Diversity of supply for oil and oil products in OECD countries in 2018

Introduction and summary

Countries meet their oil needs through a combination of indigenous production and trade. This article is a comparative assessment of how OECD countries manage their crude oil and transport fuel demand using data from the IEA database[1]. The aim is to determine how the UK compares with other OECD countries in terms of how it secures oil supplies.

Within the OECD, the same three countries as last year were the only net exporters of crude oil in 2018: Norway, Canada, and Mexico. All other OECD countries met their demand at least partially through imports with 10 countries not producing any crude oil indigenously. Of these other countries, the UK had the highest self-sufficiency, producing over 90 per cent of its crude oil demand.

Half of OECD countries met their petrol demand through indigenous production, with much of Western Europe being net exporters. Subsequently petrol achieved the highest average security of supply score. Jet fuel had the joint lowest average diversity index with petrol, although on average OECD countries were 95 per cent self-sufficient. The self-sufficiency average was greatly increased by the high contributions notably from Lithuania (meeting 7.4 times the demand) and Korea (at 3.2 times the demand).

Approximately 43 per cent of OECD countries were self-sufficient in diesel production, Greece, Finland, and Korea remained the top three. Greece produced nearly four times the amount it consumed.

The UK could have met more than 90 per cent of its demand for crude through indigenous production and ranked in the top five for security of supply. The UK was able to more than meet demand for petrol through indigenous production. For jet fuel, the UK was in the lower half of the OECD in terms of indigenous production scores, even though consumption was the second highest. However, with a diversity score of 0.78 ranked joint second in terms of security of supply with Denmark and after France alone. On diesel, the UK produced less than half of demand, below the median for the OECD, but scored third highest for diversity and security of supply.

Charting oil self-sufficiency and diversity of supply

Bubble charts
The bubble charts demonstrate the relationship between demand, indigenous production, diversity of gross imports and the political stability of import sources. This year we have grouped OECD countries in Asia, the Middle East and the EU for the first time, using the average scores. See Appendix 1 for a list of the countries included in each of these categories. The profiles show:

- Self-sufficiency: the proportion of a country's demand that could be met through indigenous production is shown on the vertical axis. A score of 1 indicates a country produces as much oil as it uses, a score of 0 indicates that no demand was met with own production.

- A diversity score: the diversity and political stability – defined via the World Bank's governance indicators - of a country's gross imports is shown on the horizontal axis (see Appendix 3 for a methodological note).

- Consumption: is represented by the circle or bubble, the area of which indicates the level of consumption for 2018 for each OECD country.

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[1] http://data.iea.org/ Following implementation of a new country list in the annual survey of member states in 2018 more detailed data was available for sources of supply. Compared to the 104 countries (and groupings) available for 2017 data, this analysis uses data from 163 supply sources. This has been reflected in movements in some countries' diversity scores where supply sources previously grouped into one category (e.g. Other Africa) have been counted separately.

<u>Bar charts</u>
The bar charts provide a means of comparing OECD countries by self-sufficiency and diversity of imports. These profiles combine the proportion of demand that could be met through indigenous production with the diversity and political stability of import origins. The sum of these two components is used as a simplified metric for security of supply, and thus does not represent a full description of security of supply beyond import diversity, stability and self-sufficiency. Appendix 2 shows the underlying data.

<u>Choropleth map</u>
These maps indicate a visual representation of the source countries and quantities of each product's exports. A darker shade represents a high proportion of the world's exports originated from that country, whereas lighter shades indicate that fewer exports originated in that country. Appendix 2 shows the underlying data.

Results

<u>Crude</u>

Only three OECD countries were self-sufficient for crude oil again in 2018 (Chart 1). Norway had by far the highest self-sufficiency score, producing nearly five and a half times its own consumption. With a self-sufficiency score of 0.92, the UK was above the OECD average of 0.41 and this marks an increase in self-sufficiency for the UK compared to 2017. Similarly, the UK's diversity score of 0.65 was above the average score of 0.38.

Chart 1: Diversity and self-sufficiency of crude oil for OECD countries, 2018
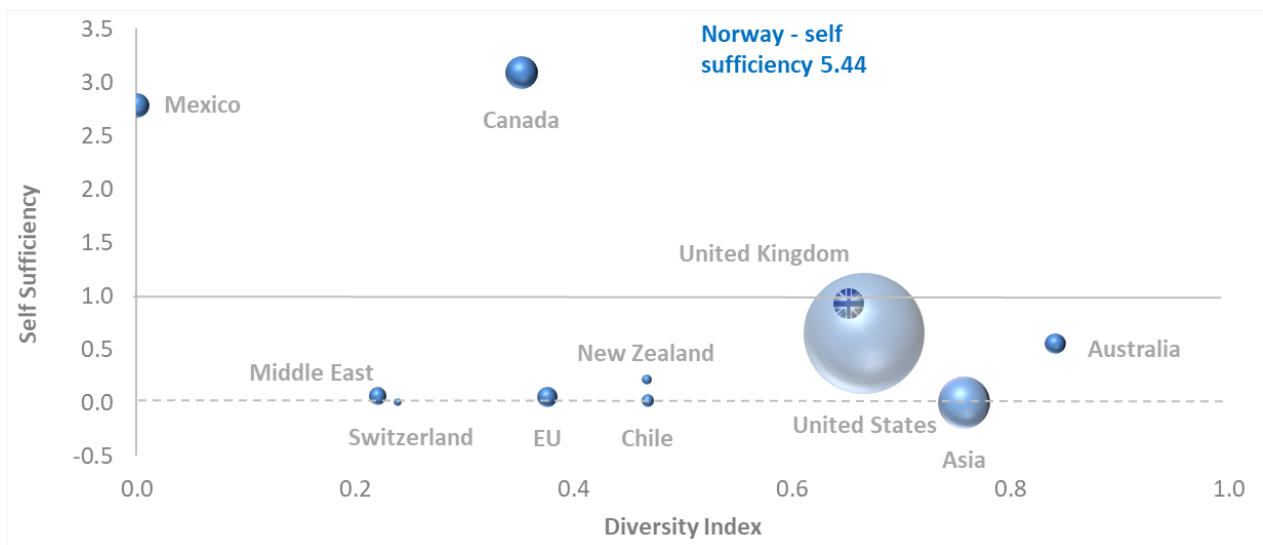
Most OECD countries showed diversity and political stability scores that reflect a strong trading element, with a relatively small contribution from indigenous production (Chart 2). Chart 2 shows that the UK placed highly in the ranking of OECD countries being one of only a few countries with substantial oil production.

Chart 2: Security of supply of crude oil for OECD countries, 2018
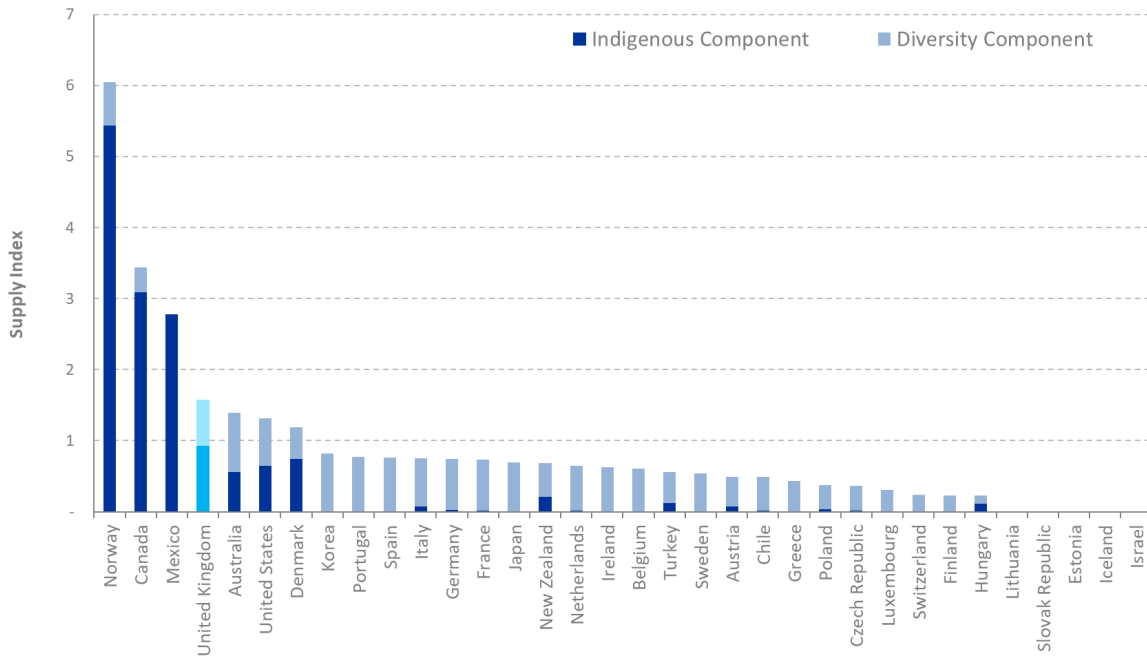
Note: No data was available for Lithuania, Slovak Republic, Estonia, Iceland or Israel

Map 1 is an illustration of where crude oil exports originated in 2018. Saudi Arabia, Russia and increasingly the US[2] are the biggest exporters of crude in the world. Within the OECD, the UK was the 4th biggest exporter.

Map 1: Worldwide crude oil exports (kt), 2018
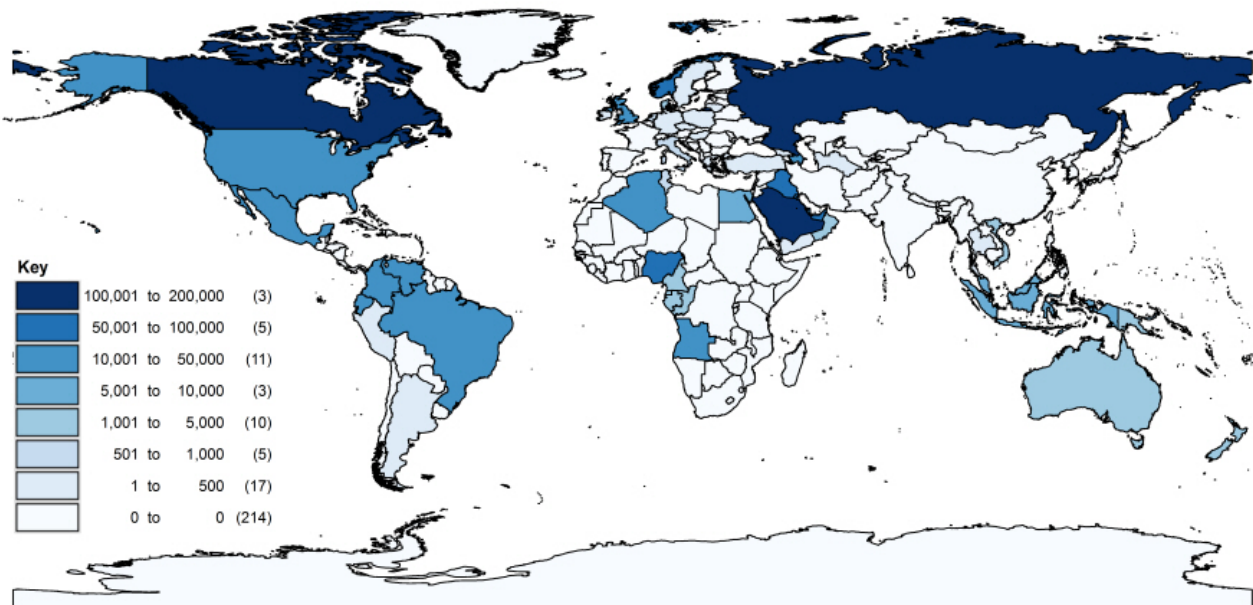
[2] www.eia.gov/dnav/pet/pet_move_expc_a_EPC0_EEX_mbbl_a.htm

Petrol

The profiles for petrol are different to that of crude. Half of the 36 OECD countries were self-sufficient in 2018 (Chart 3). Lithuania (combined in the EU average and who only joined the OECD in 2018), had a self-sufficiency score of 11.38, making it by far the highest ranking in this regard. Consumption in the US dwarfs that of other OECD countries, equal to nearly 64 per cent of the OECD total. The UK had a self-sufficiency score of 1.36, which was above the 0.96 average across all OECD countries. The UK's diversity score of 0.69 was also much higher than the OECD average of 0.38 and was the third highest overall after the US and Australia.

Chart 3: Diversity and self-sufficiency of petrol for OECD countries, 2018

Our simplified security of supply index (Chart 4) shows how most countries produce enough petrol to meet their needs and how much trade there is in petrol amongst the OECD countries. The UK ranks 3rd out of the 36 OECD countries for security of supply of petrol.

Chart 4: Security of supply of petrol for OECD countries, 2018
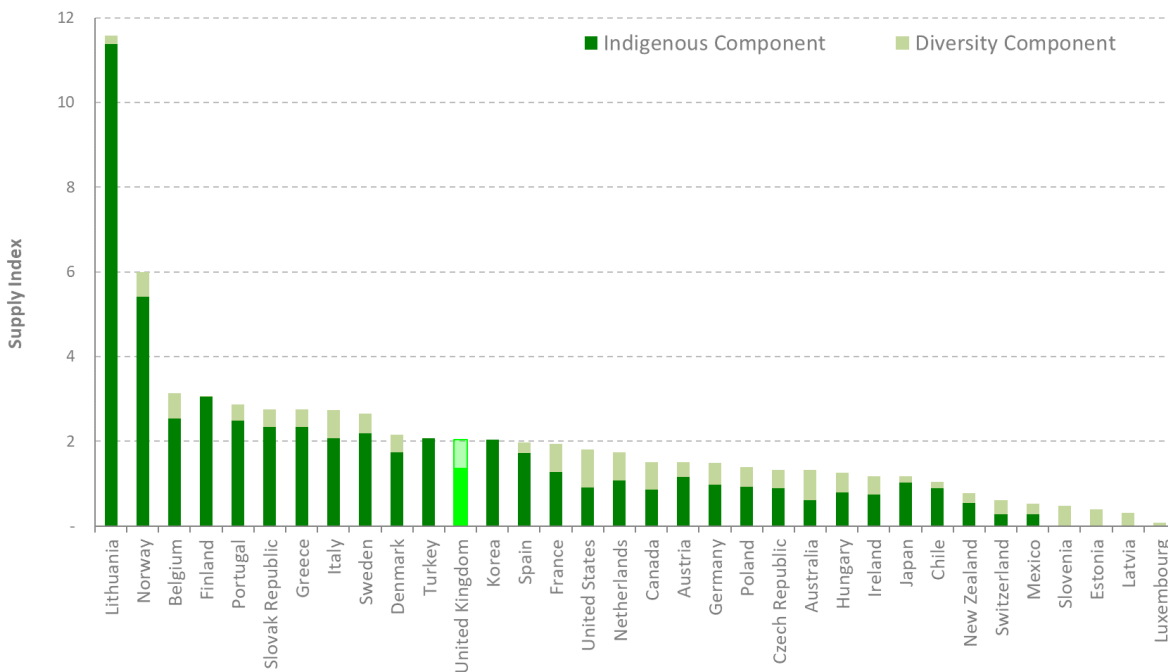
The main exporter of petrol around the world is North America, exporting more than twice the amount of Canada, the next biggest exporter. Europe is also shown on the map to be a very significant exporter of petrol to the rest of the world, notably including the United Kingdom, the Netherlands and Belgium. Many large economies such as Australia, Japan and China export comparatively low quantities of petrol.
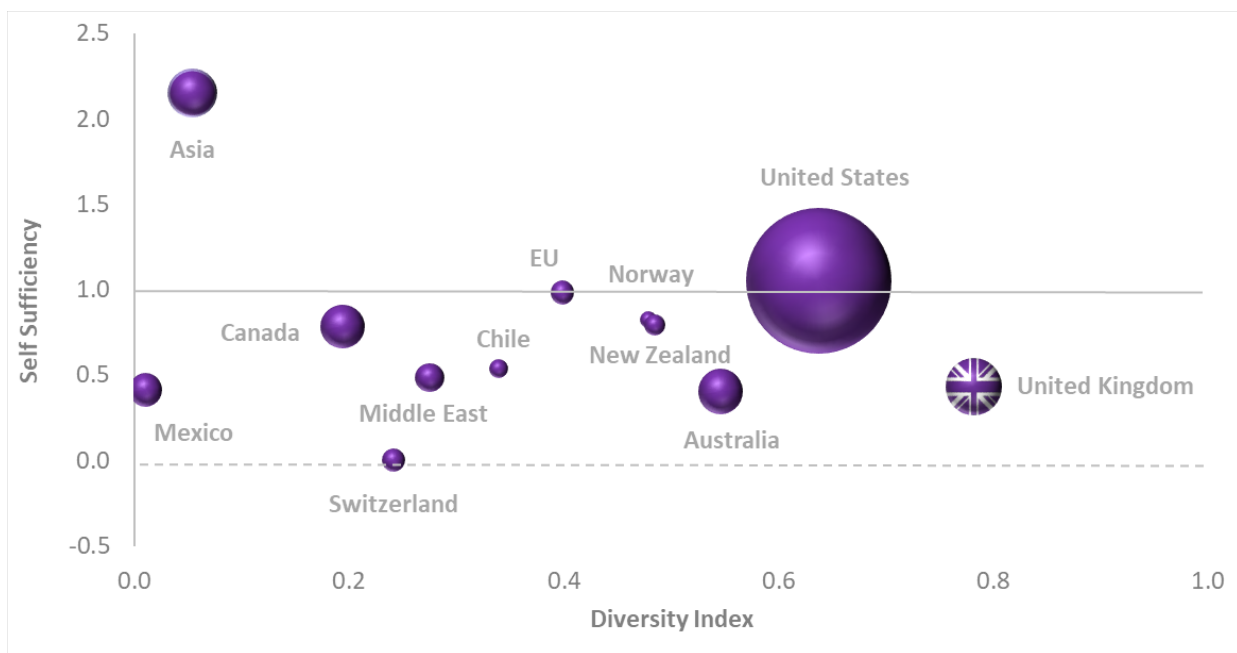
Map 2: Worldwide petrol exports (kt), 2018
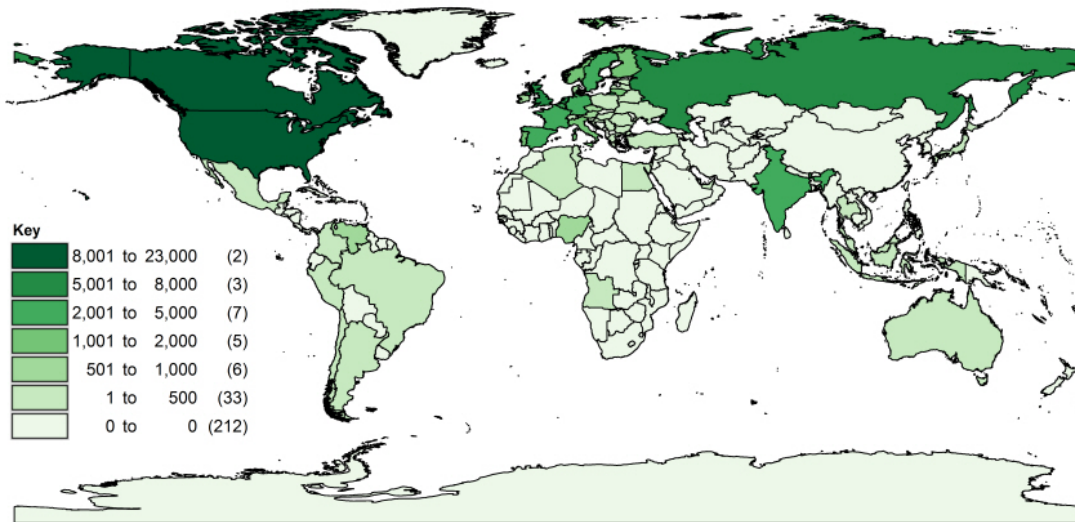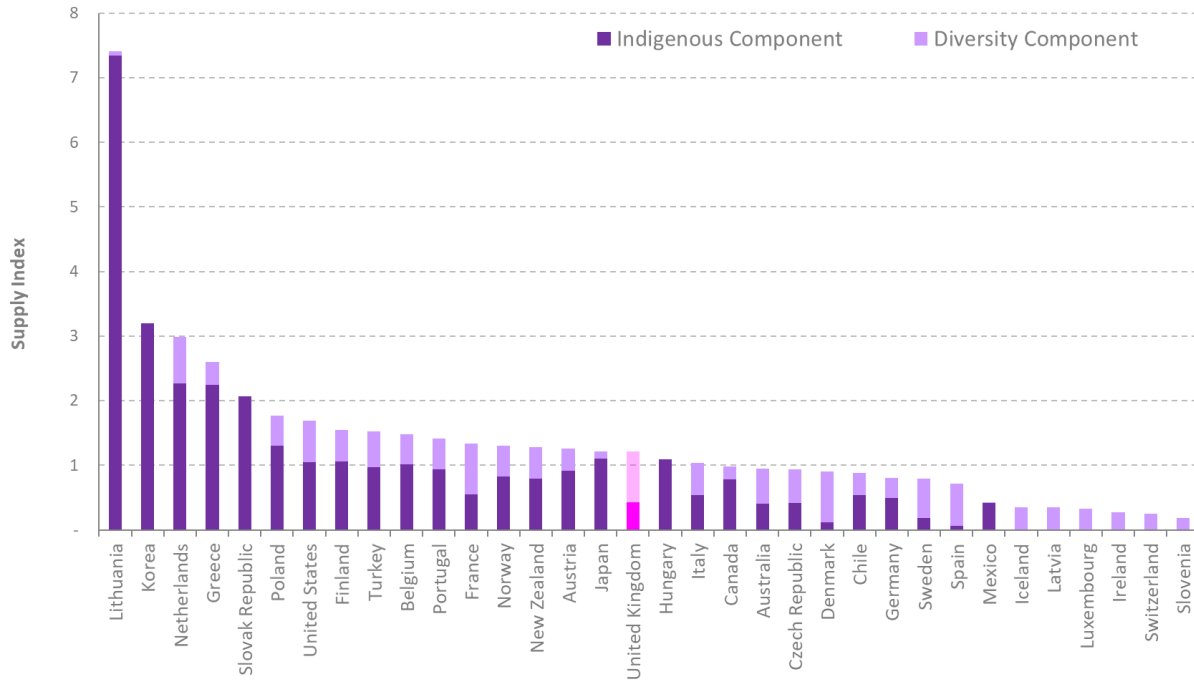

Jet Fuel

Chart 5 shows that, with a score of 0.43, the UK was below both the self-sufficient threshold of 1 and the OECD average 0.95 for jet fuel. However, the UK's import diversity score of 0.78 was higher than the average for all OECD countries of 0.38.

Chart 5: Diversity and self-sufficiency of jet fuel for OECD countries, 2018

Many OECD countries have significant production capacity of jet fuel. For instance, with a refining capacity of approximately 10 million tonnes a year Lithuania has relatively low demand so produces more than seven times its demand, and Korea more than three times. The UK's low capacity to meet demand through indigenous production is of the largest deficits in the OECD, significantly lower than the OECD and EU average. However, Heathrow (being the busiest airport in Europe), causes the UK to have the second highest demand for jet fuel, behind only the United States.

Chart 6: Security of supply of jet fuel for OECD countries, 2018

Jet fuel is only exported in significant quantities in a few countries around the world with Korea, the Netherlands, the United Arab Emirates, the United States and Saudi Arabia exporting the most. The Netherlands is a trading hub for many oil products, with large amounts of imports 're-exported' and not used for the country's own consumption. Europe exports relatively small amounts of jet fuel (excluding the Netherlands), as does Canada and North Africa.

Map 3: Worldwide jet fuel exports (kt), 2018

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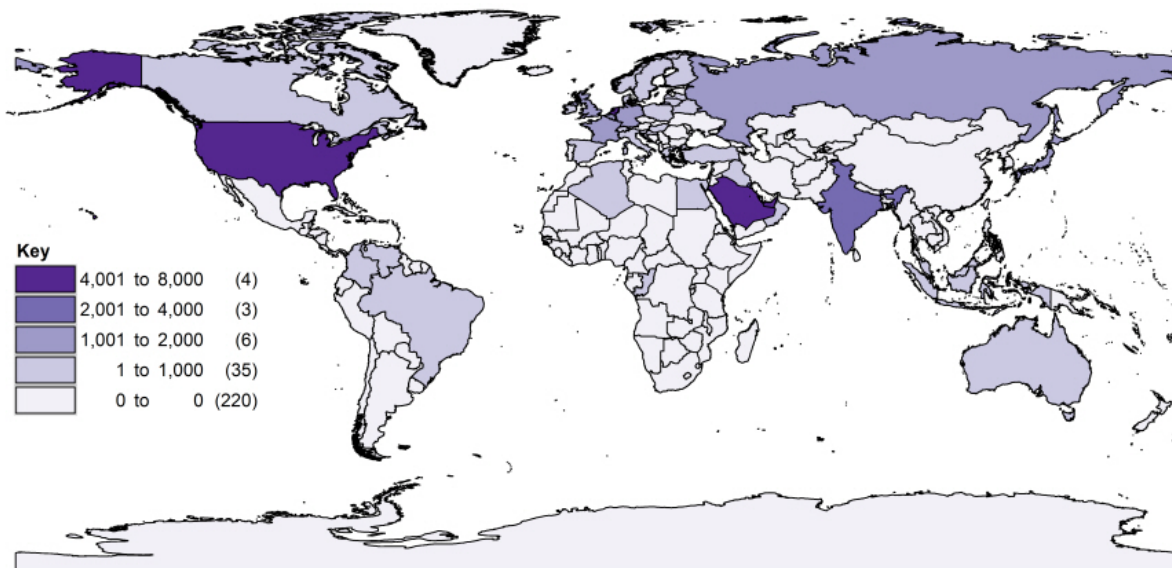
Diesel road fuel

At 0.50 on the self-sufficiency axis the UK was below the average OECD self-sufficiency score of 0.90 in 2018, producing just half of the diesel it consumed. However, the UK is in a favourable position in terms of diversity and political stability of imports; the UK's diversity score of 0.71 was the joint second with Denmark only after France, but with demand of around 12 million tonnes compared to 1.0 for Denmark and 7.6 for France. The UK score was also substantially above the OECD average of 0.38 (Chart 7).

Chart 7: Diversity and self-sufficiency of diesel for OECD countries, 2018
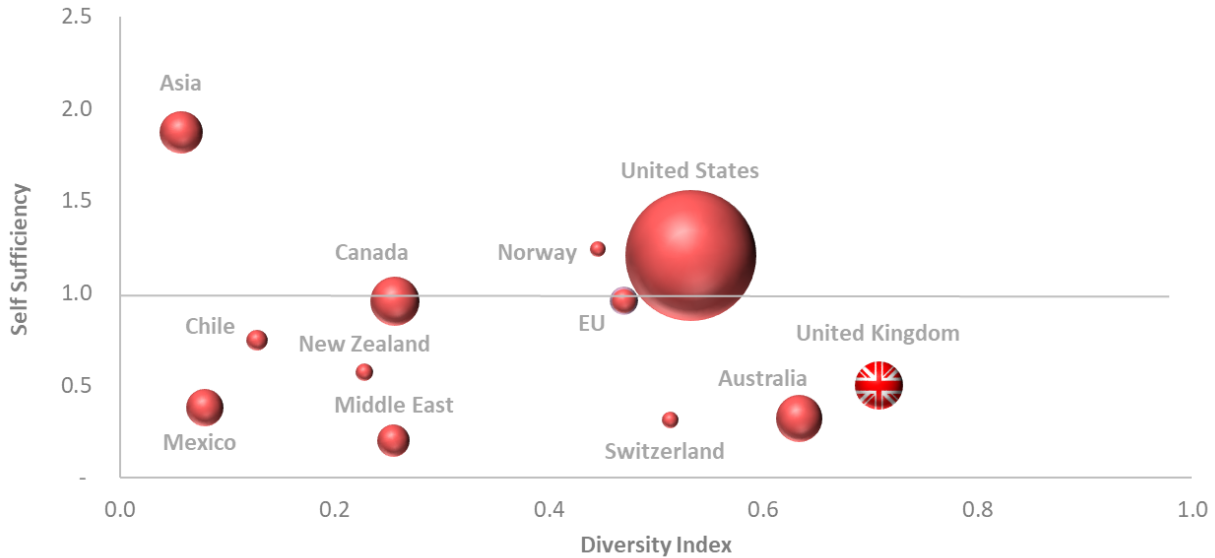
Note: Data on imports to Australia in 2018 was not available; 2017 data was used in its place.

Most countries either met demand through indigenous production or by a combination of production and diverse imports. The profile depicts how the UK's security of supply score was the highest value of all of the OECD countries' scores owing to its high diversity component (Chart 8).

Chart 8: Security of supply of diesel for OECD countries, 2018
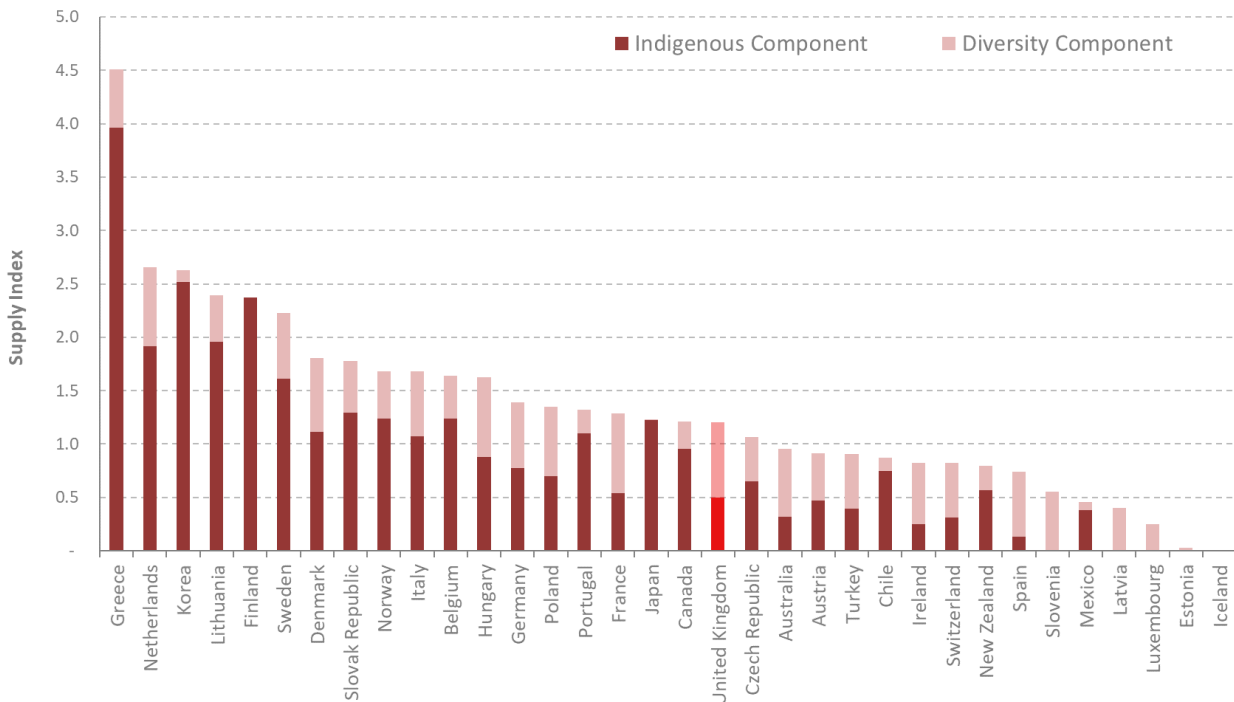
Note: No data was available for Iceland

Map 4 shows that the United States and Russia are the most significant exporters of diesel. There are limited quantities of exports from Asia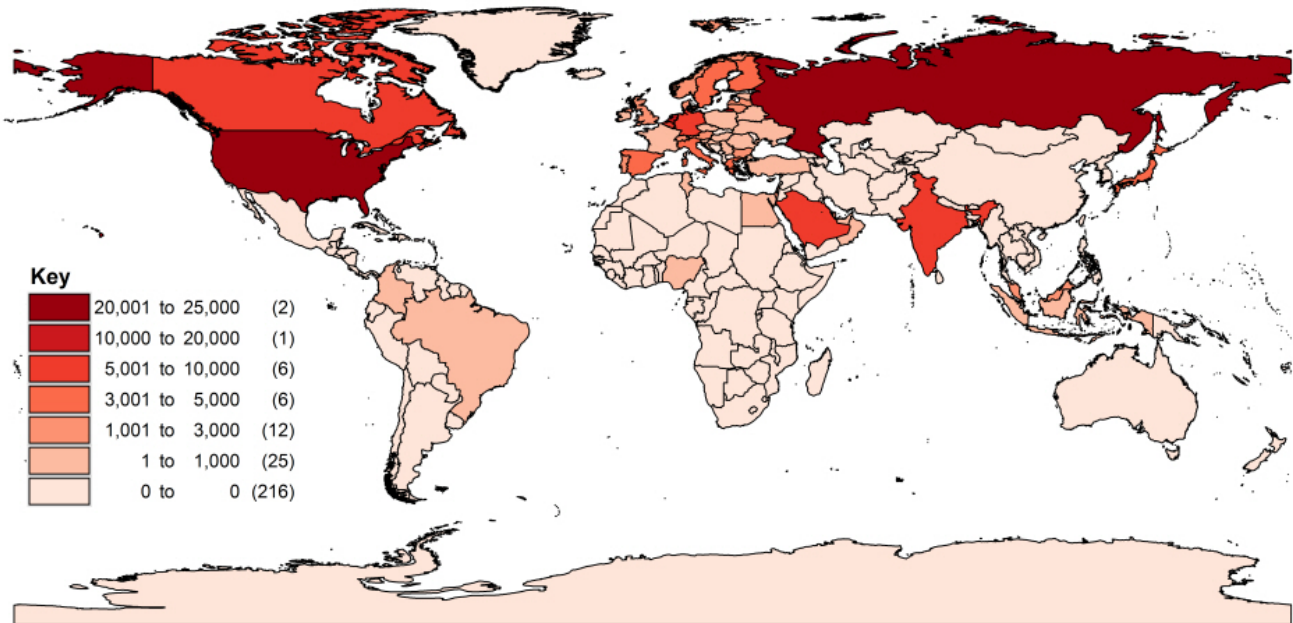 and South America, with Europe and Canada exporting diesel in moderate quantities. The UK was the 4th largest exporter out of all 36 OECD countries in 2018.

Map 4: Worldwide diesel exports (kt), 2018

Summary

Self-Sufficiency and Import Diversity of OECD countries in 2018

The overall picture of diversity of supply for oil and oil products reflects a higher security of supply for oil products than for crude oil, primarily driven by higher levels of refinery production than for crude itself. With an average self-sufficiency score of 0.41, OECD countries are very much dependent on imports of crude oil to meet refinery demand, compared to average scores of 1.55, 0.92 and 0.90 for petrol, jet fuel and diesel respectively. Although average self-sufficiency scores for transport fuels were much higher, these scores are dependent on refining crude oil, and as such indigenous production of these products cannot be decoupled easily from crude oil security of supply.

Total petrol production was an average of one and a half times the average consumption in OECD countries. However, half of these 36 countries were self-sufficient; particularly notable were Lithuania, Norway, Finland and Belgium, each country producing much higher quantities than the amounts they consumed. With an average self-sufficiency score of 1.55 the OECD is well-placed to meet demand for petrol.

Diesel consumption across the OECD is around 10 per cent higher than production, with an average self-sufficiency score of 0.90. Almost 40 per cent of OECD countries were self-sufficient in 2018, with Greece notably producing nearly four times the amount it consumed. These comparatively robust self-sufficiency scores along with a diversity and political stability score of 0.42, makes diesel the oil product with the highest security of supply score, according to our simplified index.

Jet fuel imports had an average diversity score of 0.38 amongst OECD countries. This was the joint lowest diversity score along with petrol, but OECD countries on average met 95 per cent of demand with own production. The UK, along with several north-western European countries, scored much higher than average on the diversity index which offsets the relatively low production,

and suggesting that a number of countries have taken steps to maximise the diversity and political stability of jet fuel imports.

<u>Self-Sufficiency and Import Diversity of the UK in 2018</u>

The UK compares well with other OECD countries for both self-sufficiency and diversity, with strong diversity scores for jet fuel, petrol and diesel. Offsetting the relatively lower diversity score for crude oil, the UK could have met over 90 per cent of crude consumption via indigenous production and ranks strongly amongst OECD countries for self-sufficiency. The UK more than meets its needs for petrol from indigenous production. Conversely, the UK relies on imports to meets its requirements for jet fuel and road diesel because its refineries do not produce sufficient volumes to meet increasing demand.

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Appendix 1 – List of OECD countries in category averages

Asia
Japan
Korea

EU (excluding UK)

Austria	Greece	Netherlands
Belgium	Hungary	Poland
Czech Republic	Iceland	Portugal
Denmark	Ireland	Slovak Republic
Estonia	Italy	Slovenia
Finland	Latvia	Spain
France	Lithuania	Sweden
Germany	Luxembourg	

Middle East
Israel
Turkey

Appendix 2 – Provisional data for 2018

	CRUDE			PETROL			JET FUEL			DIESEL		
	Diversity index	Self-sufficiency	Demand (kt)	Diversity index	Self-sufficiency	Demand (kt)	Diversity index	Self-sufficiency	Demand (kt)	Diversity index	Self-sufficiency	Demand (kt)
Australia	0.84	0.55	22,513	0.71	0.61	13,801	0.55	0.40	7,415	0.63	0.32	24,119
Austria	0.42	0.07	8,950	0.34	**1.16**	1,659	0.34	0.91	833	0.44	0.47	7,170
Belgium	0.61	-	33,025	0.61	**2.53**	1,587	0.46	**1.02**	1,813	0.40	**1.24**	6,730
Canada	0.35	**3.09**	59,266	0.65	0.86	37,564	0.19	0.78	7,089	0.26	0.95	26,570
Chile	0.47	0.02	8,469	0.16	0.88	3,364	0.34	0.54	1,170	0.13	0.74	4,515
Czech Republic	0.35	0.01	7,546	0.43	0.88	1,605	0.52	0.42	430	0.42	0.65	4,861
Denmark	0.44	0.75	7,586	0.42	**1.74**	1,261	0.78	0.11	1,023	0.69	**1.11**	2,634
Estonia	-	-	-	0.39	-	256	0.16	-	46	0.03	-	536
Finland	0.23	-	11,587	0.00	**3.05**	1,455	0.49	**1.06**	749	-	**2.37**	2,539
France	0.72	0.01	53,681	0.67	**1.27**	8,212	0.79	0.55	7,637	0.75	0.54	34,938
Germany	0.72	0.02	87,763	0.52	0.98	21,205	0.31	0.50	10,237	0.61	0.78	37,407
Greece	0.42	0.01	24,328	0.42	**2.33**	2,297	0.35	**2.25**	1,394	0.55	**3.96**	2,399
Hungary	0.11	0.11	7,009	0.47	0.79	1,405	-	**1.09**	274	0.75	0.88	3,276
Iceland	-	-	-	0.00	-	133	0.35	-	418	0.01	-	367
Ireland	0.63	-	3,023	0.43	0.74	810	0.27	-	1,028	0.58	0.25	3,035
Israel	-	-	9,792	-	-	3,005	-	-	1,113	-	-	-
Italy	0.68	0.07	66,660	0.67	**2.06**	7,244	0.50	0.54	4,797	0.61	**1.07**	22,293
Japan	0.70	0.00	148,796	0.15	**1.02**	36,657	0.11	**1.11**	10,994	0.01	**1.23**	23,002
Korea	0.82	0.00	154,336	-	**2.04**	9,334	-	**3.20**	6,747	0.11	**2.52**	16,987
Latvia	-	-	-	0.32	-	197	0.35	-	149	0.40	-	841
Lithuania	-	0.00	9,688	0.21	**11.38**	225	0.06	**7.35**	130	0.44	**1.96**	1,661
Luxembourg	0.30	-	-	0.08	-	350	0.32	-	574	0.25	-	1,753
Mexico	-	**2.78**	34,155	0.25	0.27	31,911	0.01	0.41	3,906	0.08	0.38	15,238
Netherlands	0.63	0.02	52,938	0.66	**1.08**	3,351	0.72	**2.27**	3,846	0.74	**1.91**	6,804
New Zealand	0.47	0.21	5,145	0.24	0.54	2,447	0.48	0.79	1,543	0.23	0.57	3,073
Norway	0.61	**5.44**	13,513	0.58	**5.42**	815	0.48	0.83	949	0.45	**1.24**	2,607
Poland	0.34	0.04	26,897	0.46	0.92	4,578	0.47	**1.30**	1,006	0.65	0.70	16,846
Portugal	0.77	-	12,483	0.39	**2.49**	1,022	0.47	0.93	1,519	0.22	**1.10**	4,471
Slovak Republic	-	0.00	5,428	0.41	**2.34**	581	-	**2.07**	45	0.48	**1.29**	2,031
Slovenia	-	-	-	0.48	-	430	0.19	-	34	0.56	-	1,468
Spain	0.76	0.00	67,894	0.24	**1.73**	5,329	0.65	0.06	6,687	0.61	0.13	23,559
Sweden	0.54	-	20,193	0.47	**2.18**	2,296	0.61	0.19	1,079	0.61	**1.61**	4,728
Switzerland	0.24	-	3,015	0.33	0.27	2,349	0.24	0.00	1,857	0.51	0.31	2,845
Turkey	0.44	0.12	23,800	-	**2.07**	2,266	0.55	0.97	4,927	0.51	0.39	22,506
United Kingdom	0.65	0.92	51,511	0.69	**1.36**	12,225	0.78	0.43	11,873	0.71	0.50	25,271
United States	0.67	0.65	836,944	0.89	0.91	399,110	0.64	**1.05**	78,978	0.53	**1.20**	190,416
OECD - Asia average	0.76	0.00	151,566	0.07	**1.53**	22,995	0.05	**2.15**	8,871	0.06	**1.87**	19,994
OECD - EU average	0.38	0.05	22,029	0.39	**1.72**	2,934	0.40	0.98	1,989	0.47	0.96	8,363
OECD - Middle East average	0.35	0.30	26,255	-	**1.03**	2,636	0.27	0.48	3,020	0.26	0.20	11,253
OECD average	**0.41**	**0.41**	**52,165**	**0.38**	**1.55**	**17,287**	**0.38**	**0.92**	**5,120**	**0.42**	**0.90**	**15,264**

Source: IEA (http://data.iea.org/)
Items in **bold** highlight those countries where indigenous capacity exceeded domestic consumption

Appendix 3 – Methodology

Data for crude oil and transport fuel self-sufficiency

Data for crude oil, petrol and jet fuel were extracted from the IEA database. For diesel, data were provided on request from the IEA. Self-sufficiency was determined from data on indigenous production and consumption (production (kt) ÷ consumption (kt)).

Crude oil and transport fuel diversity indices

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. The Shannon-Wiener index is of the form:

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

Where *x* is the proportion of total fuel supply represented by the ith 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 2 represents a country with a wide range of import sources. The minimum value of zero denotes a country that has one imported fuel source or relies entirely on indigenous production.

A previous comparative study on import diversities in Energy Trends March 2011 used the Herfindahl Index as the basic diversity index. Although both of these indices have their advantages, the Shannon-Wiener was chosen here as this represents the data with less skew, as well as placing more weight on the diversity of contributions from smaller countries and lessening 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)

Once Shannon-Wiener and political stability indices were determined, these 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 for each petroleum product 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 product, 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.