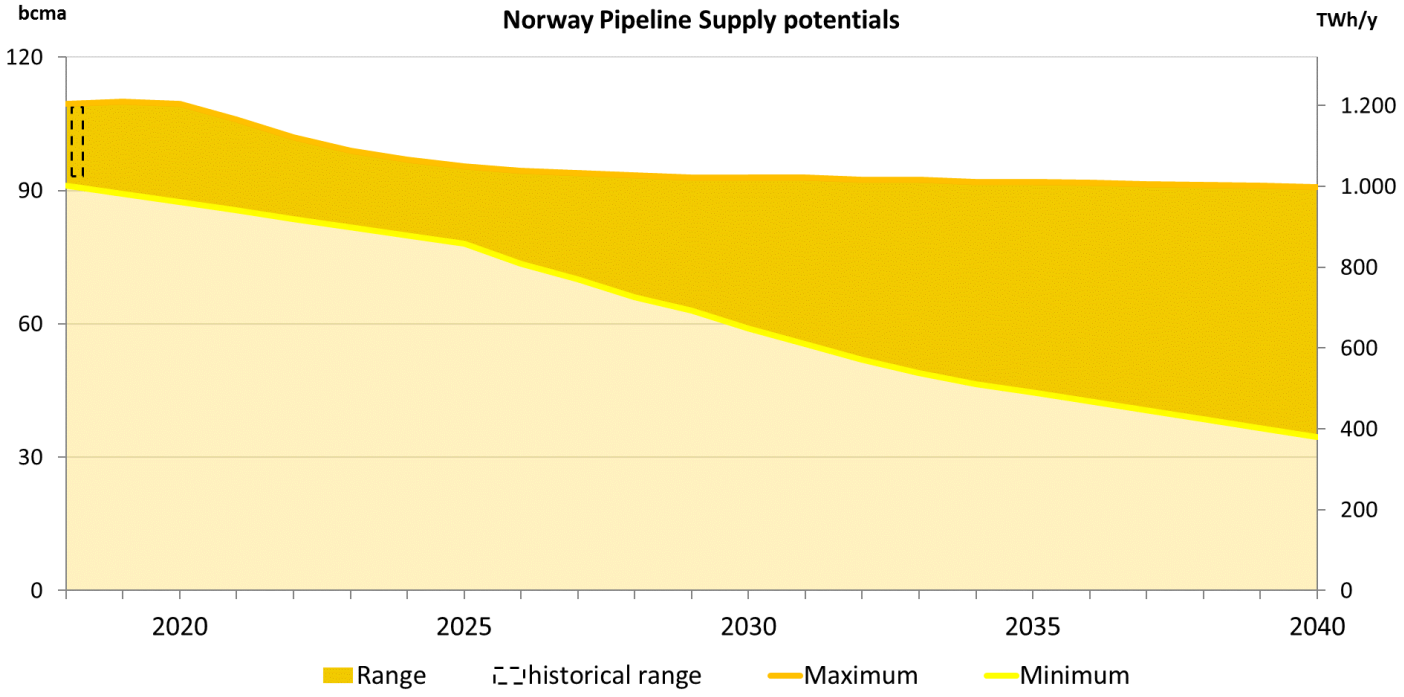


Figure 42: Potential pipeline gas potentials from Norway

Pipeline Gas Supply Potential for Norway				
bcma	**2020**	**2025**	**2030**	**2040**
Maximum	110	96	93	91
Minimum	87	78	59	41

Table 3: Potential pipeline gas potentials from Norway (bcma)

Algerian pipeline supply potentials

Algeria ranks in the top ten of countries with the largest gas reserves in the world, being the second largest reserves in Africa. Its export potential will highly depend on the amount of new investments in the upstream sector. In order to define its maximum and minimum supply potentials ENTSOG has considered different sources:

Maximum Algerian pipeline gas potential

Own methodology based on Algerian Production IEA World Energy Outlook 2017 - New Policies Scenarios - multiplied by the historical maximum share (43%) exported to EU (source BP Statistical).

Minimum Algerian pipeline gas potential

Based on Oxford report May 2016 "Algerian Gas: Troubling Trends, Troubled Policies" starting on recently observed historical minimum (from BP Statistical) interpolated to 2025.

Algeria also exports LNG which is included as part of the LNG analysis.

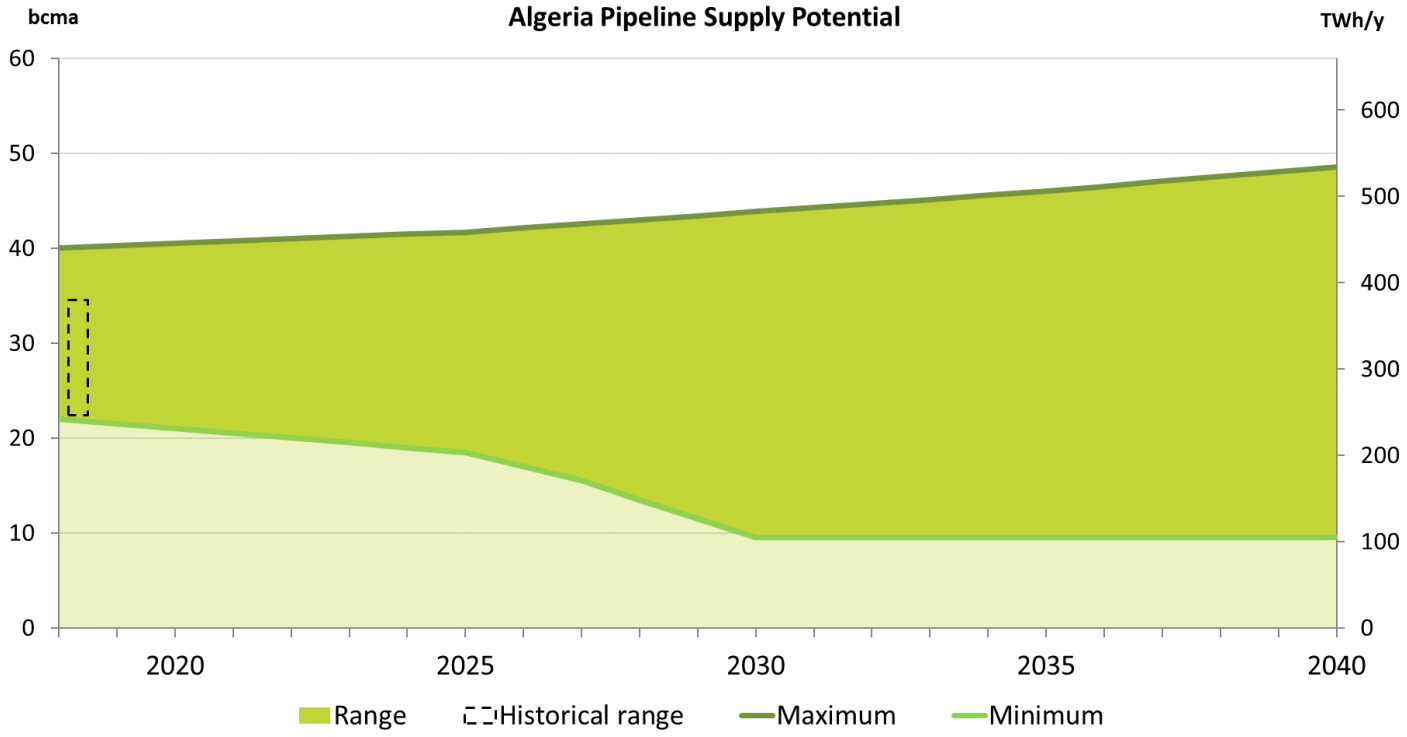


Figure 43: Potential pipeline gas potentials from Algeria

Pipeline Gas Supply Potential for Algeria				
bcma	**2020**	**2025**	**2030**	**2040**
Max	45	44	46	45
Min	21	19	10	10

Table 4: Potential pipeline gas potentials from Algeria (bcma)

Libyan pipeline supply potentials

Libya is one of the smallest gas supplier of the EU via Green Stream pipeline which connects Libya to Italy with a total capacity of around 17 bcma. In 2011 Libyan exports to Italy were completely interrupted due to the civil turmoil and Masra El-Brega LNG plant was damaged and since then Libya has not exported LNG again. ENTSOG has considered a maximum and a minimum potential for Libyan pipe exports based on different assumptions:

Maximum Libyan pipeline gas potential

Based on the export capacity of Green Stream, the maximum potential assumes a 90% load factor of the pipeline (116 TWh/y).

Minimum Libyan pipeline gas potential

The minimum potential is based on the average of the two lowest exporting years, 2.5 bcm in 2011 and 4.4 bcm in 2016.

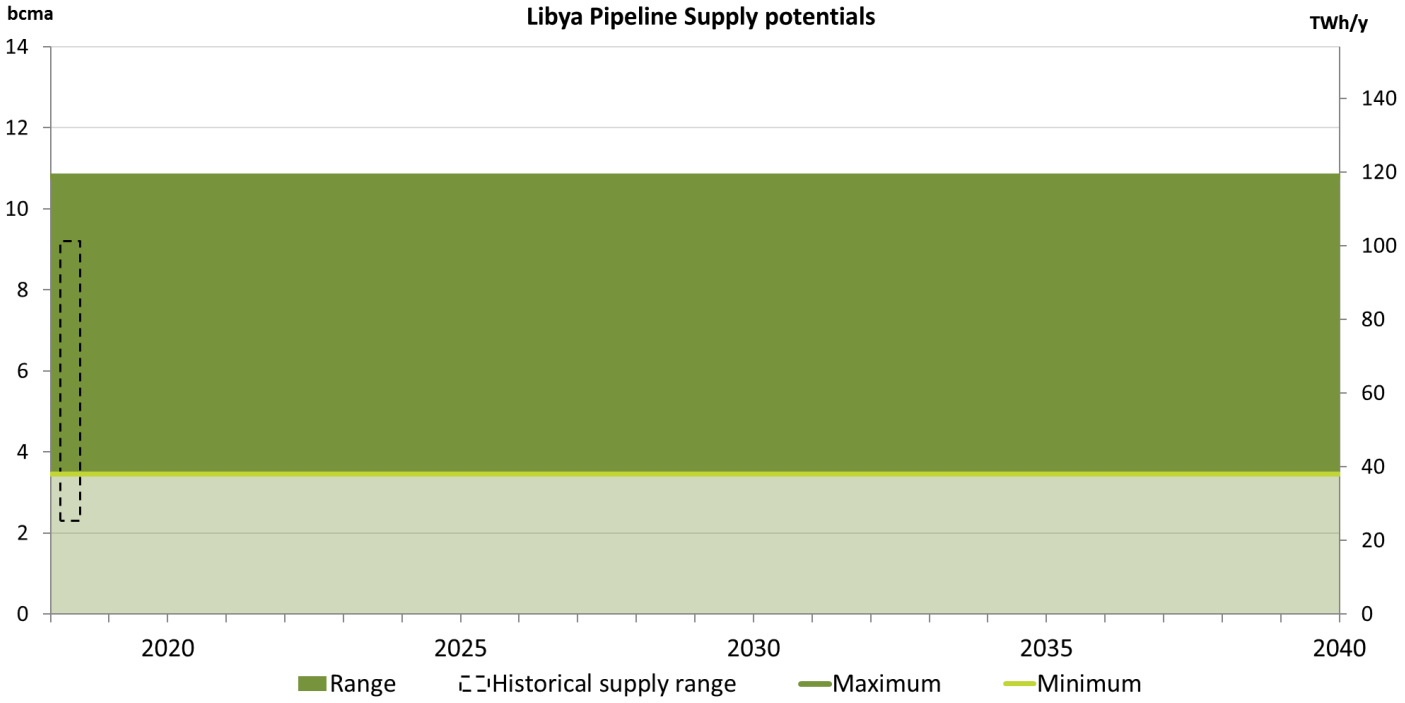


Figure 44: Potential pipeline gas potentials from Libya

Pipeline Gas Supply Potential for Libya				
bcma	**2020**	**2025**	**2030**	**2040**
Max	11	11	11	11
Min	3	3	3	3

Table 5: Libya pipeline gas potential potentials (bcma)

Turkey pipeline supply potential

Turkey is strategically geopositioned, the country already receives gas from plenty of different sources and its intention is to increase the overall connection capacities in the medium and the long term. [1]OIES report: Gas Supply Changes in Turkey shows how the entry capacity to Turkey might almost double by 2023, and many other sources are also considering that the supply potential coming from the Turkish portfolio to the EU could be very high in the near future, nevertheless, ENTSOG is developing conservative assumptions and takes only into account only the volumes that are currently visible according to the Turkey's Ministry of Foreign Affairs, like the existing deliveries to Greece and the potential agreement of an additional 1 bcm to Bulgaria.

Maximum Turkish pipeline gas potential

Maximum scenario considers 2 bcma delivered from Turkey to EU, as currently reflected in Turkey's Energy Profile and Strategy, potentially maintained in the long term to both Greece and Bulgaria.

Minimum Turkish pipeline gas potentials

Minimum potential reflects 1 bcma contracted from Turkey to Greece until 2021, as reflected in Turkey's Energy Profile and Strategy, and no more flows coming directly from the Turkish portfolio by then.

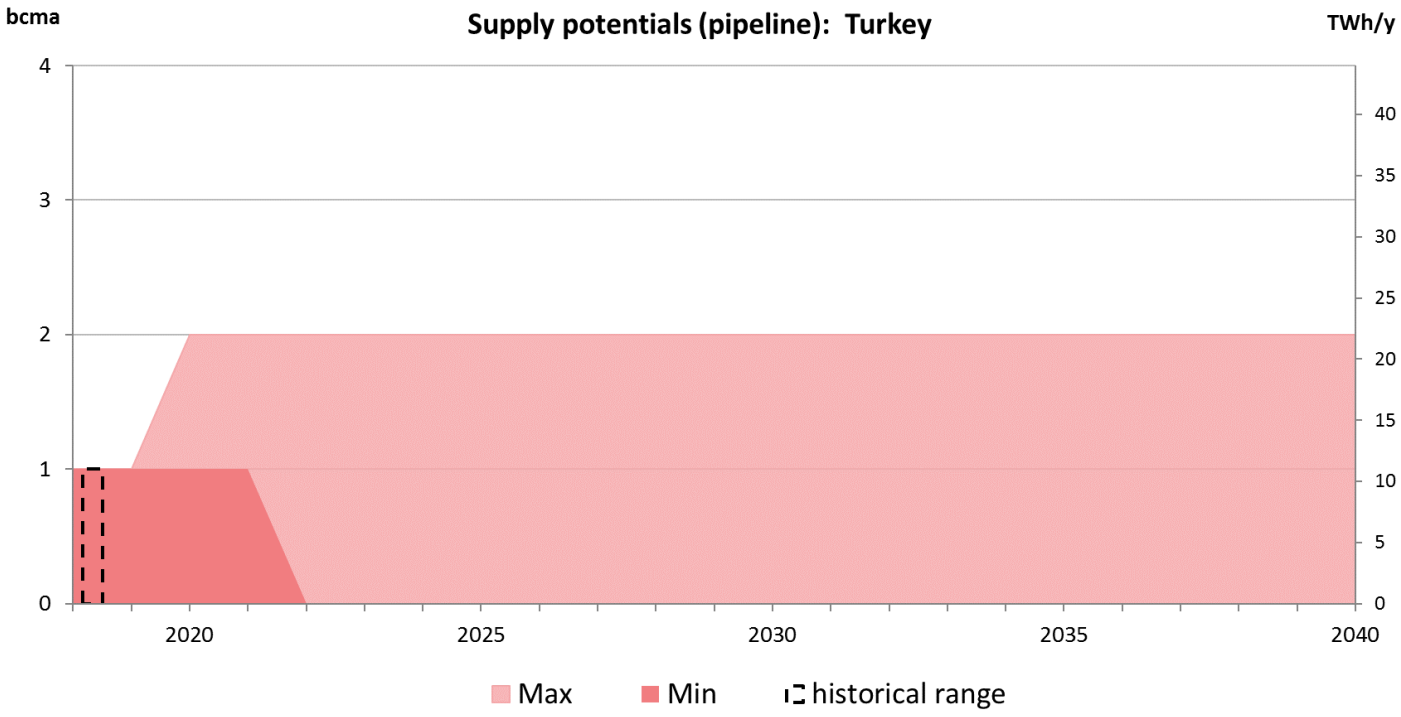


Figure 44: Potential pipeline gas potentials from Turkey

Pipeline Gas Supply Potential for Turkey				
bcma	**2020**	**2025**	**2030**	**2040**
Max	2	2	2	2
Min	1	0	0	0

Table 5: Turkey pipeline gas potential potentials (bcma)

[1]https://www.oxfordenergy.org/publications/gas-supply-changes-turkey/

Azerbaijan pipeline supply potentials

Shah Deniz phase 1 production has already started and will remain stable and limited to regional markets. ENTSOG considers as potential Azeri supply for EU gas coming from phase 2 starting as of 2019.

Maximum Azeri pipeline gas potential

This potential considers the 10 bcma (110 TWh/y) contracted for the EU market as it was done in TYNDP 2017. The ramp-up phase gradually increases the gas imports from 2019 to 2022.

Minimum Azeri pipeline gas potentials

With the final decision of the aforementioned transit route, the likelihood of receiving this gas is now considered to be sure. Hence, this minimum potential has been set at 80 % of the maximum one.

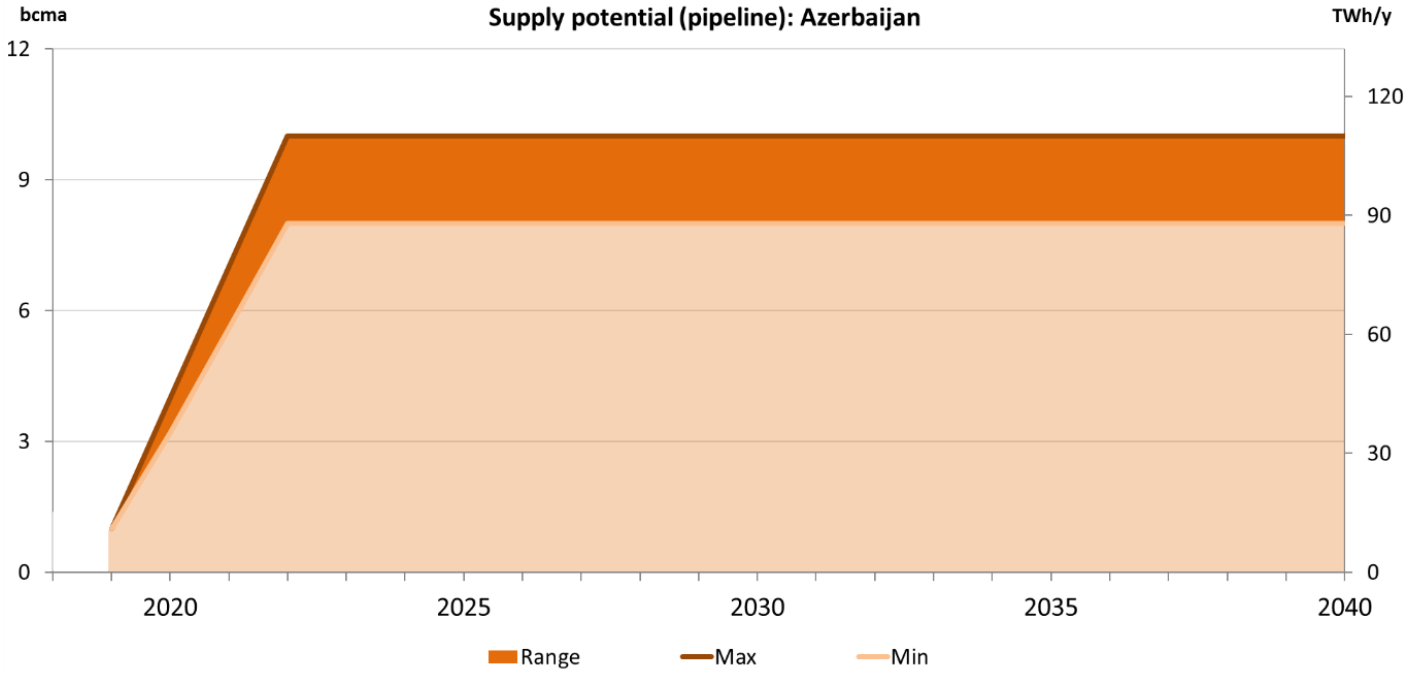


Figure 45: Pipeline gas potentials from Azerbaijan

Pipeline Gas Supply Potential for Azerbaijan				
bcma	**2020**	**2025**	**2030**	**2040**
Maximum	4	10	10	10
Minimum	3	8	8	8

Table 7: Pipeline gas potentials from Azerbaijan (bcma)

Turkmenistan pipeline supply potential

As there is currently no facility to export gas from Turkmenistan to Europe and no FID has been taken yet in any project, in order to derive this new gas supply potential ENTSOG has considered to link this potential volumes to the submission of the Trans-Caspian Pipeline project to the TYNDP 18 Project Collection.

Maximum Turkmenistan pipeline gas potential

Maximum potential considers Turkmenistan has enough reserves and production capability to fulfil the Trans-Caspian Pipeline capacity with 30 bcma (330 TWh/y) once the necessary infra is commissioned.

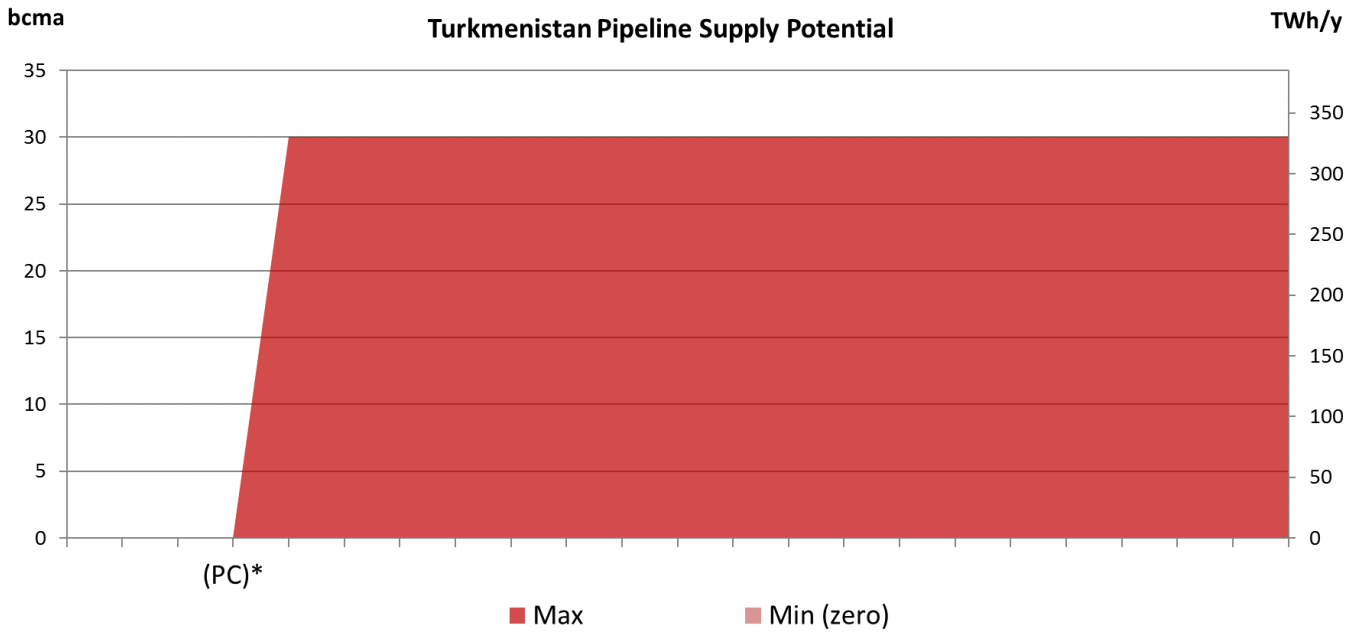


Figure 45: Pipeline gas potentials from Turkmenistan

Pipeline Gas Supply Potential for Turkmenistam				
bcma	2020	2025	2030	2040
Max	0	30	30	30
Min	0	0	0	0

Table 5: Turkmenistan pipeline gas potential potentials (bcma)

Minimum Turkmenistan pipeline gas potentials

Minimum potential considers no flows from Turkmenistan gas reaching the EU.

Turkmenistan maximum potential would only be available when the Trans-Caspian Pipeline is considered in the assessment. Even if this project is activated, these volumes still need to rely on the submission of further projects that would allow the Turkmenistan gas to flow through the east and reach the EU border.

Israel supply potential

Israel currently has 200 bcm of proved gas reserves but the two offshore fields Leviathan and Tamar in the Eastern Mediterranean Sea could reach total estimated reserves of almost 1 Tcm.

Israel's priority is to protect its own energy security and in 2013 approved an export cap of 40% of the country's natural gas reserves as an estimation to supply the national domestic demand for 25 years. Israel is anyway open to export additional gas to countries like Egypt or Jordan, to which Leviathan partners have already agreed to supply 45 bcm over the next 15 years.

Leviathan's platform is planned in a modular way and consists of two stages, Phase-1A is mainly about to supply the domestic Israeli market, Jordan and the Palestinian Authority markets. Once phase 1b is completed it will add 9 bcma surplus to be contracted for exports starting from 2019. Some options for Israeli gas are considering supplying gas directly to Turkey or Greece, the latter through the Trans-Med project, and the most probable one at the date of writing this report, by LNG using the existing and operational liquefaction facility in IDKU, Egypt.

LNG supply potentials

LNG is traded in a global market which has been constantly growing during the last decades. By giving access to a large variety of sources and routes, LNG makes gas reserves around the world accessible to the EU market. The ranges defined for the LNG import potentials reflect the particularly high uncertainty in the level of LNG supplies to Europe.

Maximum LNG potential

New LNG export capacity based on WEO 2017 New Policies scenario trading mix from Middle East, North America, North Africa, Sub Saharan Africa, Latin America, North America and Australia. Starting point is 83 bcm, as the historical year peak imports (2011, BP Statistical 2012), plus the additional surplus from the net exporting regions projected in the WEO 2017 (NPS) for 2025 and 2040.

Highest historical maximum share is applied to the LNG exporting regions Middle East, North Africa (plus an additional 9 bcma available in Egypt coming from Israel) and Sub Saharan Africa. For North America, South America and Australia the share is estimated based on WEO trading flows. Other LNG exports are considered as from Russia (WEO) and Norway (considering 75% capacity).

Some values have been rounded for maximization on a statistical 95% sensitivity.

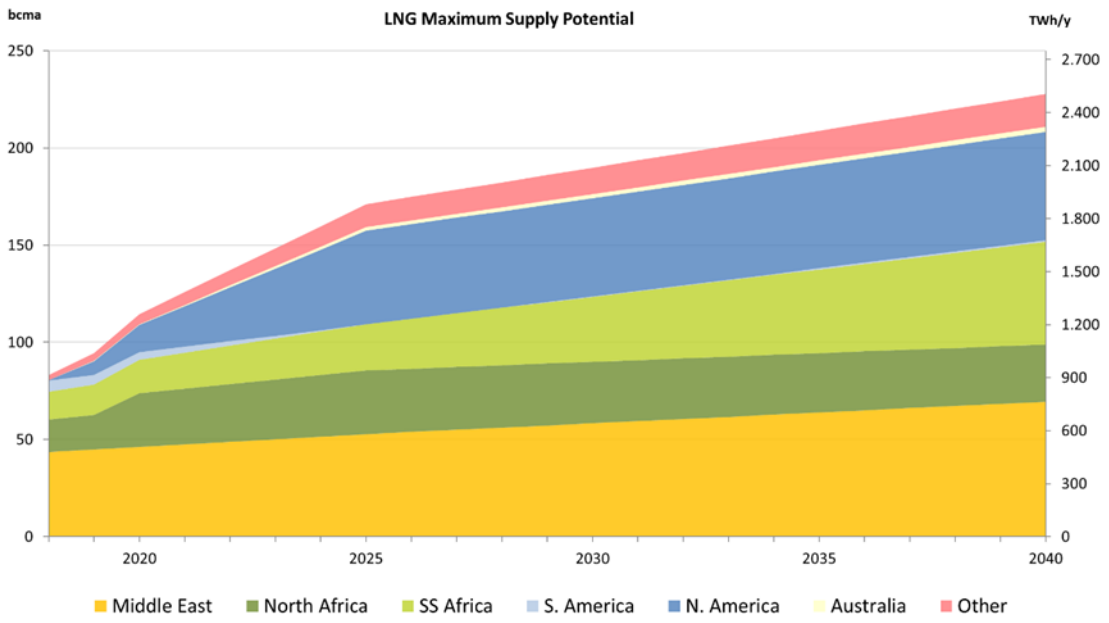


Figure 46: Maximum LNG potential

Maximum Gas Supply Potential LNG				
bcma	**2020**	**2025**	**2030**	**2040**
Middle East	46	53	58	69
North Africa	28	33	32	29
SS Africa	17	24	33	53
S. America	4	0	0	1
N. America	14	48	51	56
Australia	0	2	2	3
Other	5	12	14	17
Total	**115**	**171**	**190**	**228**

Table 7: LNG maximum potentials (bcma)

Minimum LNG potential

The minimum supply potential has been defined on the assumption of a decrease of the imports to a 70 % of the minimum EU historical imports (between 2009 and 2016) and applying the exporting share to all regions, excluding Australia and Israel (included in North Africa) which minimums have been downgraded to zero.

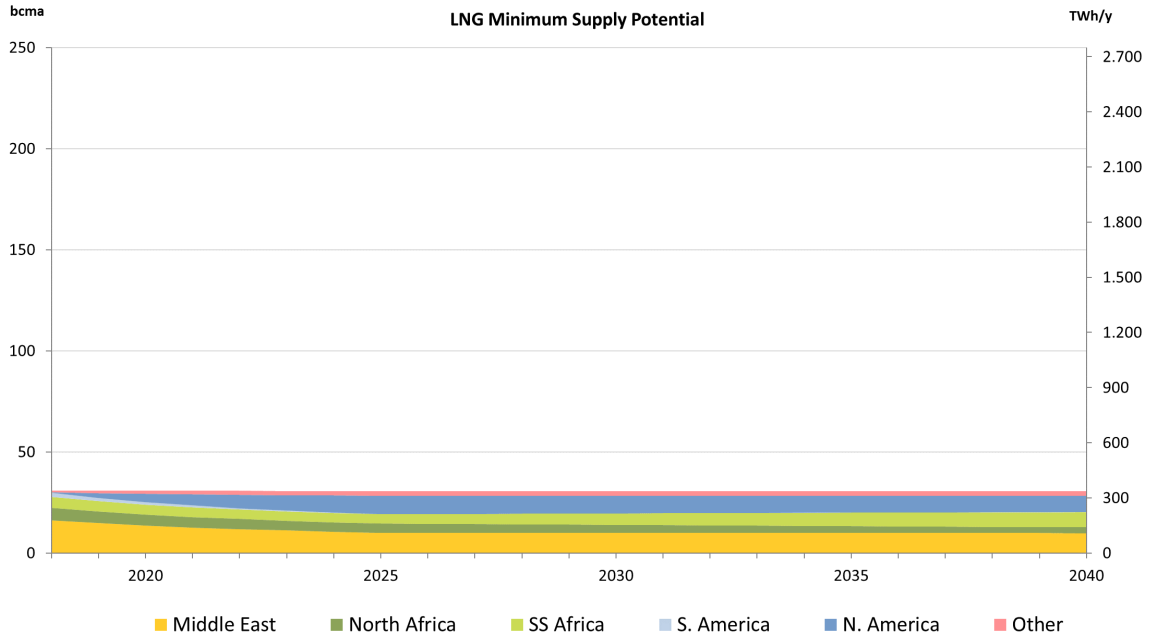
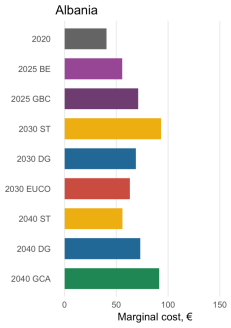


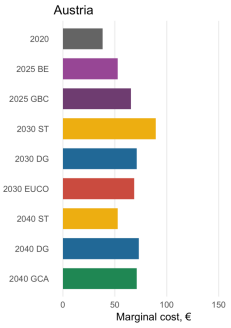
Figure 47: Minimum LNG potential

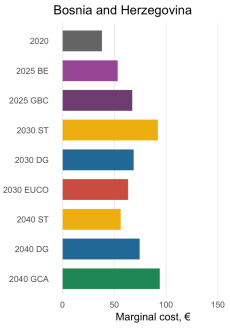
Minimum Gas Supply Potential LNG				
bcma	**2020**	**2025**	**2030**	**2040**
Middle East	14	10	10	10
North Africa	5	5	4	3
SS Africa	5	5	6	7
S. America	1	0	0	0
N. America	4	9	9	8
Australia	0	0	0	0
Other	2	2	2	2
Total	**31**	**31**	**31**	**31**

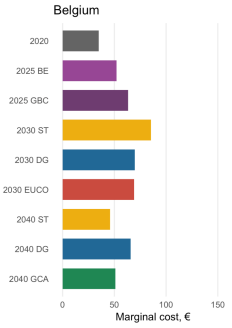
Table 8: LNG minimum potentials (bcma)

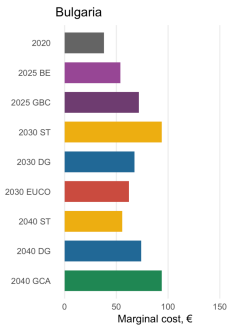
Marginal Costs

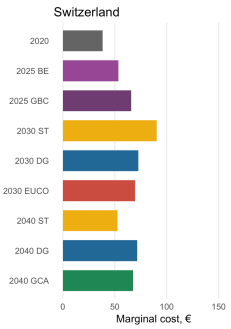


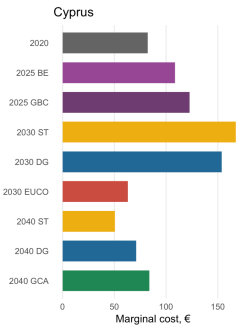


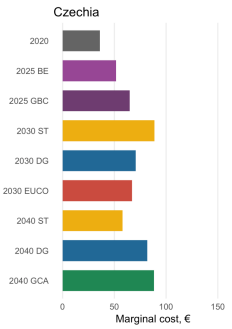


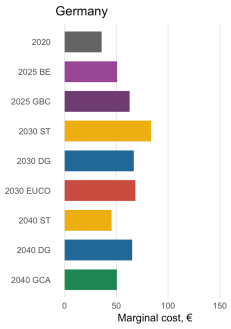


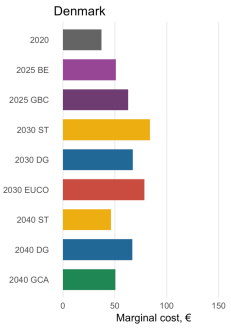


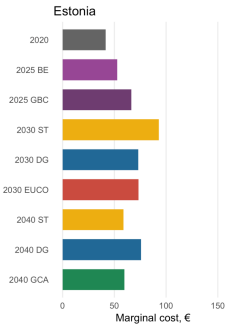


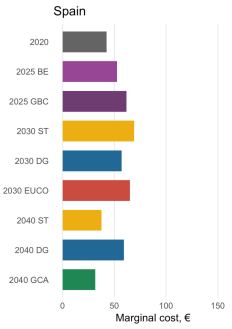


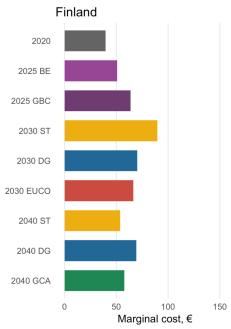


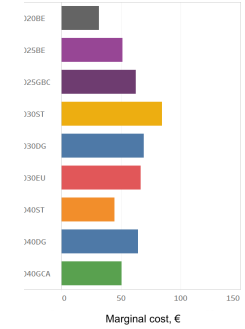


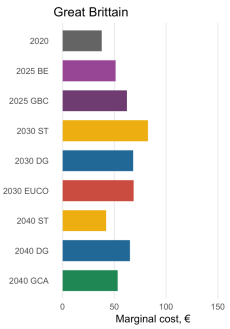


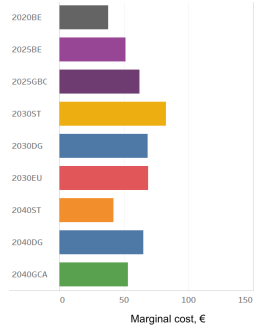


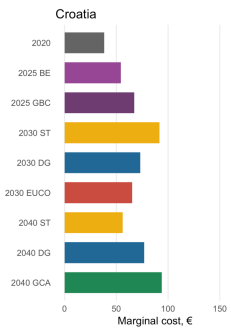


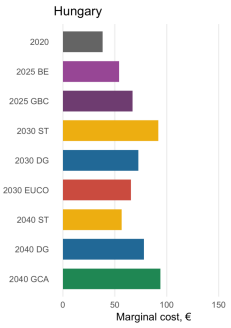


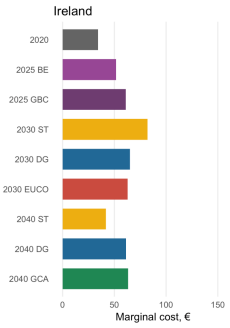


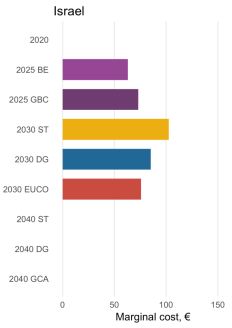


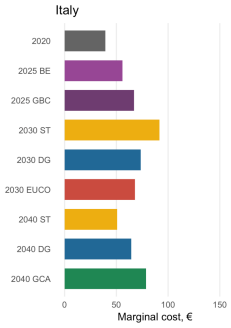


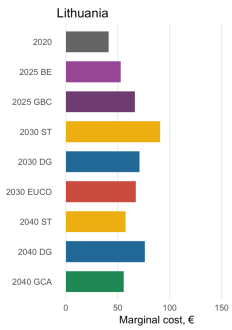









Italy
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Lithuania
2020
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2025 GBC
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2030 DG
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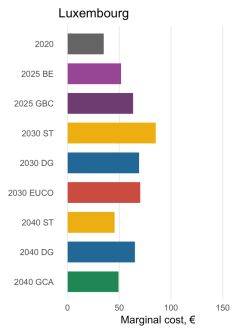
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Luxembourg
2020
2025 BE
2025 GBC
2030 ST
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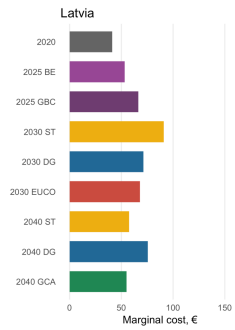
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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2020
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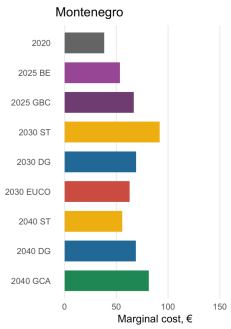
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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2040 ST
2040 DG
2040 GCA
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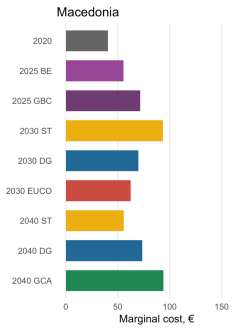
50
100
150
Marginal cost, €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2020
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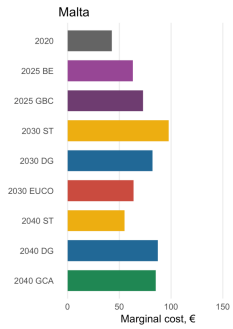
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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2020
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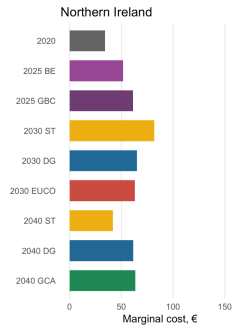
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Northern Ireland
2020
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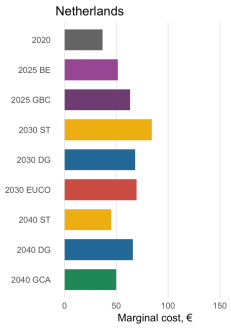
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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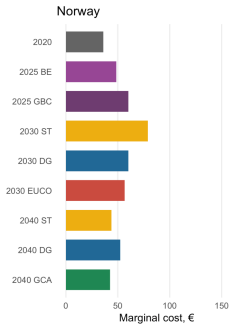
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Norway
2020
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2025 GBC
2030 ST
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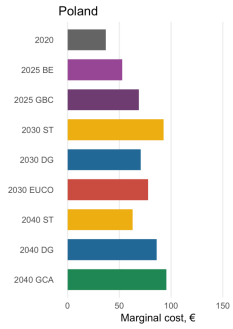
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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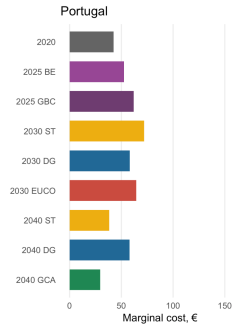
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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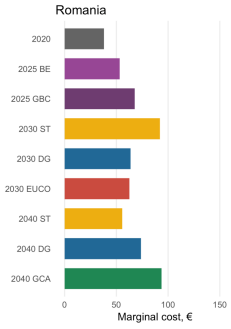
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €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2020
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2040 ST
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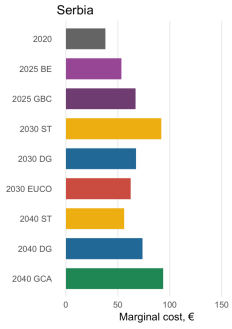
2040 GCA
0
50
100
150
Marginal cost, €


Serbia
2020
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2030 ST
2030 DG
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2040 ST
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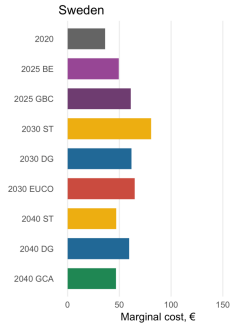
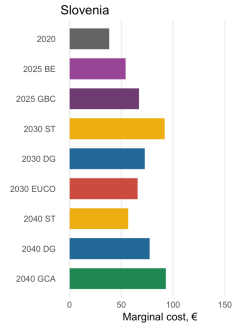
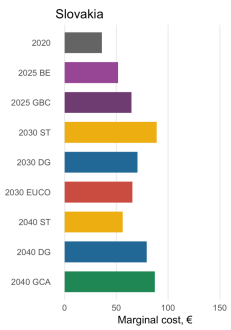
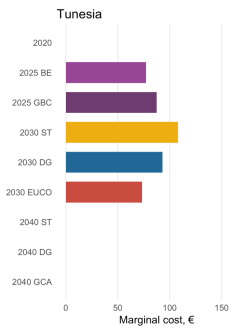
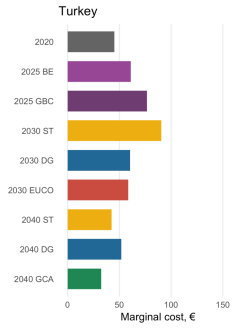
2040 GCA
0
50
100
150
Marginal cost, €


Sweden
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Slovenia
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Slovakia
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Tunesia
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €


Turkey
2020
2025 BE
2025 GBC
2030 ST
2030 DG
2030 EUCO
2040 ST
2040 DG
2040 GCA
0
50
100
150
Marginal cost, €