

Diversity and security of gas supply in Europe, 2021

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Key headlines

Europe consumed 558 billion cubic metres (bcm) of natural gas in 2021.¹ Indigenous production within Europe could have met 40 per cent of demand in 2021, largely due to substantial production by Norway, one of the largest gas-producing countries in the world and by far the largest in Europe.

The UK is the second largest producer of natural gas in Europe and, in 2021, could have met 42 per cent of national demand with indigenous production. This was despite production a record low in 2021 due to substantial maintenance of key North Sea infrastructure. Imports from a diverse range of sources met the remainder of supply, leading the UK to rank fourth overall when considering the security of supply index presented in this article.

An extensive pipeline network provides the infrastructure for much of the gas trade across Europe. Additionally, in recent years Liquefied Natural Gas (LNG) has come to play an important role in balancing both UK and European gas markets. In 2021, the UK and Europe sourced LNG imports from more countries some of which are further afield, due to increased demand in Asia.

Background

Demand for natural gas is met through indigenous production and imports the sum of which is equal to gross supply. In 2021, indigenous production met 40 and 42 per cent of demand in Europe and the UK respectively. The remainder was met through imports, which arrive via pipeline or as shipments of Liquefied Natural Gas (LNG). Pipeline imports made up 81 per cent of total European imports, compared to 19 per cent for LNG. For the UK, this was 72 per cent and 28 per cent respectively.

This article assesses the diversity and security of gas supply in Europe and the UK. The data used in this article were sourced from the International Energy Agency (IEA), and as such reflect IEA member state countries. This includes the majority of Europe. The European countries not included are Andorra, Kosovo, Liechtenstein, Monaco, San Marino, and Vatican City. Cyprus, Iceland, and Montenegro were excluded from this analysis as they did not produce or consume natural gas in 2021. Russia is not considered part of Europe for this analysis.

Methods

This article uses three indicators to analyse the diversity and security of natural gas supply.

Self-sufficiency reflects a country's ability to meet natural gas demand through indigenous production alone. This is calculated by dividing the volume of indigenous production by demand. Countries with a self-sufficiency score of 0 did not produce natural gas; countries with a score greater than 0 and less than 1 meet some demand through imports; countries with a score of 1 produced as much gas as was used; and countries with a score greater than 1 produced more gas than was used. In general, high self-sufficiency means natural gas supply is secure.

Diversity index measures the number of import sources for a given country, weighted by each source country's political stability². This means that a country with many import sources of high political stability will have a high diversity index. Conversely, a country with few import sources of low political stability will have a

¹ Europe wide data for 2022 are not yet available. Information on UK production and trade to October 2022 can be found in [Energy Trends](#).

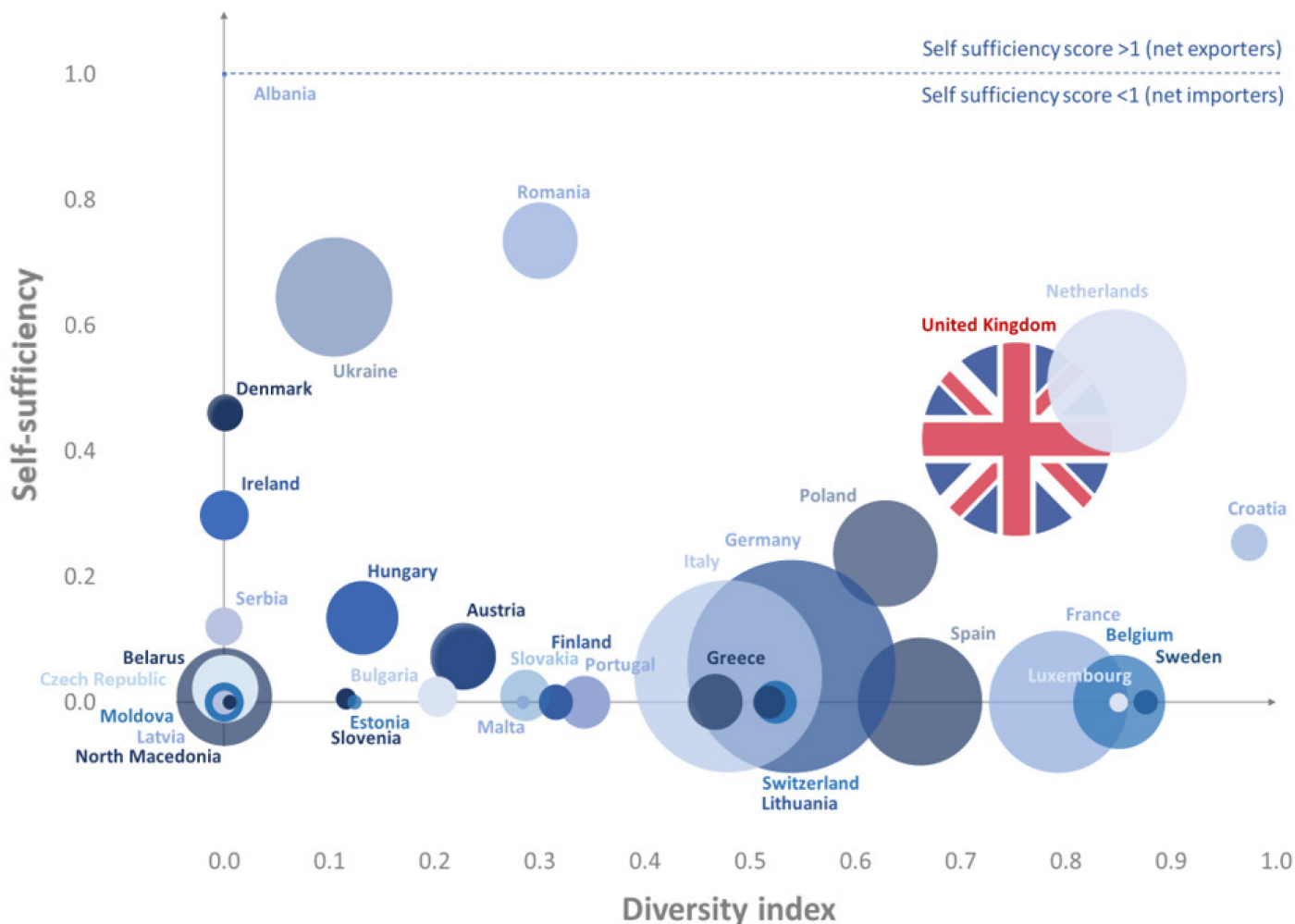
² Data sourced from World Bank governance indicators. See Appendix 1 for underlying data and Appendix 2 for method.

low diversity index. In general, a diverse source of imports means gas supply is more secure. This is further improved if the source countries are politically stable.

Supply index calculates the sum of a country's self-sufficiency score and diversity index score. This is a simple indication of security of supply. A supply index of 0 indicates that a country has no indigenous production and only one import source.

Security and diversity of gas supply in UK and Europe

Chart 1: Self-sufficiency and diversity index for European countries, 2021



Norway has been excluded as it is substantially larger than the other countries and therefore distorts the graph, see Appendix 1 for underlying data

Chart 1 shows the relationship between a country's self-sufficiency score and diversity index. The size of each bubble equates to the natural gas demand in each European country.

Self-sufficiency

In 2021, Norway and Albania were the only self-sufficient countries in Europe. Norway had a self-sufficiency score of 21.6, meaning it produced significantly more natural gas than it used. Historically Denmark has been self-sufficient however the closure of Tyra, the country's largest natural gas field, has led to lower production, and therefore a lower self-sufficiency score of 0.46. Reopening of Tyra has been delayed to 2023 due to manufacturing and supply chain disruptions. Romania, Ukraine, and the Netherlands met more than half of demand with indigenous production.

The UK had a self-sufficiency score of 0.42 in 2021, meaning that UK indigenous production met 42 per cent of demand. Previously UK production had sat at around 50 per cent of demand but this reached a record low in 2021, falling almost a fifth on the previous year. This was due to extensive maintenance on key North Sea

infrastructure including the Forties Pipeline System (FPS) which serves a significant proportion of UK continental shelf (UKCS) oil and gas infrastructure. Despite this, the UK remained the seventh most self-sufficient country in Europe.

16 countries had a self-sufficiency score of 0 as they didn't produce any natural gas in 2021 and were reliant on imports to meet supply.

Diversity

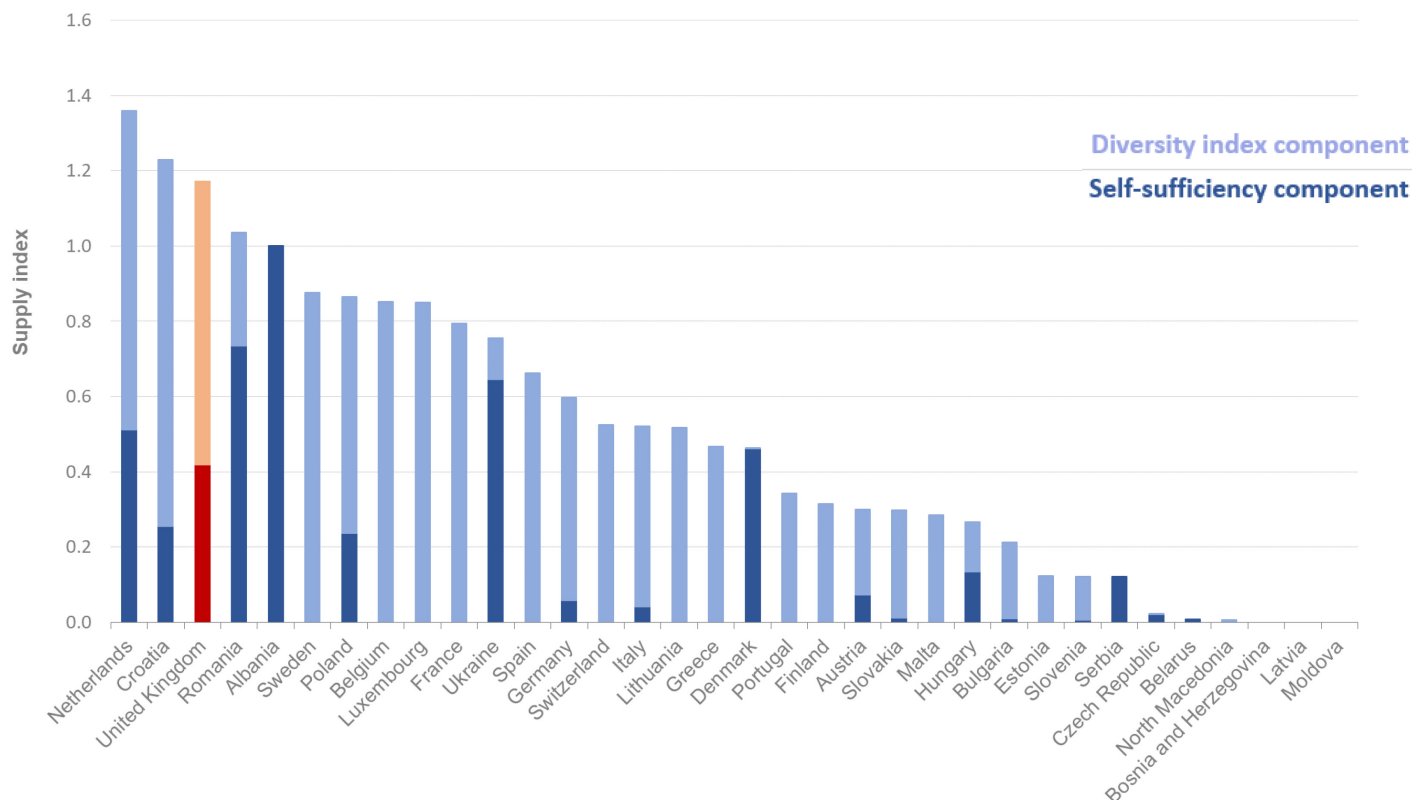
Countries use imports to meet demand. Western European countries tend to have higher diversity indexes. This is in part related to their proximity to the sea which facilitates shipments of LNG from a large number of countries in comparison to pipelines alone. All countries with a diversity index above the European average of 0.35 were in Western Europe, the highest being Croatia, Sweden, Belgium, Luxembourg, the Netherlands, France and the UK. Croatia had the highest diversity index of 0.99, importing gas from twelve countries in 2021. This followed the opening of Croatia's first LNG terminal, which saw a diversification of import sources.

The UK had a diversity index of 0.76, larger than the European average. The UK's high score was due to imports from multiple sources. Import sources to Europe and the UK will be discussed in greater detail later in this article.

Demand

Germany was the largest consumer of natural gas in Europe, consuming 94 bcm in 2021, followed by the UK at 78 bcm. Some large consumers appear in the bottom right quadrant of Chart 1, showing a high diversity index yet relatively lower self-sufficiency score. As self-sufficiency shows production in relation to demand, it is harder to be self-sufficient if a country consumes more natural gas. Albania consumed the least natural gas, and was self-sufficient, as it met demand exactly with indigenous production.

Chart 2: Supply index for European countries, 2021



Norway has been excluded from this graph, see Appendix 1 for underlying data

Chart 2 shows the supply index for European countries in 2021. The self-sufficiency score and diversity index have been stacked, indicating the relative contribution of these components to the security of supply ranking.

Supply index

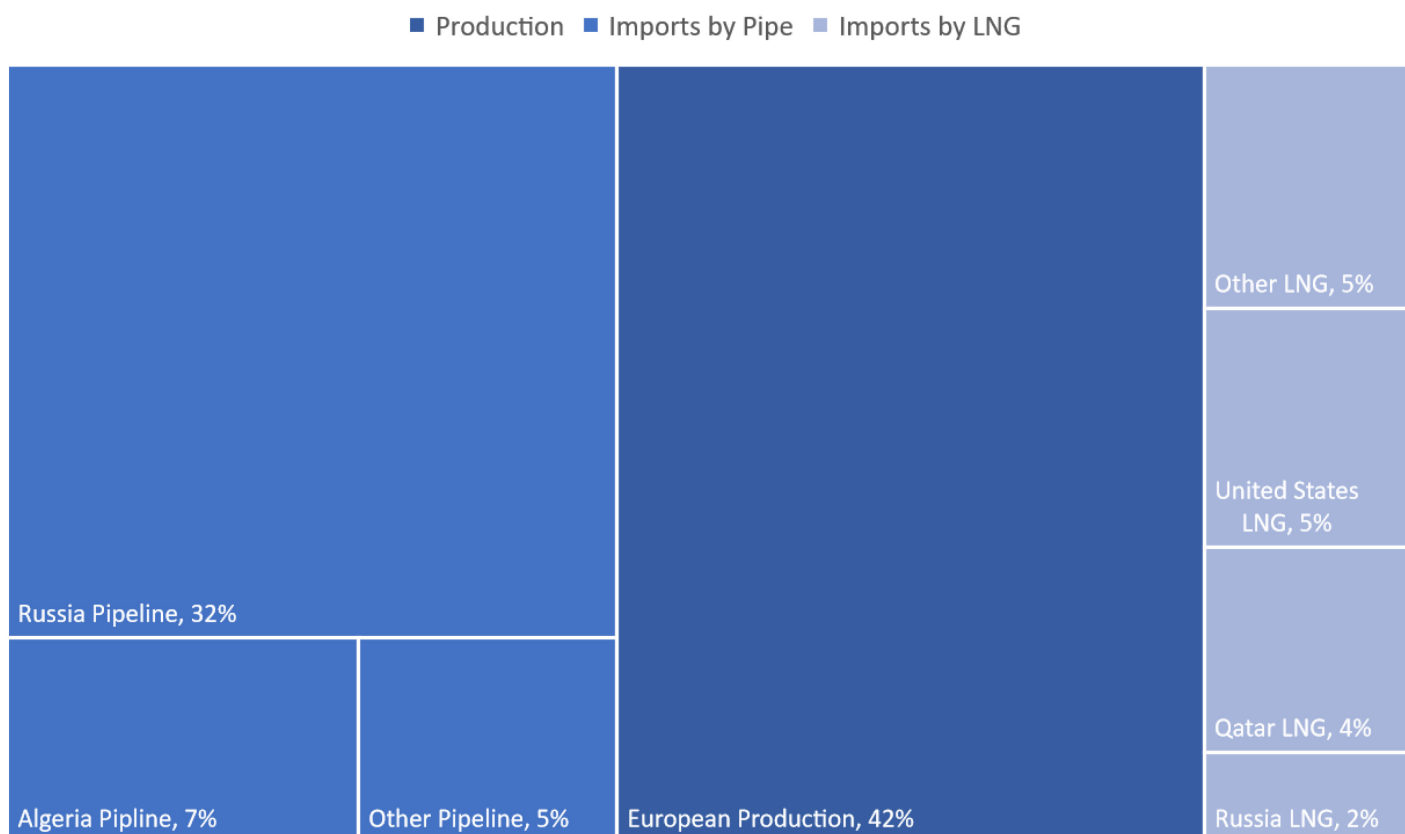
In 2021, most countries had a supply index between 0 and 1.5. The only country outside of this range was Norway, which had a supply index of 22.0, this was the result of its high self-sufficiency score. The average supply index across Europe was 1.09. However, when excluding Norway’s score of 22.0, the average falls to 0.5. For most European countries, a diverse range of imports made a greater contribution to overall security of supply rather than indigenous production. Sixteen countries used imports alone to meet demand, with Bosnia and Herzegovina, Latvia, and Moldova meeting demand with only one import source - leading to a supply index of zero.

The UK ranked in fourth place with a supply index of 1.18, behind Norway, the Netherlands and Croatia. This reflects the UK’s relatively high self-sufficiency and diversity index scores.

European gas supply

The majority of European and UK natural gas imports arrive via pipeline as infrastructure is well-established. In 2021, imports by pipe made up 81 per cent and 72 per cent of total imports respectively. Pipeline infrastructure means it is often convenient to import gas from neighbouring countries. Countries can also import natural gas as shipments of LNG. This is gas that has been cooled to a liquefied state, making it easier to store and transport. It can then be regasified at import terminals, before being transferred to the pipeline system. The UK has well-established LNG infrastructure, with three import terminals: the Isle of Grain, South Hook, and Dragon³.

Chart 3: Sources of European gas supply, 2021



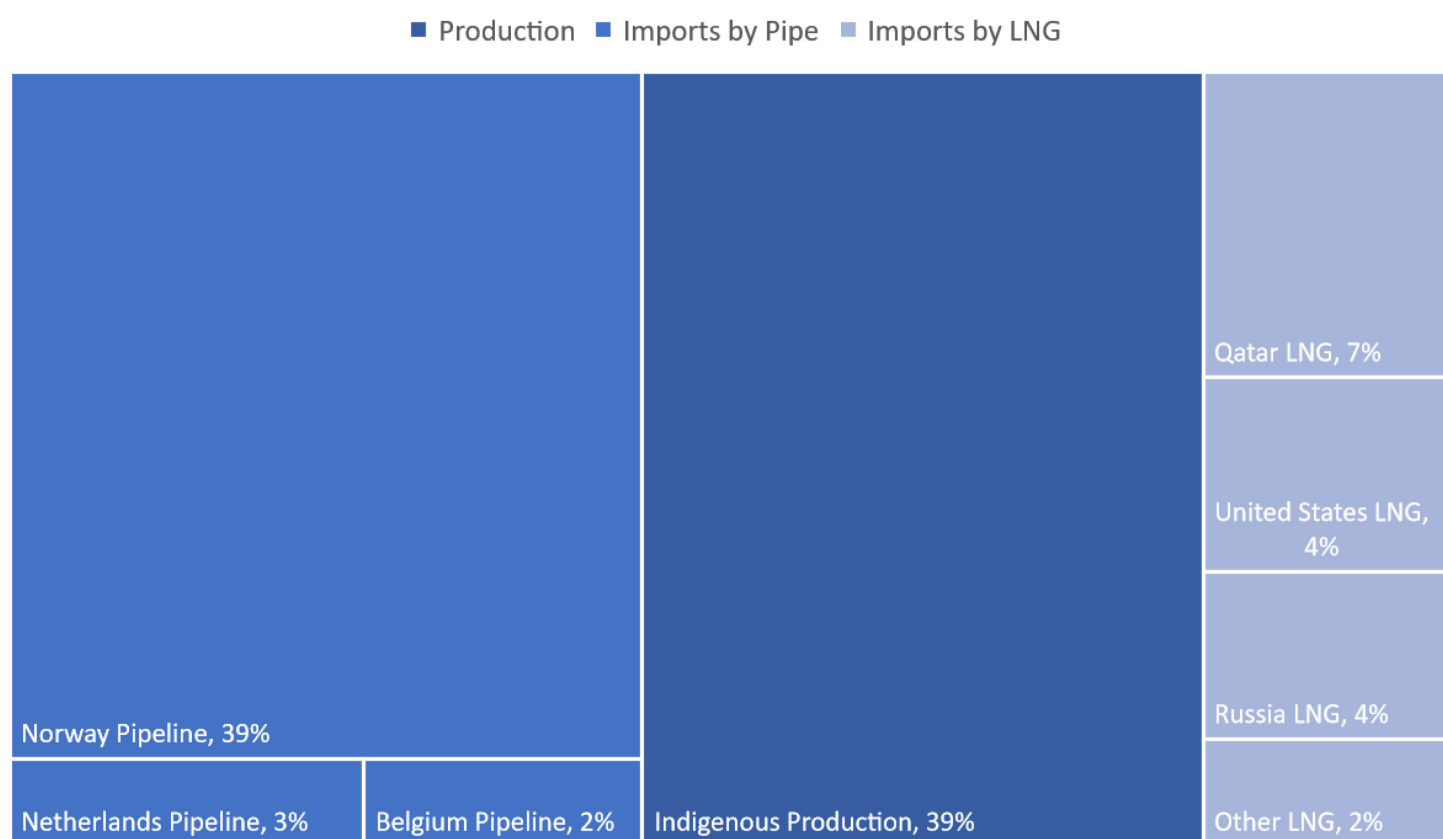
³ For more information on LNG trends please see [Supply of Liquefied Natural Gas in the UK](#), this will be updated with data for 2022 in March 2023

Chart 3 shows gross European natural gas supply in 2021. Gross supply is equal to indigenous production plus imports; imports have been split into pipeline and LNG sources. Smaller quantities of gas imports have been grouped together as ‘Other Pipeline’ and ‘Other LNG’ (see Appendix 1 for the complete list).

When considering European countries together, pipeline imports from Russia were the largest single import source, accounting for 32 per cent of gross supply. Russian LNG made up an additional 2 per cent of Europe’s gas supply. Six European countries imported gas from Russia alone due to their proximity and existing pipeline infrastructure. Russia acts as a transit country for gas from Kazakhstan and Turkmenistan, so it should be noted that the origin of this gas is not necessarily all Russian. Algeria was the second largest import source of natural gas to Europe accounting for 7 per cent of supply, followed by Azerbaijan, Libya, and Turkey.

In 2021, 27 per cent of LNG came from the US, overtaking Qatar at 23 per cent, who have historically been Europe’s largest LNG source. The diversification of LNG imports can be observed due to increased demand from Asia in early 2021, with LNG imports from Nigeria, Algeria, Trinidad and Tobago, and Peru (classed within ‘Other LNG’) increasing considerably.

Chart 4: Sources of UK gas supply, 2021



Similar to Chart 3, Chart 4 shows indigenous production and imports for the UK in 2021.

UK gas production reached a record in 2021 following maintenance on key North Sea infrastructure. Production fell to 364 TWh, which was 47 TWh below the previous record low in 2013 and over 70 per cent lower than the peak in 2000. This was not the case across Europe, with European production remaining stable on the previous year.

UK natural gas imports increased by 17 per cent in comparison with the previous year to account for this low production. The largest import source was Norway due to shared infrastructure on the North Sea, constituting 39 per cent of gross supply. The UK has two other pipeline import sources, the Netherlands and Belgium; all three import sources are deemed politically stable, meaning that the UK has a high diversity index.

Similar to European trends, UK imports of LNG fell by one fifth compared with high levels in 2020, as a cold winter in Asia increased demand. As a result, LNG imports diversified, as the UK imported LNG from 9 countries including Peru and Algeria (categorised under ‘Other LNG’ in Chart 4). Historically, a large proportion

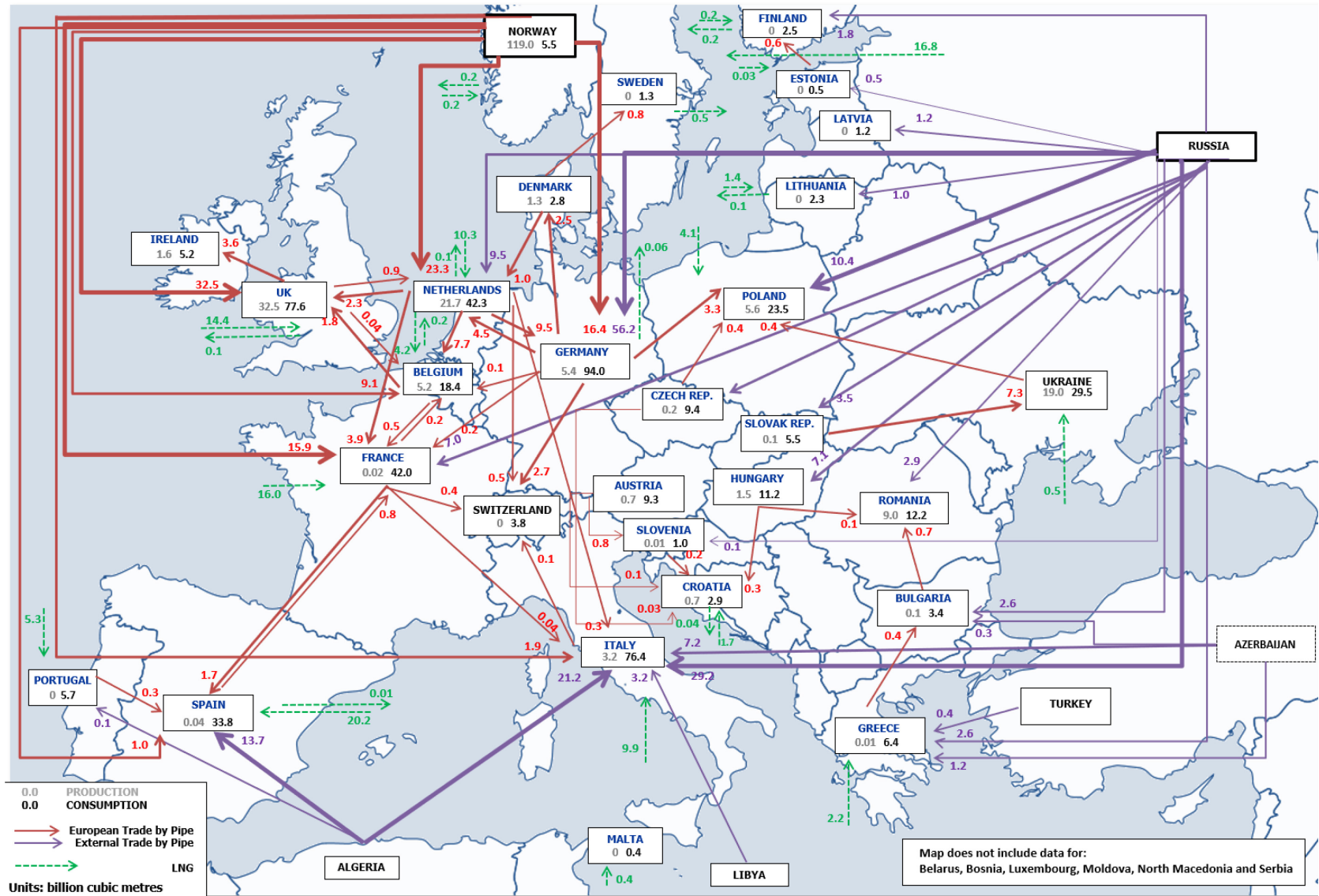
of LNG imports have been Qatari, peaking at 98 per cent in 2012. However, in 2021, Qatari imports accounted for just under 40 per cent of total LNG imports, the lowest in over a decade.

Imports of LNG from the US and Russia increased considerably since 2018, accounting for 7 and 6 per cent of total imports respectively in 2021. In 2022, following Russia's invasion of Ukraine, this has decreased significantly, the last cargo of LNG from Russia was received in March 2022. Sanctions on Russian gas will come into force on the 31 December 2022⁴.

⁴ For more recent data on Russian LNG imports see [Energy Trends Table 4.4](#).

Map 1:

Map 1 illustrates the diversity of import supply, as well as the complexities of inter-EU gas trade.



Appendix 1: Underlying data for charts

Table 1: Underlying data for Chart 1 and Chart 2

Country	Self-sufficiency	Diversity index	Supply index	Demand (mcm)
Albania	1.00	0.00	1.00	62
Austria	0.07	0.23	0.30	9333
Belarus	0.01	0.00	0.01	19966
Belgium	0.00	0.86	0.86	18367
Bosnia and Herzegovina	0.00	0.00	0.00	243
Bulgaria	0.01	0.21	0.21	3418
Croatia	0.25	0.99	1.24	2926
Czech Republic	0.02	0.00	0.02	9459
Denmark	0.46	0.00	0.46	2815
Estonia	0.00	0.13	0.13	456
Finland	0.00	0.32	0.32	2584
France	0.00	0.80	0.80	42004
Germany	0.06	0.55	0.60	94043
Greece	0.00	0.47	0.47	6446
Hungary	0.13	0.13	0.27	11247
Ireland	0.30	0.00	0.30	5214
Italy	0.04	0.49	0.53	76400
Latvia	0.00	0.00	0.00	1187
Lithuania	0.00	0.52	0.52	2269
Luxembourg	0.00	0.86	0.86	762
Malta	0.00	0.29	0.29	379
Netherlands	0.51	0.86	1.37	42333
Norway	21.56	0.41	21.97	5521
Poland	0.24	0.64	0.87	23542
Portugal	0.00	0.35	0.35	5725
Republic of Moldova	0.00	0.00	0.00	3262
Republic of North Macedonia	0.00	0.01	0.01	421
Romania	0.73	0.30	1.04	12262
Serbia	0.12	0.00	0.12	3007
Slovak Republic	0.01	0.29	0.30	5471
Slovenia	0.01	0.12	0.12	952
Spain	0.00	0.67	0.67	33820
Sweden	0.00	0.89	0.89	1301
Switzerland	0.00	0.53	0.53	3824
Ukraine	0.65	0.11	0.76	29504
United Kingdom	0.42	0.76	1.18	77626
Average	0.74	0.35	1.09	14688

Source: IEA (<http://data.iea.org/>)

Countries included in 'Other Pipeline' in Chart 3: Azerbaijan, Libya, Turkey, and non-specified sources.

Countries included in 'Other LNG' in Chart 3: Nigeria, Algeria, Trinidad, Peru, Equatorial Guinea, Egypt, Angola and non-specified sources

Countries included in 'Other LNG' in Chart 4: Peru, Algeria, Trinidad, France, Belgium, Nigeria

Appendix 2: Methodology

Self-sufficiency

Data for natural gas was extracted from the IEA database. Self-sufficiency was determined from data on indigenous production and demand (indigenous production (mcm) ÷ demand (mcm)).

Diversity index

The diversity index used here is a product of a standard diversity index and an index for political stability. As a basic index for measuring diversity, we used the Shannon-Wiener diversity index:

$$\sum_{i=1}^n -x_i \ln(x_i)$$

Where x is the proportion of total natural gas supply represented by the i^{th} source country and n represents the final source country. A value below 1 signifies a country that is dependent on a small range of import sources, a value above 1 represents a country with a wider range of import sources. The minimum value of zero denotes a country that has one imported fuel source or relies entirely on indigenous production (or a country with no imports). The Shannon-Wiener was chosen here because it places weight on the diversity of contributions from smaller countries and reduces the impact of larger nations.

Political stability was determined using data from the World Bank worldwide governance indicators. Specifically, the index reflects perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically motivated violence and terrorism. These data were standardised between 0 and 1.

Source: World Bank <http://info.worldbank.org/governance/wgi/index.aspx#home>

Shannon-Wiener and political stability indices were multiplied and summed:

$$\sum_{i=1}^n -x_i \ln(x_i) b_i$$

Where b is an index of political stability of producing country. This is called the SWNI (Shannon-Weiner-Neumann index), in line with previous work. Each SWNI index was normalised between 0 and 1, in order to have a standardised index. This was done by working out a maximum diversity score, by assuming maximum diversity was equivalent to importing products in line with proportional contributions of exporting countries (e.g. if a single country were responsible for exporting 50 per cent of all natural gas, and five other countries were responsible for 10 per cent each, we assumed maximum import diversity at a ratio of 5:1:1:1:1:1). This maximum diversity score then acted as our upper score of 1, with all other scores divided by this maximum to standardise the data.

Other sources of gas

Sometimes, due to a variety of reasons, countries may report an import of natural gas from a “Non-Specified/Other” source country. Border Point Data was used to reallocate imports for Austria, Hungary, Ireland, North Macedonia, Portugal, Slovakia and Ukraine, which is available at www.iea.org/gtf/. This data is collected by the IEA and shows monthly gas flows in Europe.



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