Diversity of supply for oil and oil products in OECD countries in 2014

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 four countries were net exporters of crude oil in 2014: Norway (producing over 5 times its indigenous demand), Mexico, Canada and Denmark. All other OECD countries had to meet their demand through imports with some 10 countries producing no crude oil indigenously.

The majority 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. Denmark and the United Kingdom were the top two scorers for diversity of imports within the OECD, with Mexico, Finland and Canada all scoring the lowest for diversity of imports.

Most OECD countries were not able to support their diesel consumption by indigenous production alone. Greece and the Netherlands scored highest for indigenous production within the OECD with Spain and Turkey being able to cover the least of their demand by indigenous production.

The UK was able to meet over half of its demand for crude oil through indigenous production; the UK also ranked sixth overall for security of supply with regards to crude oil. The UK was able to meet its demand for motor gasoline through indigenous production but still ranked fourth for diversity of import sources. For jet and diesel, the UK scored below average for indigenous production for both of these oil products, but scored in the top half overall for respective diversity of imports compared to the OECD average.

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 relative level of consumption for 2014 for each OECD country.

[1] **http://data.iea.org/IEASTORE/DEFAULT.ASP**

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 is 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. This is a simplified metric, and 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

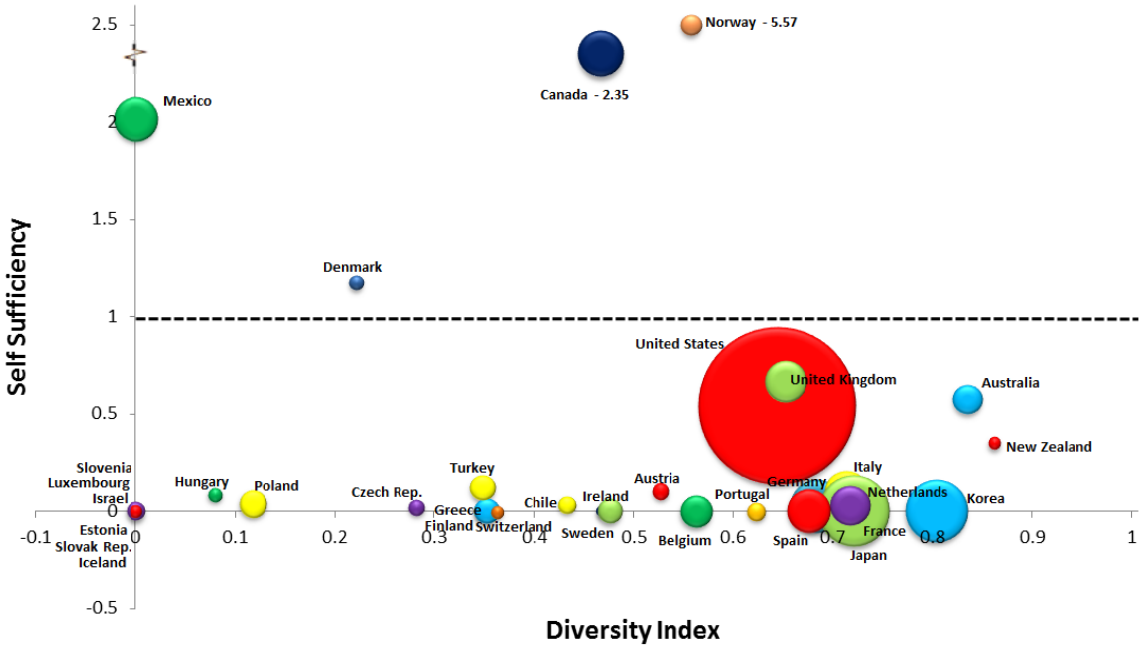
These maps indicate a visual representation of where and how much of each fuel has been initially imported from. The darker shades of colour show a high proportion of World imports originating from a particular country and as shades get lighter, the proportion shrinks indicating that very few, or none of the Worlds imports originated from that country. Appendix 1 shows the underlying data.

Results

Crude

Only four OECD countries were self-sufficient for crude oil in 2014 (Chart 1). Norway had by far the highest self-sufficiency score, producing over 5 times its own consumption of crude oil. With a self-sufficiency score of 0.67, the UK was above the OECD average of 0.41. Similarly, the UK's diversity score of 0.65 was above the average score of 0.42.

Chart 1: Diversity and self-sufficiency of crude oil for OECD countries, 2014



The majority of OECD countries showed 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, 2014

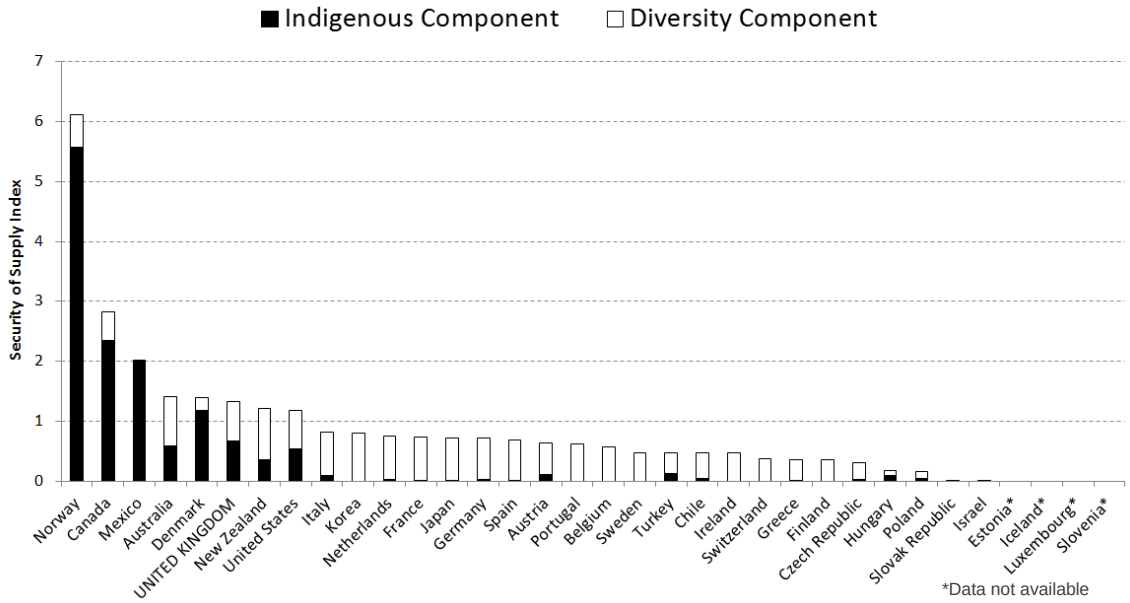
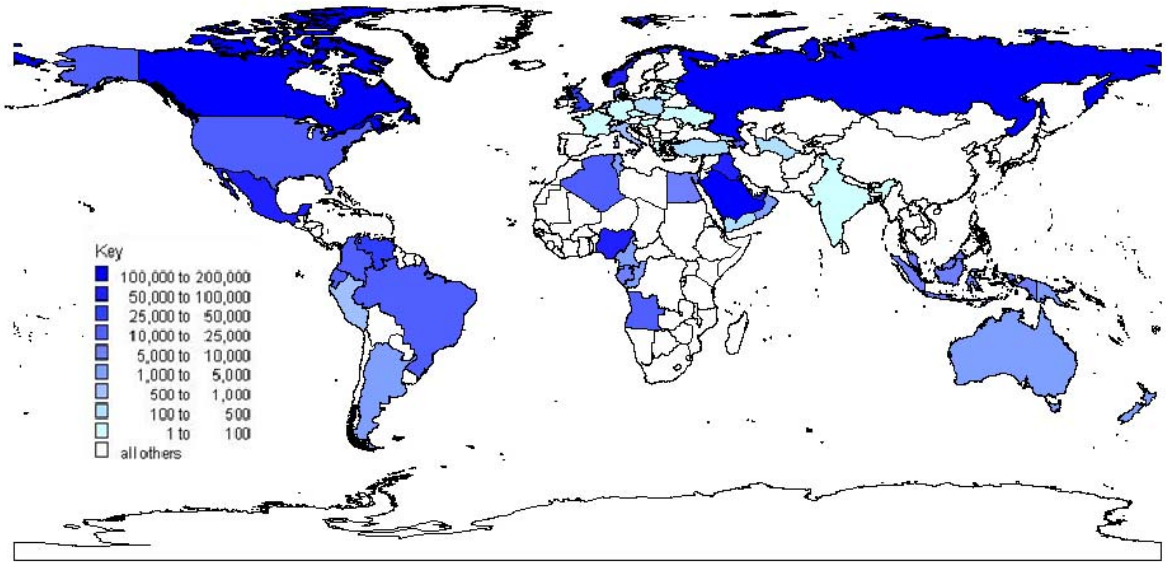


Chart 3 is an illustration of where crude oil originated in 2014. Currently, Saudi Arabia, Russia and Canada are by far the biggest exporters of crude in the world. However, though the United States produced over twice as much as any other OECD country, they exported relatively little. Norway exported the most crude of all European nations though the UK was not far behind on the edge of the top ten exporters in the world.

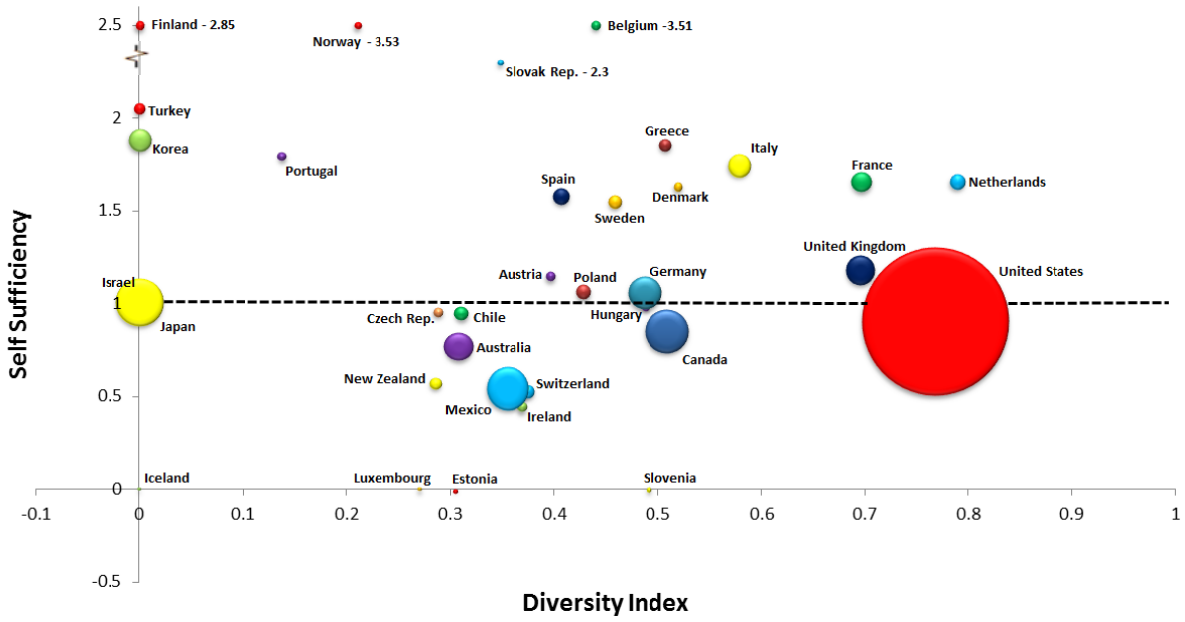
Chart 3: Worldwide Crude Oil Exports (kt), 2014



Motor Gasoline

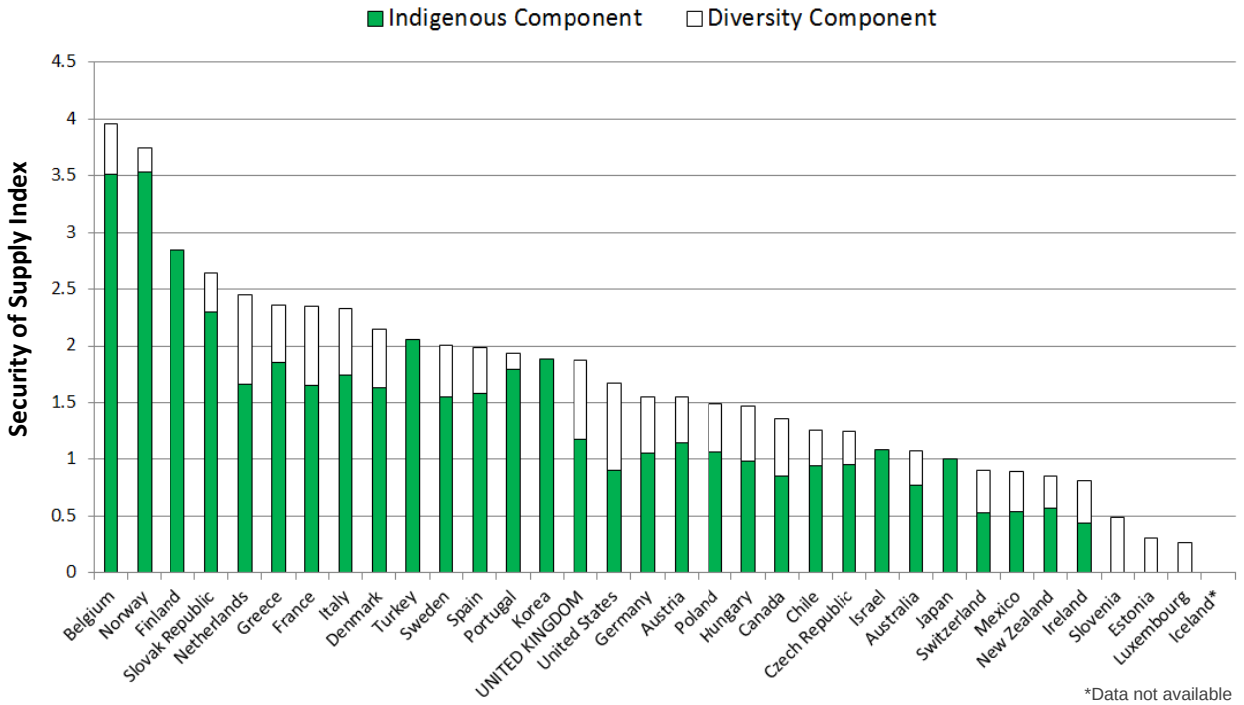
The profiles for motor gasoline are considerably different to that of crude. Over 50 per cent of the 34 OECD countries were self-sufficient in 2014 (Chart 4). Consumption in the US dwarfs that of other OECD countries; equal to 63% of the world total. The UK had a self-sufficiency score of 1.18, which was slightly below than the average across all OECD countries of 1.28. The UK's diversity score of 0.70 was higher than the average of 0.36 however.

Chart 4: Diversity and self-sufficiency of motor gasoline for OECD countries, 2014



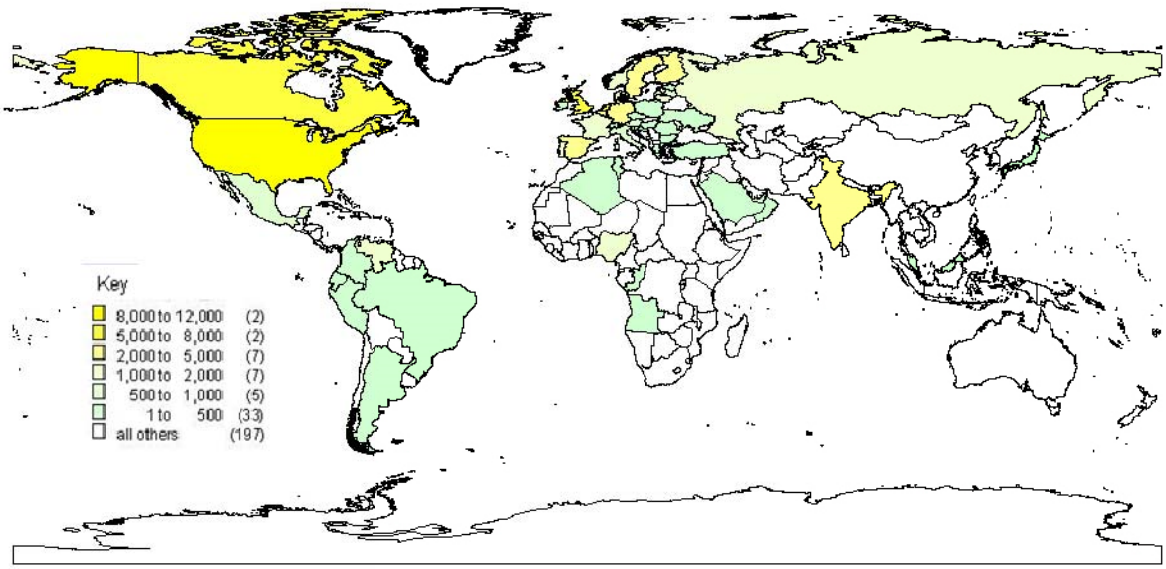
Our simplified security of supply index (Chart 5) shows how the vast majority of countries produce enough petrol to meet their needs and how much trade there is in motor gasoline amongst the OECD countries. The UK ranks in the top half out of all OECD countries.

Chart 5: Security of supply of motor gasoline for OECD countries, 2014



The main area of exports for motor gasoline around the world is North America, with the United States the largest exporter in the world. 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, Netherlands and Belgium of particular note. However, many large economies such as Australia, Japan and China hardly export any motor gasoline at all.

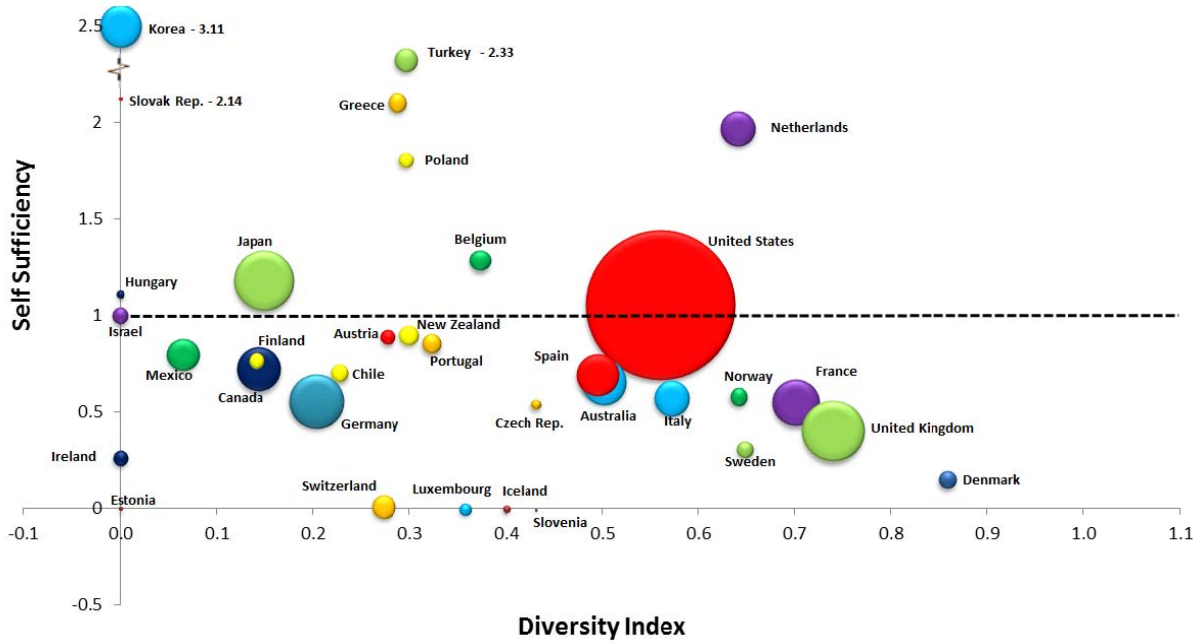
Chart 6: Worldwide Motor Gasoline Exports (kt), 2014



Jet Fuel

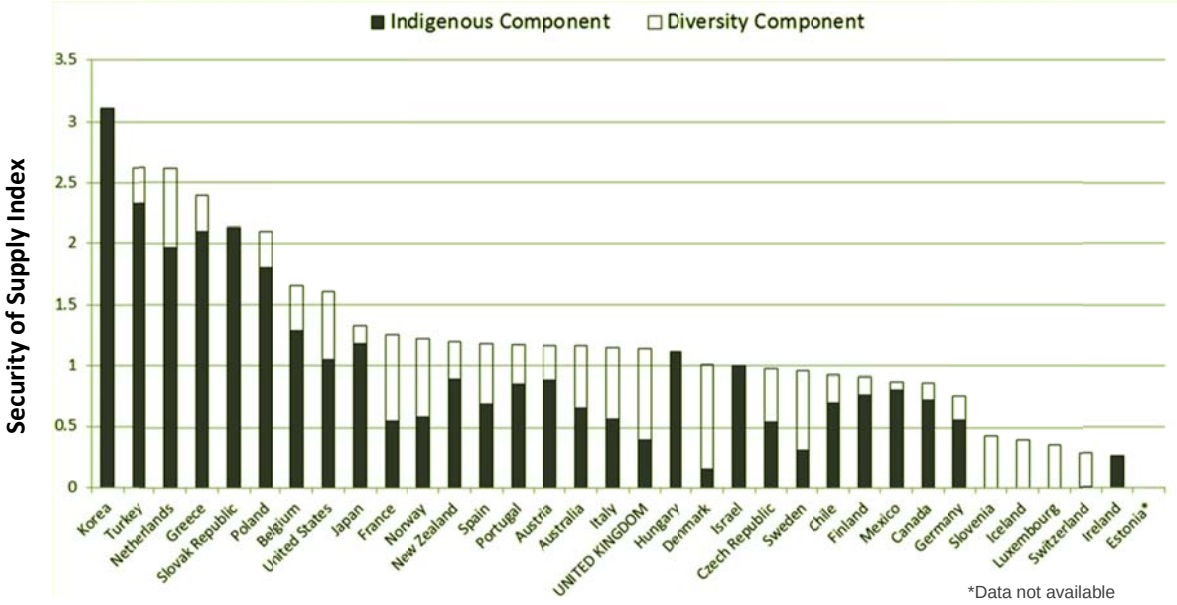
Chart 7 shows that, with a self-sufficiency score of 0.40, the UK was below both the self-sufficient threshold of 1 and the OECD average 0.88 for jet fuel. However, the UK's import diversity score of 0.74 was more than double the average for all OECD countries (0.33) and was the second highest of all OECD countries after Denmark.

Chart 7: Diversity and self-sufficiency of jet fuel for OECD countries, 2014



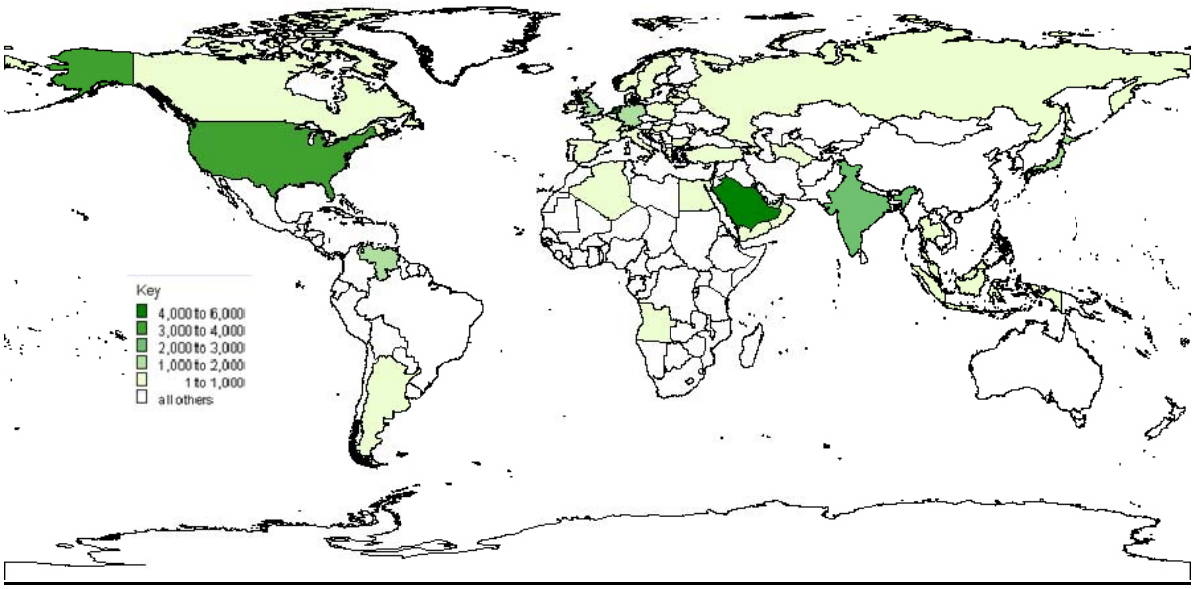
Many OECD countries have significant production capacity of jet fuel. For instance, Korea produces some three times its demand and doesn't require any imports. The UK's capacity to meet its demand through indigenous production is low: in 2014 the UK met only around half its demand; one of the largest deficits in the OECD. However, this was compensated by having one of the most diverse and stable import sources within the OECD.

Chart 8: Security of supply of jet fuel for OECD countries, 2014



Jet fuel is only produced in significant quantities in a few countries around the world. Korea, Saudi Arabia, Kuwait and the United States produce the most which is shown on the map. Europe exports relatively small amounts of jet fuel as does Japan, Russia and North Africa.

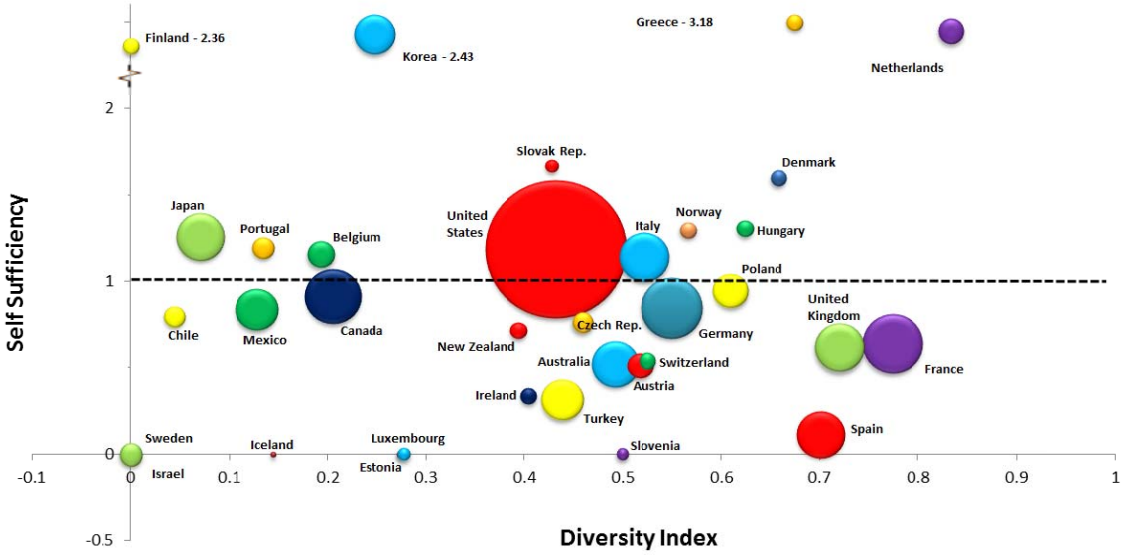
Chart 9: Worldwide Jet Fuel Exports (kt), 2014



Diesel Road Fuel

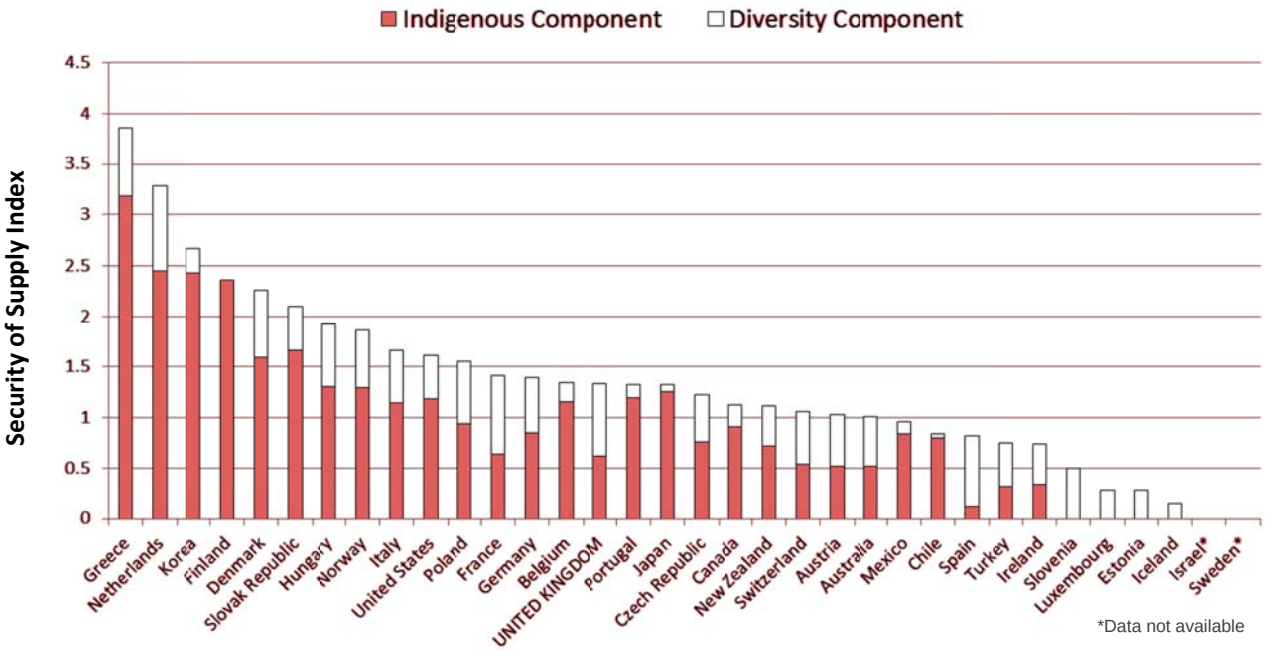
At 0.62 on the self-sufficiency axis, the UK produces just under 2/3rds of the diesel it consumes. The UK was below the average OECD self-sufficiency score of 0.93 in 2014. However, the UK is in a favourable position in terms of diversity and political stability of imports; the UK's diversity score of 0.72 was higher than the OECD average of 0.40 (Chart 10).

Chart 10: Diversity and self-sufficiency of diesel for OECD countries, 2014



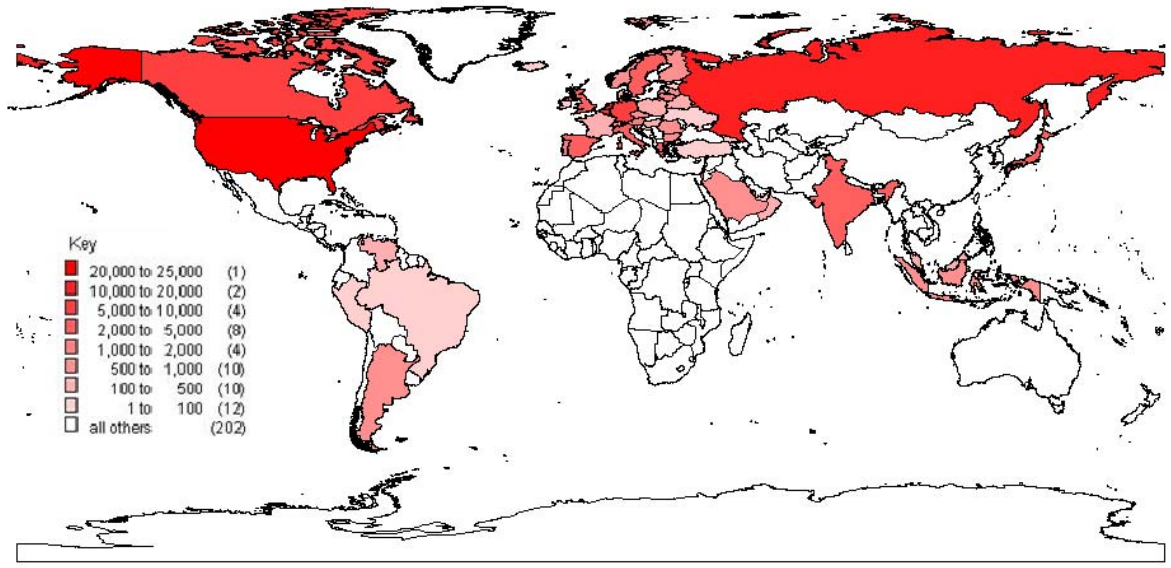
The majority of countries either met demand through indigenous production or by a combination of production and diverse imports. The profile depicts how the UK was close to the median of all other OECD countries (Chart 11).

Chart 11: Security of supply of diesel for OECD countries, 2014



The map shows that only two countries in the world export a significant amount of diesel, United States and Russia. There is limited production throughout Asia and South America with Europe producing diesel in moderate quantities. The United Kingdom met just over half of its demand through indigenous production (Chart 12).

Chart 12: Worldwide Diesel Exports (kt), 2014



Summary

Self-Sufficiency and Import Diversity of OECD Countries in 2014

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 products than for crude itself. With an average self-sufficiency score of 0.41, OECD countries are highly dependent on imports of crude oil to meet refinery demand, compared to average scores of 1.43, 0.88 and 0.93 for motor gasoline, jet fuel and diesel respectively. However, 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 productions cannot be decoupled easily from crude oil security of supply.

Motor gasoline production across the OECD outstrips demand significantly, because the refining profile has historically been biased towards petrol production. With the increasing shift to dieselisation of passenger road transport, the majority of OECD countries more than met their consumption needs and need to export in excess.

In contrast to motor gasoline, many countries did not produce enough jet fuel or diesel domestically to meet their demand. Although diesel imports scored the highest average diversity index amongst oil products of approximately 0.40, jet fuel imports had an average score similar to that of motor gasoline, at approximately 0.33. This relatively low diversity score, combined with a low self-sufficiency score put jet fuel as the lowest scoring oil product in our simplified security of supply index. 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 2014

The UK compares well with other OECD countries for both self-sufficiency and diversity; scoring slightly better for diversity by ranking in the top ten for crude oil and all major oil products. The UK could meet around two thirds of its crude oil consumption via indigenous production, putting it fifth out of all the OECD countries. The UK meets its needs for motor gasoline from indigenous production, depending on its offshore fields for some of the crude oil and the production profiles of

its refineries. Conversely, the UK relies on imports to meets its requirements for jet fuel and diesel road fuel as its refineries do not meet demand from increasing air movements and the shift towards diesel cars.

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Appendix 1 – Provisional Data for 2014

	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	0.58	27001	0.31	0.77	13863	0.5	0.66	6040	0.49	0.52	19954
Austria	0.53	0.11	8443	0.4	**1.15**	1624	0.28	0.89	654	0.52	0.52	6352
Belgium	0.56	0	32123	0.44	**3.51**	1297	0.37	**1.29**	1294	0.19	**1.16**	7008
Canada	0.47	**2.35**	63655	0.51	0.85	33602	0.14	0.72	5655	0.21	0.91	27183
Chile	0.43	0.03	9377	0.31	0.95	2947	0.23	0.7	892	0.04	0.8	3980
Czech Republic	0.28	0.02	7496	0.29	0.96	1575	0.43	0.54	295	0.46	0.76	4260
Denmark	0.22	**1.18**	6910	0.52	**1.63**	1273	0.86	0.15	922	0.66	**1.6**	2411
Estonia	0	-	0	0.3	0	252	0	0	48	0.27	0	511
Finland	0.35	0	11221	0	**2.85**	1520	0.14	0.77	701	0	**2.36**	2424
France	0.72	0.01	54585	0.7	**1.66**	6920	0.7	0.55	6702	0.77	0.64	34043
Germany	0.68	0.03	90832	0.49	**1.06**	18860	0.2	0.56	8705	0.55	0.85	35793
Greece	0.35	0	20695	0.51	**1.86**	2540	0.29	**2.1**	1070	0.67	**3.18**	2485
Hungary	0.08	0.09	6519	0.49	0.99	1146	0	**1.11**	177	0.62	**1.31**	2669
Iceland	0	-	0	0	0	135	0.4	0	155	0.14	0	301
Ireland	0.47	0	2752	0.37	0.44	1107	0	0	710	0.4	0.34	2456
Israel	0	0	12303	0	**1.09**	2844	0	**1**	818	0	-	*0*
Italy	0.71	0.1	58987	0.58	**1.75**	8493	0.57	0.57	3763	0.52	**1.14**	24329
Japan	0.72	0	153397	0	**1.01**	38998	0.15	**1.18**	10211	0.07	**1.25**	19553
Korea	0.8	0	124667	0	**1.88**	8677	0	**3.11**	5484	0.25	**2.43**	15574
Luxembourg	0	-	0	0.27	0	318	0.36	0	394	0.28	0	1744
Mexico	0	**2.02**	62162	0.35	0.54	32436	0.07	0.8	3035	0.13	0.84	16872
Netherlands	0.72	0.03	49803	0.79	**1.66**	3852	0.64	**1.97**	3523	0.83	**2.45**	6364
New Zealand	0.86	0.35	5037	0.29	0.57	2271	0.3	0.9	1077	0.39	0.72	2605
Norway	0.56	**5.57**	13662	0.21	**3.53**	942	0.64	0.58	938	0.57	**1.3**	2500
Poland	0.12	0.04	24196	0.43	**1.06**	3596	0.3	**1.81**	625	0.61	0.95	11090
Portugal	0.62	0	10805	0.14	**1.79**	1113	0.32	0.85	1097	0.13	**1.19**	4275
Slovak Republic	0	0	5250	0.35	**2.3**	574	0	**2.14**	37	0.43	**1.67**	1627
Slovenia	0	-	0	0.49	0	451	0.43	0	25	0.5	0	1385
Spain	0.68	0.01	59031	0.41	**1.58**	4616	0.49	0.69	5267	0.7	0.12	20945
Sweden	0.48	0	18965	0.46	**1.55**	2788	0.65	0.31	803	0	0	4857
Switzerland	0.36	0	4889	0.37	0.53	2696	0.27	0.01	1582	0.52	0.54	2697
Turkey	0.35	0.12	19996	0	**2.05**	1908	0.3	**2.33**	1526	0.44	0.32	16454
United Kingdom	0.65	0.67	55341	0.7	**1.18**	12971	0.74	0.4	11468	0.72	0.62	23525
United States	0.64	0.54	781515	0.77	0.9	388922	0.56	**1.05**	67795	0.43	**1.18**	184969
OECD Average	0.42	0.46	52989	0.36	**1.28**	17857	0.33	0.87	4514	0.40	0.96	15094

Source: IEA (http://data.iea.org/ieastore/statslisting.asp)

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. Jet fuel production figures have in some cases been adjusted to account for transfers from other Kerosene. 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:

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

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.