Diversity of supply for oil and oil products in OECD countries in 2017

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, only three countries were net exporters of crude oil in 2017: Norway (producing over 6 times its indigenous demand), Canada, and Mexico. All other OECD countries had to meet their demand through imports with 11 countries not producing any crude oil indigenously.

Half of OECD countries met their motor gasoline (petrol) demand through indigenous production, with much of Western Europe being net exporters. Despite motor gasoline having the second lowest average diversity index, it achieved the highest average security of supply score of the four products due to high levels of indigenous production in the OECD.

For jet fuel, the position is markedly different with only a third of OECD countries self-sufficient. France and the United Kingdom were the top two scorers for diversity of imports within the OECD.

More than a third of OECD countries were self-sufficient in diesel production, with Greece, Finland, and Korea scoring highest. Greece produced nearly four times the amount it consumed.

The UK could have met more than 80 per cent of its demand for crude oil through indigenous production and ranked in the top 10 for security of supply with regards to crude oil. The UK was able to meet its demand for motor gasoline through indigenous production and was second only to the United States for diversity of imports. For jet fuel, the UK was in the lower third of the OECD in terms of indigenous production scores, but scored the second highest on diversity of imports after France. In terms of diesel, the UK produced only just over half its demand, below the median for the OECD, but scored sixth highest of all OECD countries for diversity of supply.

Charting oil self-sufficiency and diversity of supply

Bubble Charts
The bubble charts demonstrate the relationship between a country's demand, its indigenous production, diversity of its gross imports and the political stability of the countries of import. 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 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 2 for a methodological note).

- Consumption: is represented by the circle or bubble, the area of which indicates the level of consumption for 2017 for each OECD country.

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[1] http://data.iea.org/

Bar Charts

The bars 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 (shown in the coloured part of the chart) with the diversity and political stability of import origins (shown in white). 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 1 shows the underlying data.

Choropleth Map

These maps indicate a visual representation of the source countries and quantities of each product's exports. A darker shade represents that a high proportion of the world's exports originated from that particular country, whereas lighter shades indicate that fewer exports originated in that country. Appendix 1 shows the underlying data.

Results

Crude

Only three OECD countries were self-sufficient for crude oil in 2017 (Chart 1). Norway had by far the highest self-sufficiency score, producing more than six times its own consumption of crude oil. With a self-sufficiency score of 0.81, the UK was above the OECD average of 0.43. Similarly, the UK's diversity score of 0.61 was above the average score of 0.40.

Chart 1: Diversity and self-sufficiency of crude oil for OECD countries, 2017
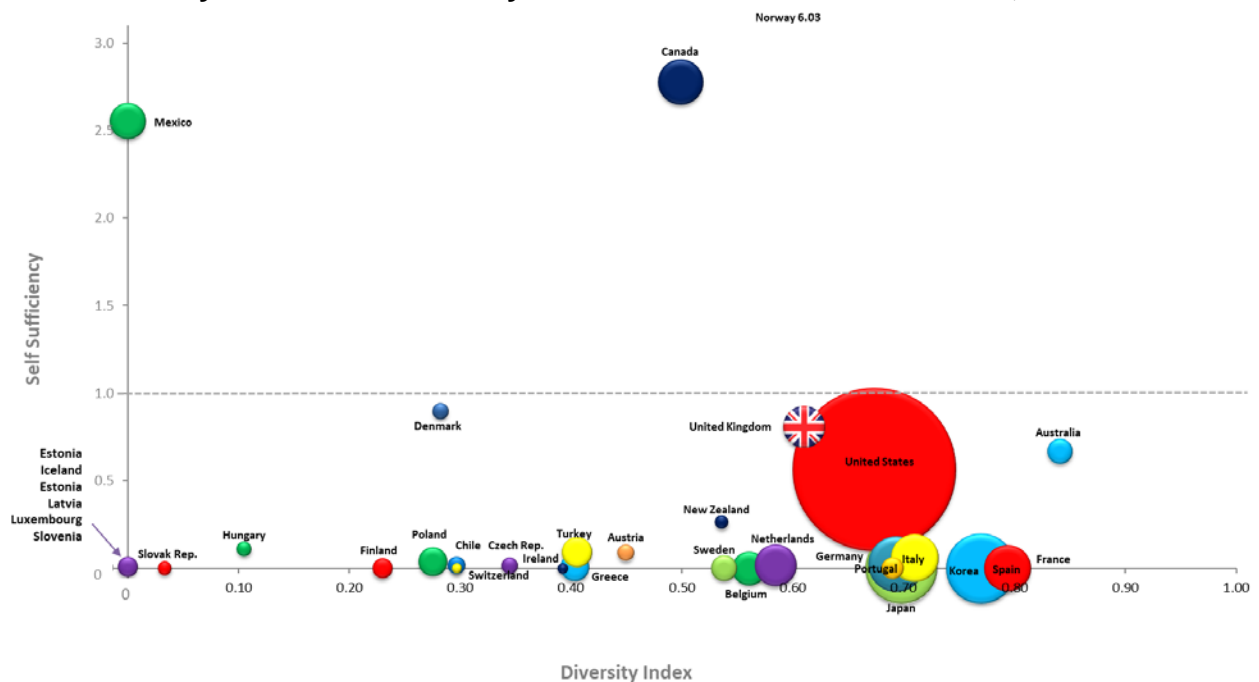

The majority of OECD countries showed diversity and political stability scores that reflect a strong trading element, with a relatively small contribution from indigenous production (Chart 2). Chart 2 shows that the UK placed highly in the ranking of OECD countries being one of only a few countries with significant oil production.

Chart 2: Security of supply of crude oil for OECD countries, 2017
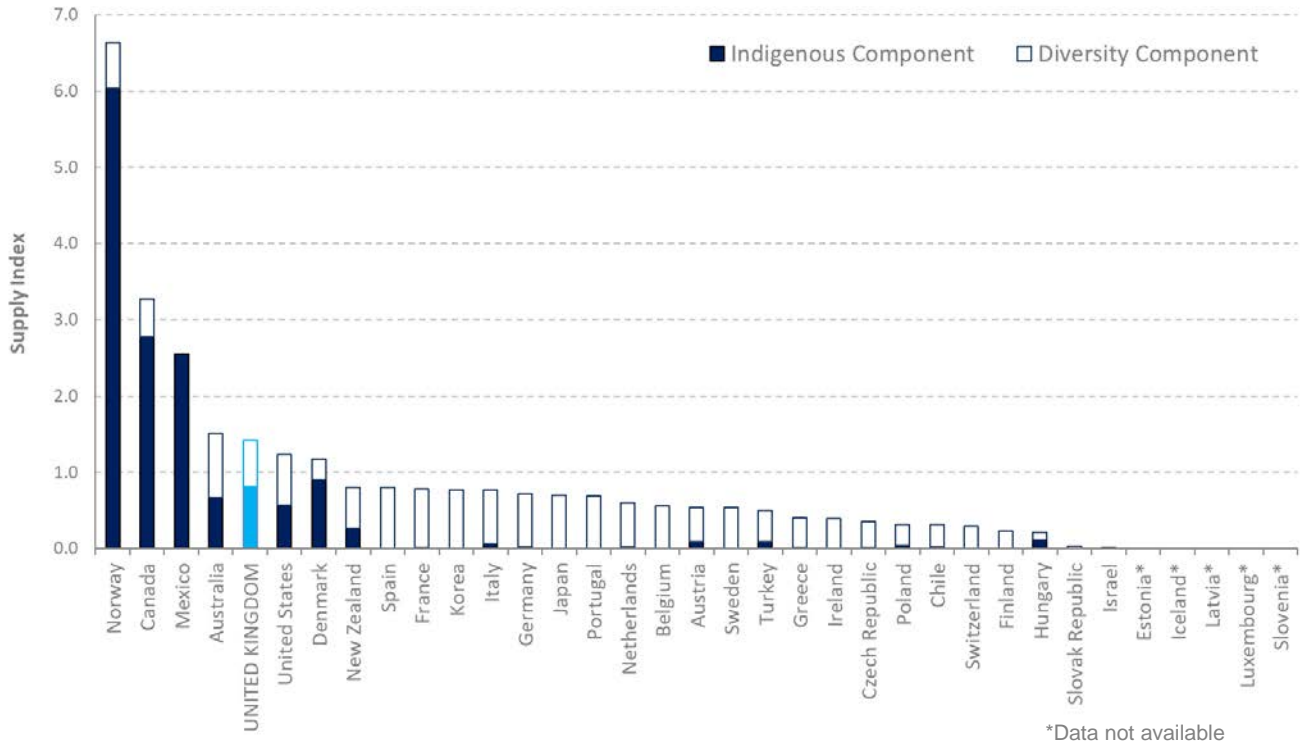
Map 1 is an illustration of where crude oil exports originated in 2017. Currently Saudi Arabia, Canada and Russia are by far the biggest exporters of crude in the world. The UK was the 5th biggest OECD exporter and placed 15th overall. Although the United States produce almost three times as much as any other OECD country they have historically exported relatively little, even after the 40 year ban on almost all crude exports nationwide was lifted in December 2015. However this looks to be changing because 2018 saw the highest quantity of crude exported from the US on EIA records[2].

**Map 1: Worldwide Crude Oil Exports (kt), 2017**
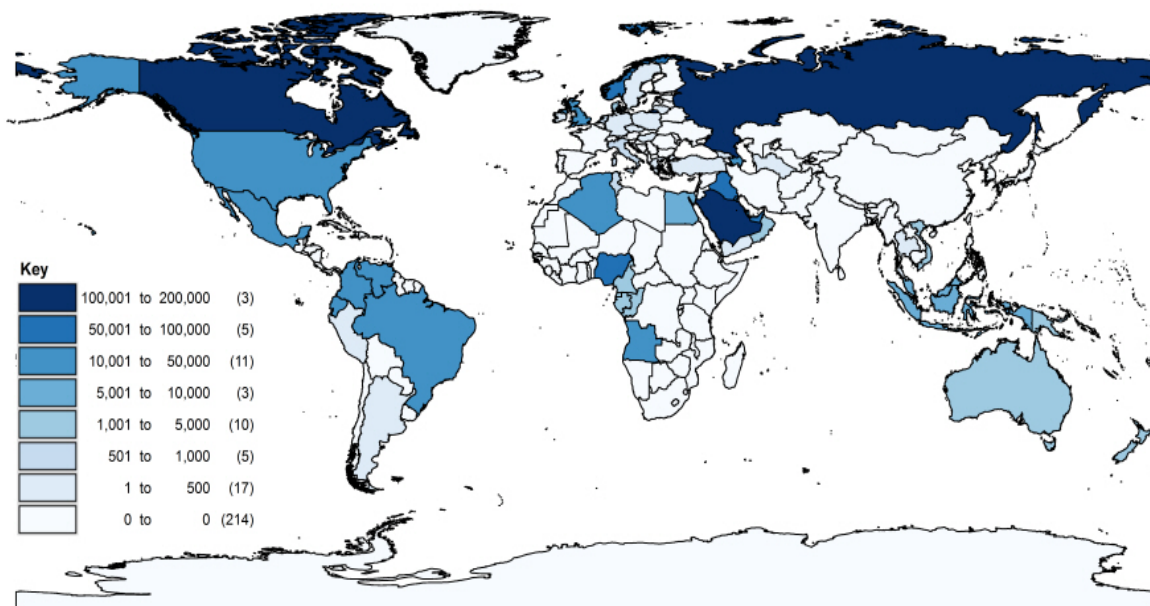
[2] www.eia.gov/dnav/pet/pet_move_expc_a_EPC0_EEX_mbbl_a.htm

Motor Gasoline

The profiles for motor gasoline are different to that of crude. Half of the 35 OECD countries were self-sufficient in 2017 (Chart 3). Consumption in the US dwarfs that of other OECD countries, equal to nearly two-thirds of the OECD total. The UK had a self-sufficiency score of 1.41, which was above the 1.29 average across all OECD countries. The UK's diversity score of 0.78 was also more than double the OECD average of 0.37.

Chart 3: Diversity and self-sufficiency of motor gasoline for OECD countries, 2017
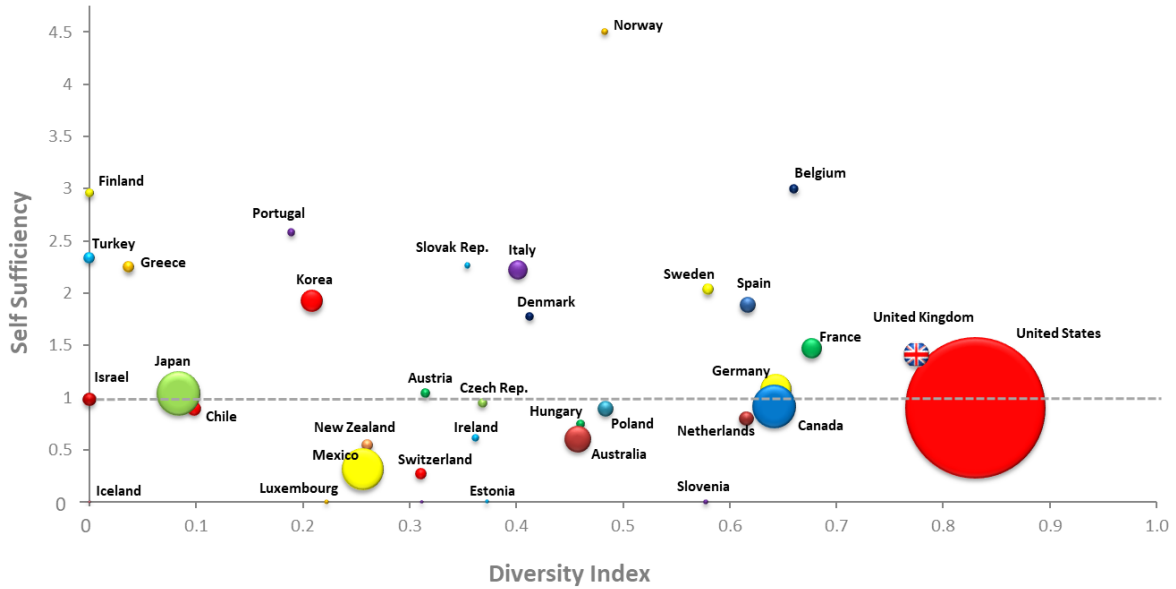
Our simplified security of supply index (Chart 4) shows how the majority of countries produce enough motor gasoline to meet their needs and how much trade there is in motor gasoline amongst the OECD countries. The UK ranks 12th out of the 35 OECD countries for security of supply of motor gasoline.

Chart 4: Security of supply of motor gasoline for OECD countries, 2017
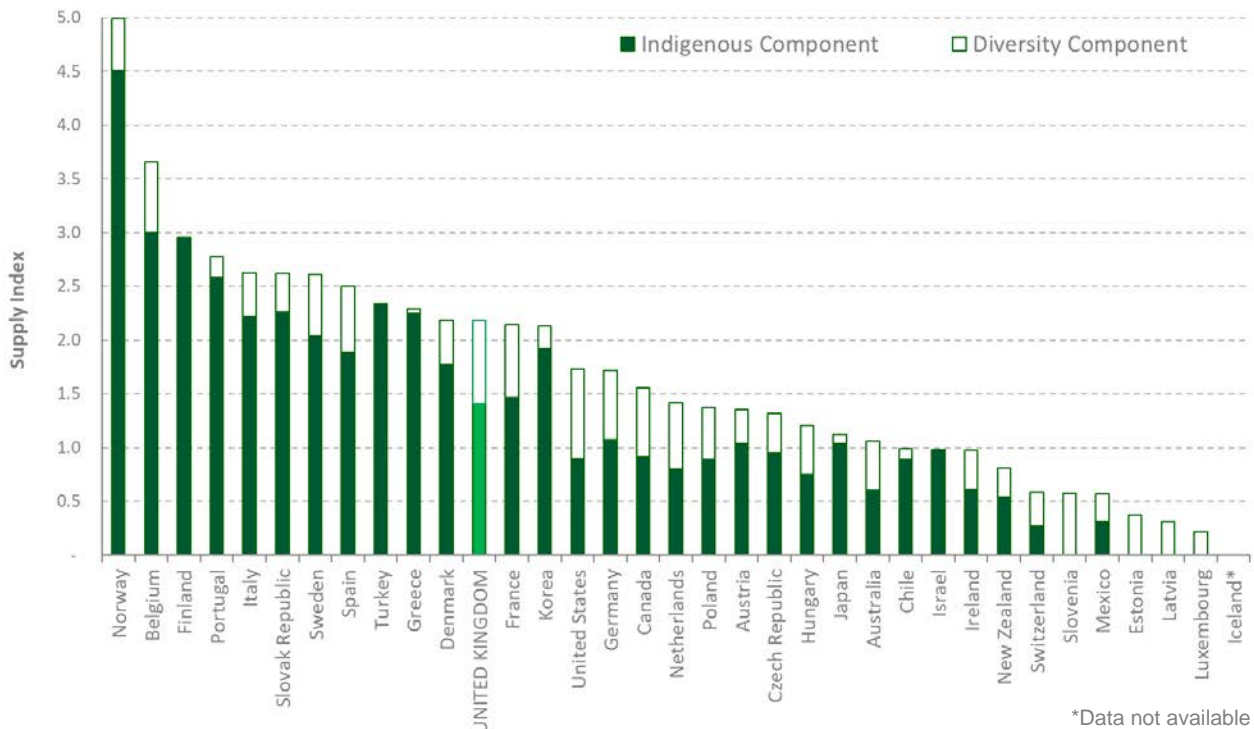
*Data not available

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The main exporter of motor gasoline around the world is North America, with the United States the largest exporter in the world and 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 motor gasoline to the rest of the world with the United Kingdom, the Netherlands and Belgium of particular note. However many large economies such as Australia, Japan and China export very low quantities of motor gasoline.

Map 2: Worldwide Motor Gasoline Exports (kt), 2017
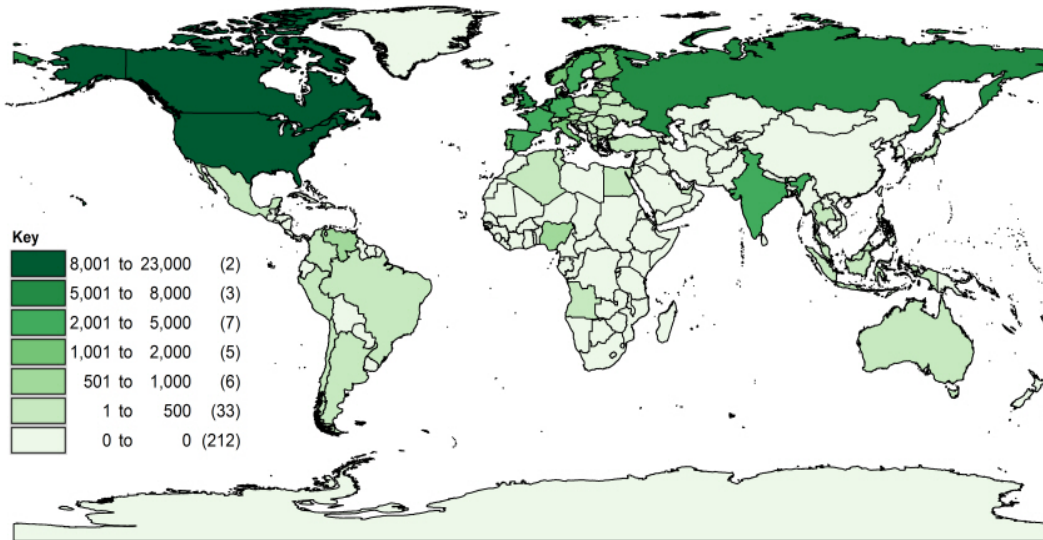
Jet Fuel

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 0.76 for jet fuel. However the UK's import diversity score of 0.76 was more than double the average for all OECD countries (of 0.35) and was the second highest of all OECD countries.

Chart 5: Diversity and self-sufficiency of jet fuel for OECD countries, 2017
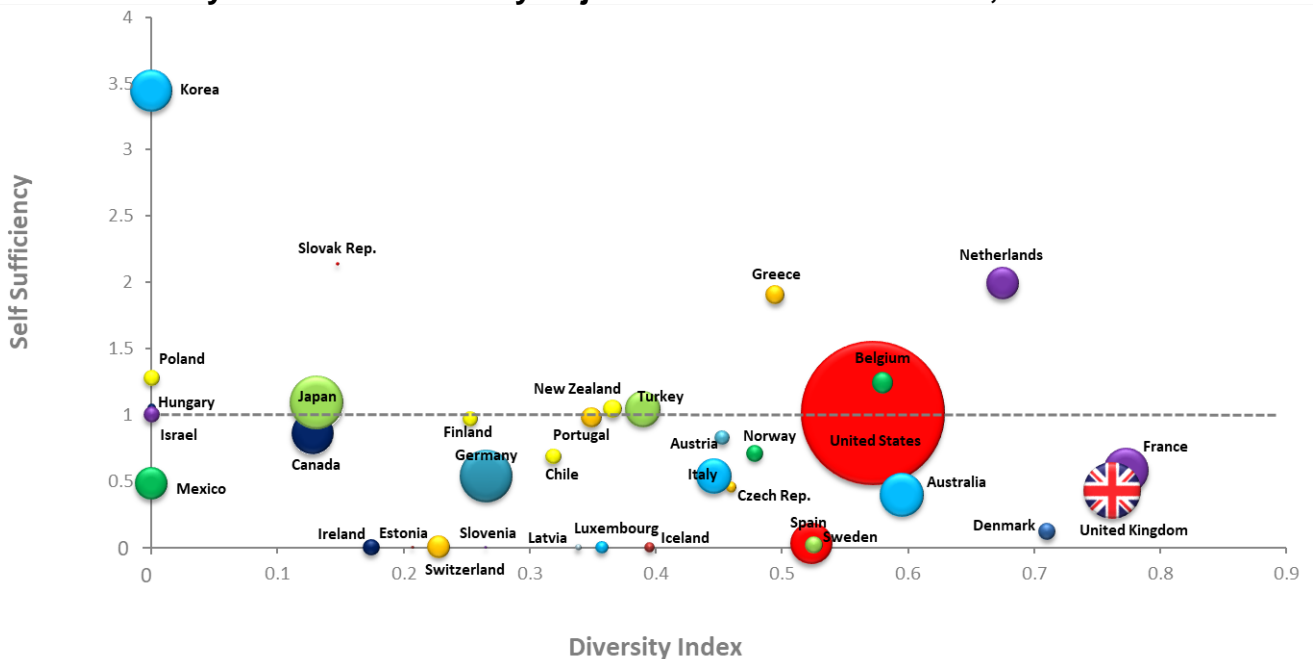
Many OECD countries have significant production capacity of jet fuel. For instance Korea produces more than three times its demand and doesn't require any imports. The UK's capacity to meet its demand through indigenous production is low; in 2017 the UK met less than half of its demand, one of the largest deficits in the OECD. However Heathrow (being the busiest airport in Europe), contributed to the UK having the second highest demand for jet fuel, behind only the United States. Despite only having the ability to meet 43 per cent of demand, the UK was 7th out of the 35 countries for total production of jet fuel and in addition the low self-sufficiency score was compensated by having the second most diverse and stable import sources within the OECD - as seen in Chart 6.

Chart 6: Security of supply of jet fuel for OECD countries, 2017
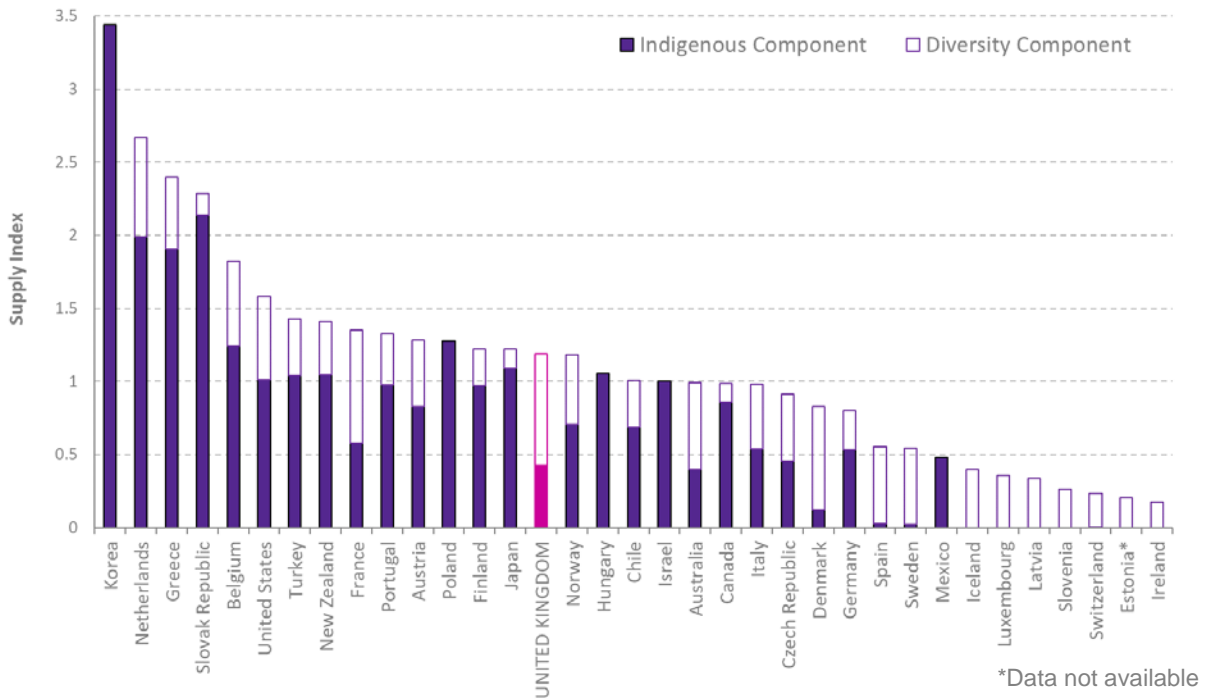
Jet fuel is only exported in significant quantities from a few countries around the world with Korea, the Netherlands, the United Arab Emirates, the United States and Saudi Arabia exporting the most. The Netherlands is a trading hub for many oil products, with large amounts of imports 're-exported' and 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), 2017
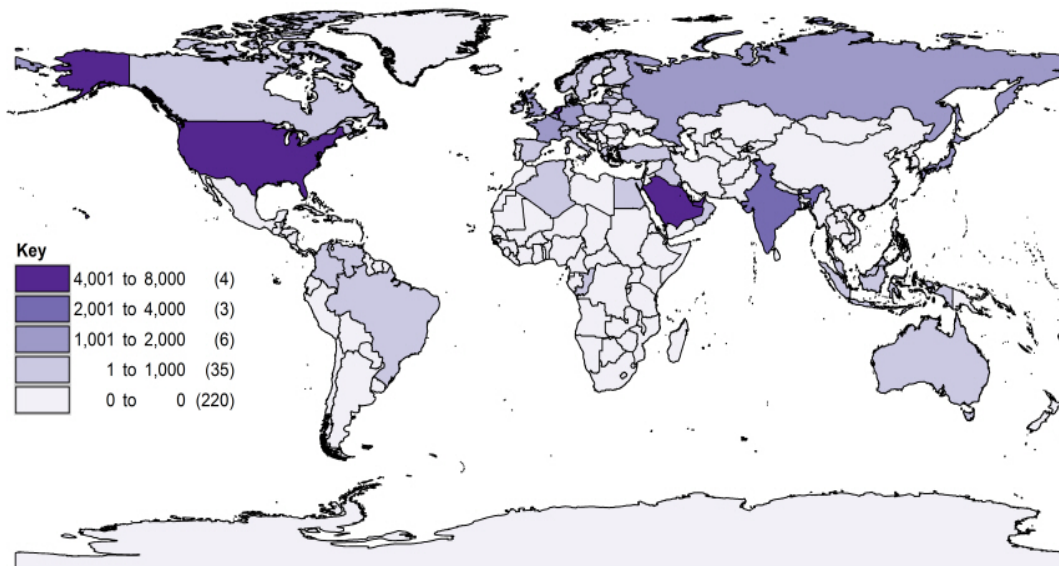
Diesel Road Fuel

At 0.53 on the self-sufficiency axis the UK was below the average OECD self-sufficiency score of 0.87 in 2017, producing just over 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 0.67 was higher than the OECD average of 0.41 (Chart 7) and was the sixth highest out of all 35 OECD countries.

Chart 7: Diversity and self-sufficiency of diesel for OECD countries, 2017
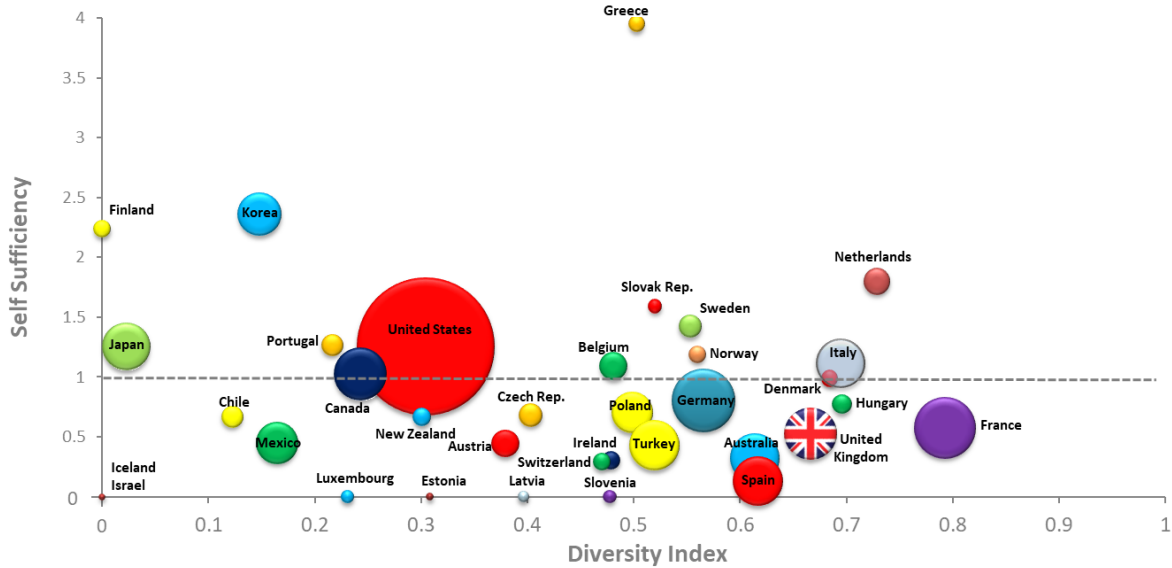
The majority of countries either met demand through indigenous production or by a combination of production and diverse imports. The profile depicts how the UK's security of supply score was around the middle value of all of the OECD countries' scores (Chart 8).

Chart 8: Security of supply of diesel for OECD countries, 2017
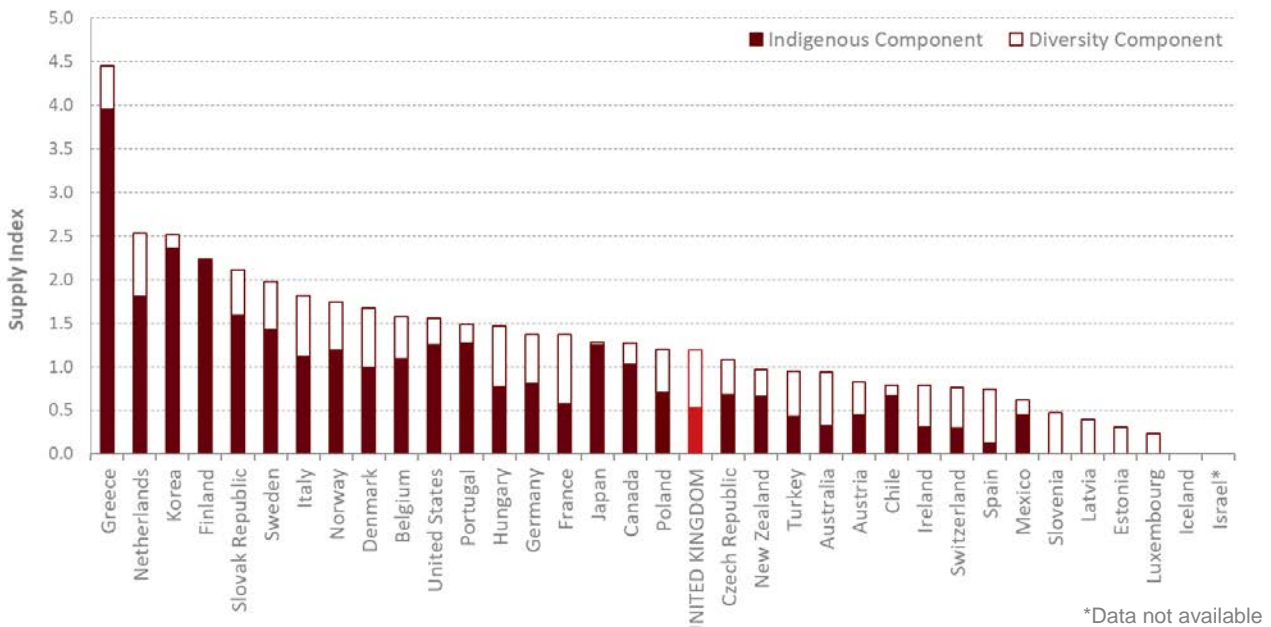
Map 4 shows that the United States and Russia are the most significant exporters of diesel. There are limited quantities of exports from Asia and South America, with Europe and Canada exporting diesel in moderate quantities. The UK was the 13th largest exporter out of all 35 OECD countries.

Map 4: Worldwide Diesel Exports (kt), 2017

Summary

Self-Sufficiency and Import Diversity of OECD Countries in 2017

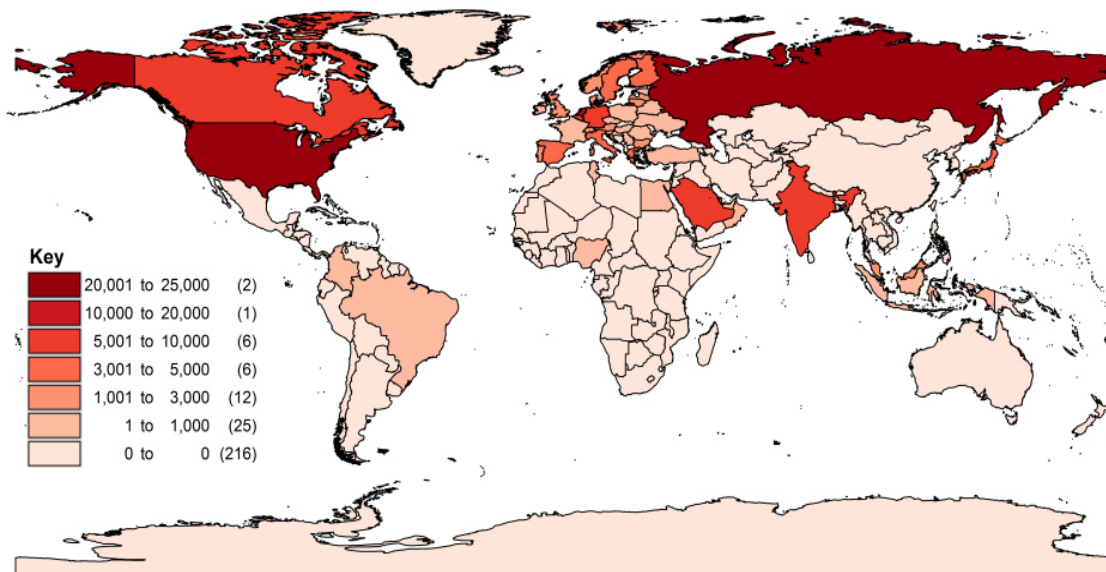The overall picture of diversity of supply for oil and oil products reflects a higher security of supply for oil products than for crude oil, primarily driven by higher levels of indigenous production for oil products than for crude itself. With an average self-sufficiency score of 0.43, OECD countries are very much dependent on imports of crude oil to meet refinery demand, compared to average scores of 1.29, 0.76 and 0.87 for motor gasoline, jet fuel and diesel respectively. This is reflected in the fact that crude oil has the second highest average diversity score out of all products for imports into OECD countries. This is possibly also due to the wide variety of crude products that are available on the market, creating a need to import from a diverse range of sources. 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 motor gasoline production was 4 per cent lower than consumption in OECD countries. However, 17 of these 35 countries were self-sufficient; particularly notable were Norway, Belgium and Finland, producing much higher quantities than the amounts they consumed. With an average self-sufficiency score of 1.29 and an import diversity score of 0.37, motor gasoline production in the OECD as a whole did not meet demand due to a small quantity of countries with little to no production. Despite this, motor gasoline was still the highest scoring oil product in our simplified security of supply index due to the contribution of indigenous production.

Diesel consumption across the OECD is around 3 per cent higher than production, with an average self-sufficiency score of 0.87. Just over a third of OECD countries were self-sufficient in 2017, with Greece producing nearly four times the amount it consumed. These comparatively robust self-sufficiency scores along with a diversity and political stability score of 0.41, makes diesel the oil product with the second highest security of supply score, according to our simplified index.

Jet fuel imports had an average diversity score of 0.35 amongst OECD countries. This being the lowest diversity score out of the four products, combined with a comparatively low self-sufficiency

score of 0.76, put jet fuel as the second lowest scoring oil product in our simplified security of supply index, only ahead of crude oil. However the UK, along with a number of north-western European countries, scored much higher than average on the diversity index suggesting that a number of countries have taken steps to maximise the diversity and political stability of jet fuel imports.

Self-Sufficiency and Import Diversity of the UK in 2017

The UK compares well with other OECD countries for both self-sufficiency and diversity, scoring slightly better for diversity by ranking second for jet fuel and motor gasoline, sixth for diesel, and in the top third for crude oil. The UK could meet around 80 per cent of its crude oil consumption via indigenous production and ranks fifth out of all OECD countries for self-sufficiency. The UK more than meets its needs for motor gasoline from indigenous production, being dependant on its offshore fields and the production profiles of its refineries to meet motor gasoline demand. 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 – Provisional Data for 2017

	Crude Oil			Motor Spirit			Jet Fuel			Diesel Road Fuel		
	Diversity plus Political Stability	Self sufficiency	Demand (KT)	Diversity plus Political Stability	Self sufficiency	Demand (KT)	Diversity plus Political Stability	Self sufficiency	Demand (KT)	Diversity plus Political Stability	Self sufficiency	Demand (KT)
Australia	0.84	0.67	19,289	0.46	0.60	13,475	0.60	0.40	7,036	0.61	0.32	22,779
Austria	0.45	0.09	8,102	0.32	**1.04**	1,606	0.45	0.83	738	0.38	0.44	6,940
Belgium	0.56	0.00	34,090	0.66	3.00	1,537	0.58	**1.24**	1,564	0.48	**1.09**	6,983
Canada	0.50	**2.78**	61,406	0.64	0.91	36,114	0.13	0.86	6,448	0.24	**1.02**	25,768
Chile	0.30	0.02	8,901	0.10	0.89	3,442	0.32	0.69	857	0.12	0.67	4,171
Czech Republic	0.34	0.01	7,877	0.37	0.95	1,600	0.46	0.45	396	0.40	0.68	4,822
Denmark	0.28	0.90	7,509	0.41	**1.78**	1,264	0.71	0.12	1,021	0.68	0.99	2,508
Estonia	0.00	0.00	0	0.37	0.00	264	0.21	0.00	28	0.31	-	482
Finland	0.23	0.00	12,035	0.00	**2.96**	1,491	0.25	0.97	773	-	**2.24**	2,625
France	0.77	0.01	57,142	0.68	**1.47**	7,852	0.77	0.58	7,348	0.79	0.58	35,294
Germany	0.69	0.02	93,154	0.64	**1.07**	18,447	0.27	0.54	9,968	0.57	0.80	37,322
Greece	0.40	0.01	24,032	0.04	**2.25**	2,350	0.49	**1.91**	1,275	0.50	**3.95**	2,324
Hungary	0.11	0.11	6,532	0.46	0.75	1,365	0.00	**1.05**	224	0.70	0.77	3,361
Iceland	0.00	0.00	0	0.00	0.00	143	0.40	0.00	335	-	-	362
Ireland	0.39	0.00	3,183	0.36	0.61	896	0.17	0.00	969	0.48	0.30	2,956
Israel	0.00	0.01	11,700	0.00	0.98	3,234	0.00	**1.00**	856	-	-	-
Italy	0.71	0.06	69,318	0.40	**2.22**	6,773	0.45	0.54	4,539	0.69	**1.12**	22,593
Japan	0.70	0.00	154,991	0.08	**1.04**	37,755	0.13	**1.09**	10,556	0.02	**1.25**	21,003
Korea	0.77	0.00	150,605	0.21	**1.92**	9,360	0.00	**3.44**	6,360	0.15	**2.36**	17,691
Latvia	0.00	0.00	0	0.31	0.00	192	0.34	0.00	133	0.40	-	1,132
Luxembourg	0.00	0.00	0	0.22	0.00	314	0.36	0.00	560	0.23	-	1,624
Mexico	0.00	**2.55**	39,491	0.26	0.31	34,311	0.00	0.48	3,905	0.16	0.45	16,181
Netherlands	0.58	0.02	53,371	0.62	0.80	4,034	0.68	**1.99**	3,885	0.73	**1.80**	6,588
New Zealand	0.54	0.26	5,367	0.26	0.55	2,401	0.37	**1.04**	1,169	0.30	0.66	2,927
Norway	0.60	**6.03**	13,039	0.48	**4.50**	836	0.48	0.71	958	0.56	**1.19**	2,581
Poland	0.28	0.04	25,138	0.48	0.89	4,382	0.00	**1.28**	853	0.50	0.70	15,820
Portugal	0.69	0.00	14,246	0.19	**2.58**	1,054	0.35	0.98	1,415	0.22	**1.27**	4,327
Slovak Republic	0.03	0.00	5,558	0.35	**2.27**	626	0.15	**2.14**	36	0.52	**1.59**	1,715
Slovenia	-	0.00	0	0.58	0.00	413	0.27	0.00	24	0.48	-	1,458
Spain	0.79	0.00	65,978	0.62	**1.88**	4,831	0.52	0.03	6,413	0.62	0.13	23,054
Sweden	0.54	0.00	19,495	0.58	**2.04**	2,296	0.53	0.02	1,044	0.55	**1.42**	4,843
Switzerland	0.30	0.00	2,851	0.31	0.27	2,375	0.23	0.00	1,754	0.47	0.29	2,803
Turkey	0.41	0.09	27,271	0.00	**2.34**	2,292	0.39	**1.04**	4,648	0.52	0.43	23,507
UK	0.61	0.81	53,261	0.78	**1.41**	12,353	0.76	0.43	11,782	0.67	0.53	25,537
US	0.67	0.56	818,460	0.83	0.90	394,718	0.57	**1.01**	77,435	0.30	**1.25**	178,948
OECD Average	0.40	0.43	53,525	0.37	**1.29**	17,611	0.35	0.76	5,066	0.41	0.87	14,777

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

Items in **bold** highlight those countries where indigenous capacity exceeded domestic consumption.

Appendix 2 – Methodology
Data for crude oil and transport fuel self-sufficiency
Data for crude oil, motor gasoline 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.