

## **Diversity of supply for oil and oil products in OECD countries**

### **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 (Organisation for Economic Co-operation and Development) countries manage their crude oil and transport fuel demand in terms of diversity of supply and self-sufficiency, using data from the IEA database<sup>1</sup>.

Within the OECD, only four countries were net exporters of crude oil: Norway, Mexico, Canada and Denmark. All other OECD countries had to meet their demand through imports with 10 countries producing no crude oil indigenously.

The majority of OECD countries met their motor gasoline (petrol) demand through indigenous production, with Western Europe being net exporters. Despite motor gasoline having the lowest average diversity index, i.e. imports came from a smaller range of countries, 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 being self-sufficient. The UK, Sweden and France were the top scorers for diversity of imports within the OECD.

Over a third of OECD countries were not able to support their diesel consumption by indigenous production alone. Greece and Finland scored highest for indigenous production within the OECD with some countries producing no diesel indigenously.

The UK was able to meet over half of its demand for crude oil through indigenous production, the UK also ranked fifth 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 maintained diverse import sources. For jet and diesel, the UK scored below average for indigenous production for both of these oil products, but scored top overall for diversity of imports for jet fuel and third overall for diesel compared to other OECD countries.

### **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 (although some of this product could be exported) 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). A higher score indicates a wider range of stable, import sources to that country.
- **Consumption:** represented by the circle or bubble, the area of which indicates the relative level of consumption for 2013 for each OECD country.

---

<sup>1</sup> <http://wds.iea.org/WDS/Common/>

### 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 an unweighted 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 are a visual representation of the import origin for each product, categorised by quantity. The darker shades of colour show a larger proportion of World imports originating from a particular country and as shades get lighter, the proportion decreases, indicating that very few, or none of the Worlds imports originated from that country. Appendix 1 again shows the underlying data.

Special feature – Supply of oil and oil products

Results

Crude Oil

Only four OECD countries were self-sufficient for crude oil in 2013 (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 0.64, the UK was above the OECD average of 0.38. Similarly, the UK's diversity score of 0.69 was above the average score of 0.42.

Chart 1: Diversity and self-sufficiency of crude oil for OECD countries 2013

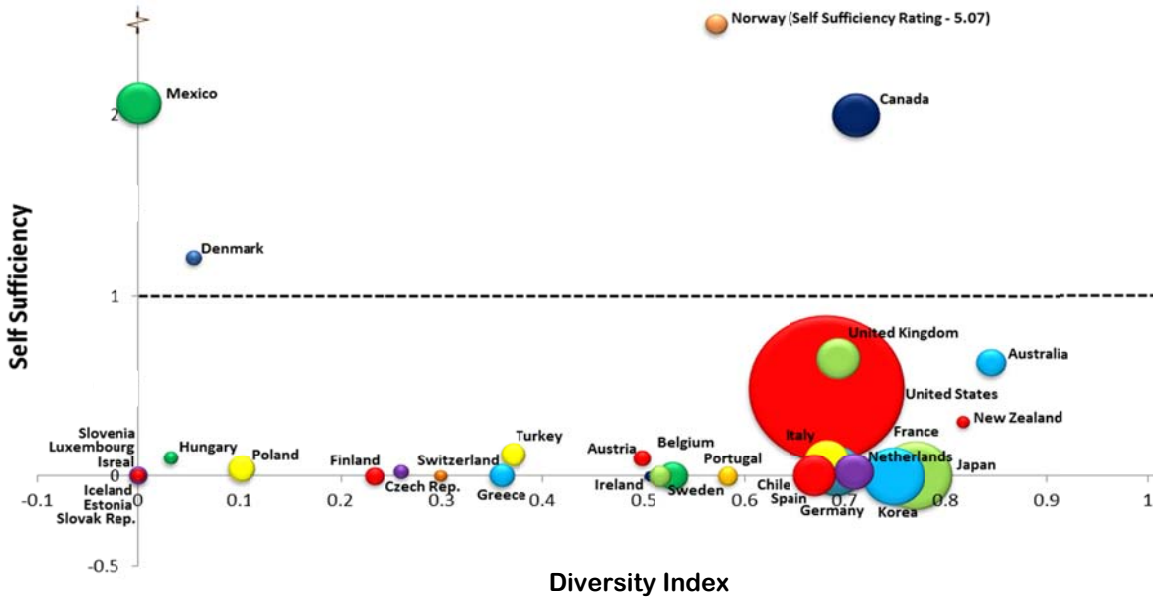
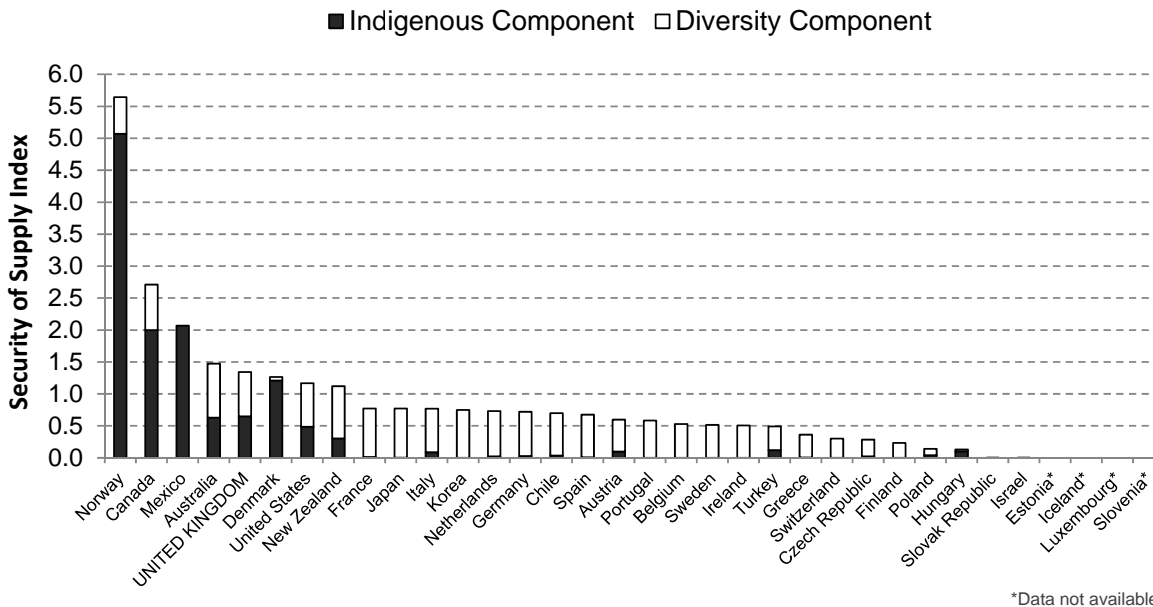


Chart 2 shows that the UK placed highly in the ranking of OECD countries being one of the few countries with significant production. The majority of OECD countries showed scores that reflect a strong trading element, with a relatively small contribution from indigenous production (Chart 2).

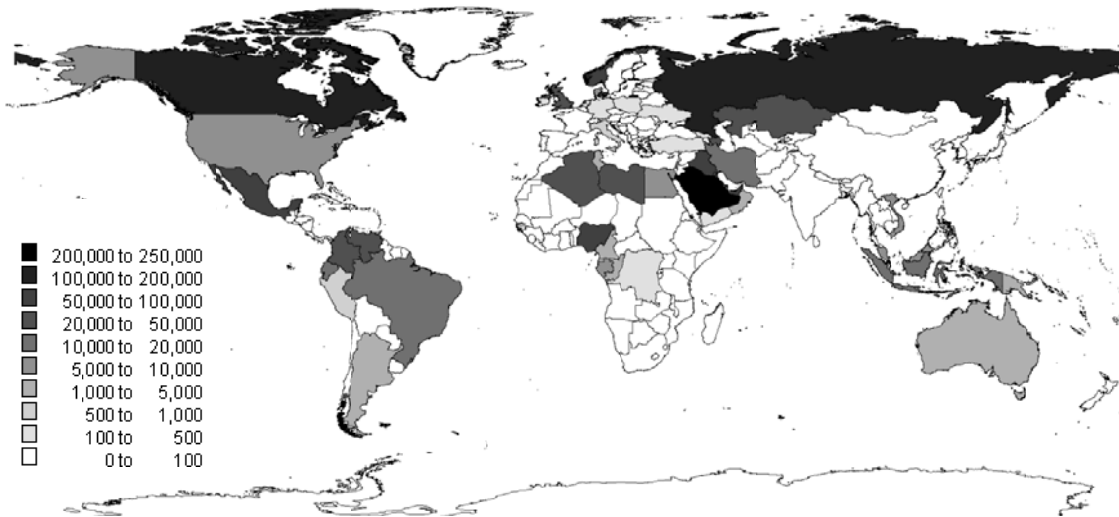
Chart 2: Security of supply of crude oil for OECD countries 2013



\*Data not available

Chart 3 is an illustration of where crude oil originated in 2013. The chart shows that the bulk of crude oil is exported from the Middle East, with Saudi Arabia being the largest producer of indigenous crude oil out of all countries. Russia, North America and South America all produce significant quantities of crude oil as well, with Norway being the largest producer and exporter of crude oil in Europe.

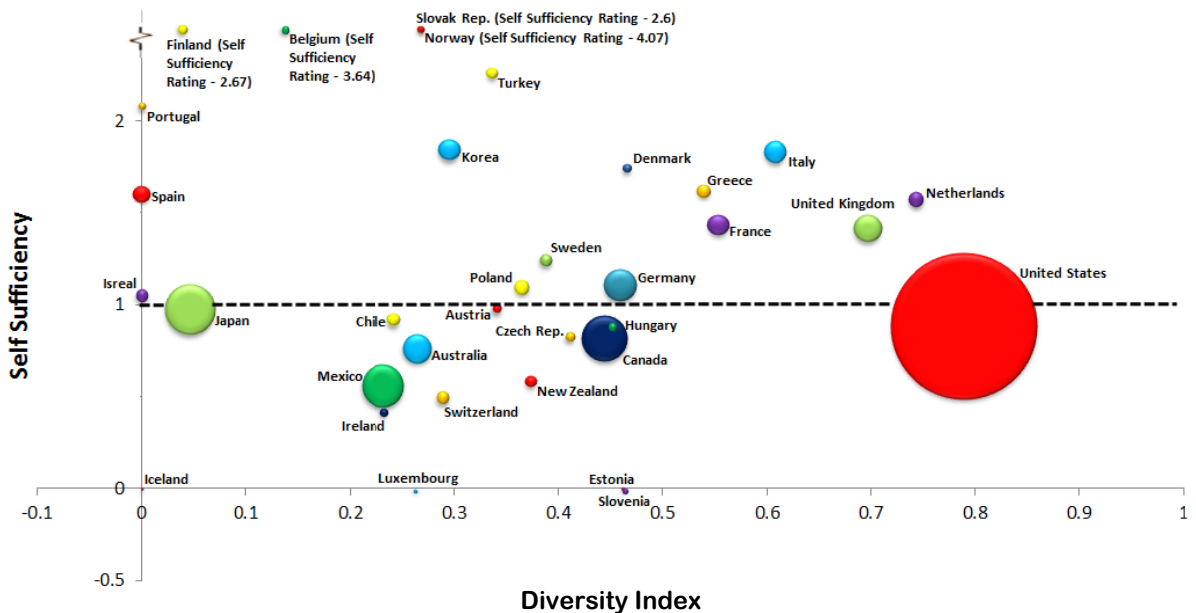
**Chart 3: Worldwide Crude Oil Exports (kt) 2013**



Motor Gasoline

The profiles for motor gasoline are considerably different to that of crude. Over 50 per cent of OECD countries were self-sufficient in 2013 (Chart 4). The UK had a self-sufficiency score of 1.41, which was higher than the average across all OECD countries of 1.29. The UK's diversity score of 0.70 was higher than the average of 0.34, reflecting the UK imports from 15 countries.

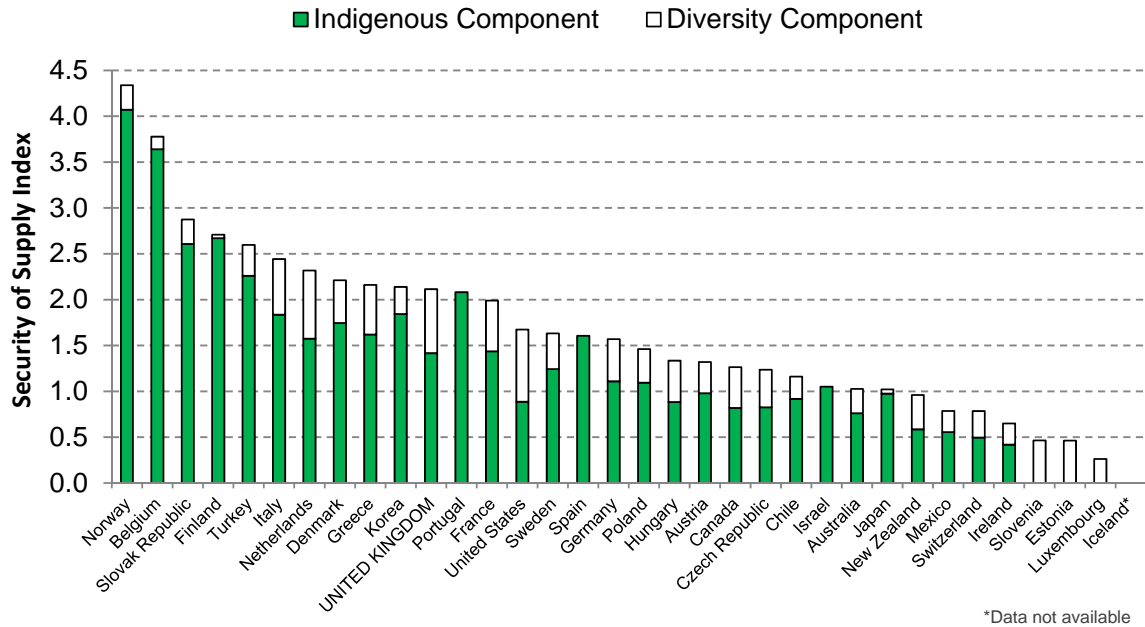
**Chart 4: Diversity and self-sufficiency of motor gasoline for OECD countries 2013**



Special feature – Supply of oil and oil products

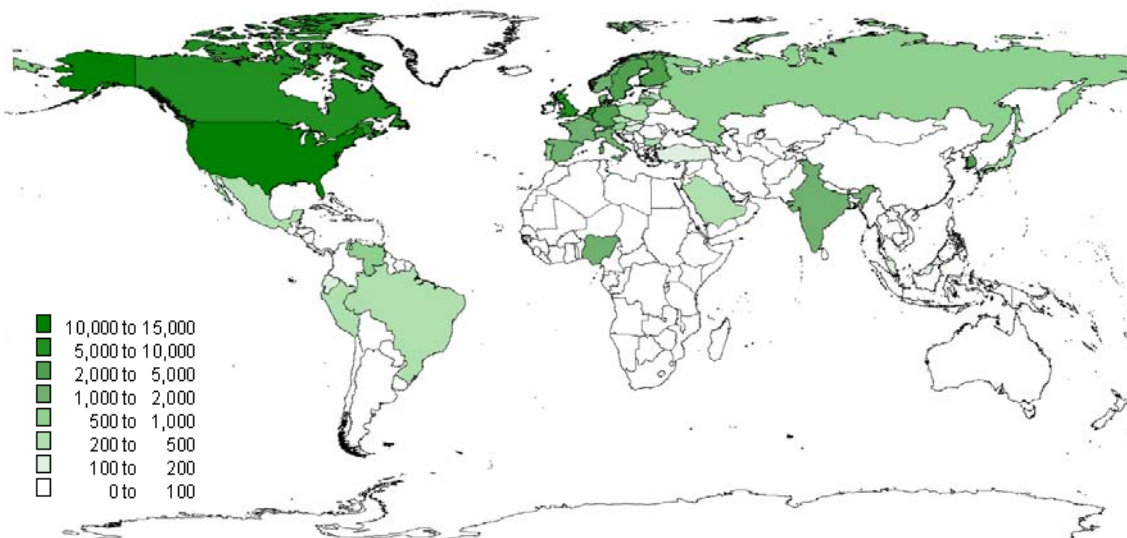
Our simplified security of supply index (Chart 5) shows how the vast majority of countries produce enough petrol to meet their needs and how much trade there is in motor gasoline amongst the OECD countries. The UK ranks in the top third out of all OECD countries.

**Chart 5: Security of supply of motor gasoline for OECD countries 2013**



The main area of export for motor gasoline around the world is North America, with the most exports from Canada and United States despite the UK exporting some amount of motor gasoline to the United States. The map also shows Europe to be a large exporter of motor gasoline with nearly all but a few, exporting some volume of motor gasoline. South East Asia, Australia and New Zealand have the lowest volume of exports.

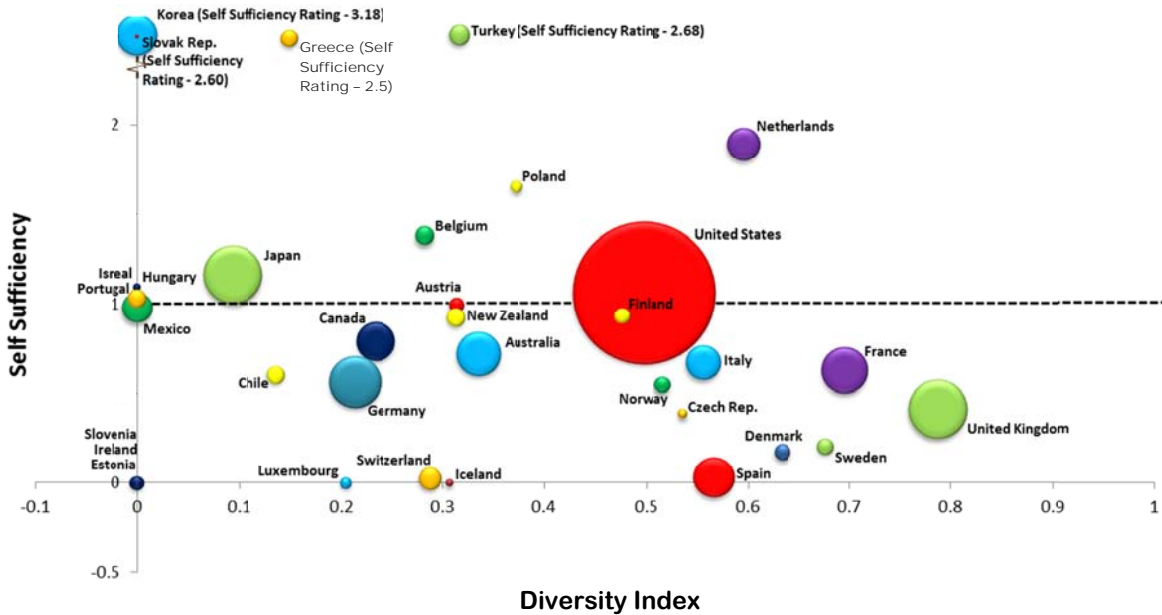
**Chart 6: Worldwide Motor Gasoline Exports (kt) 2013**



**Jet Fuel**

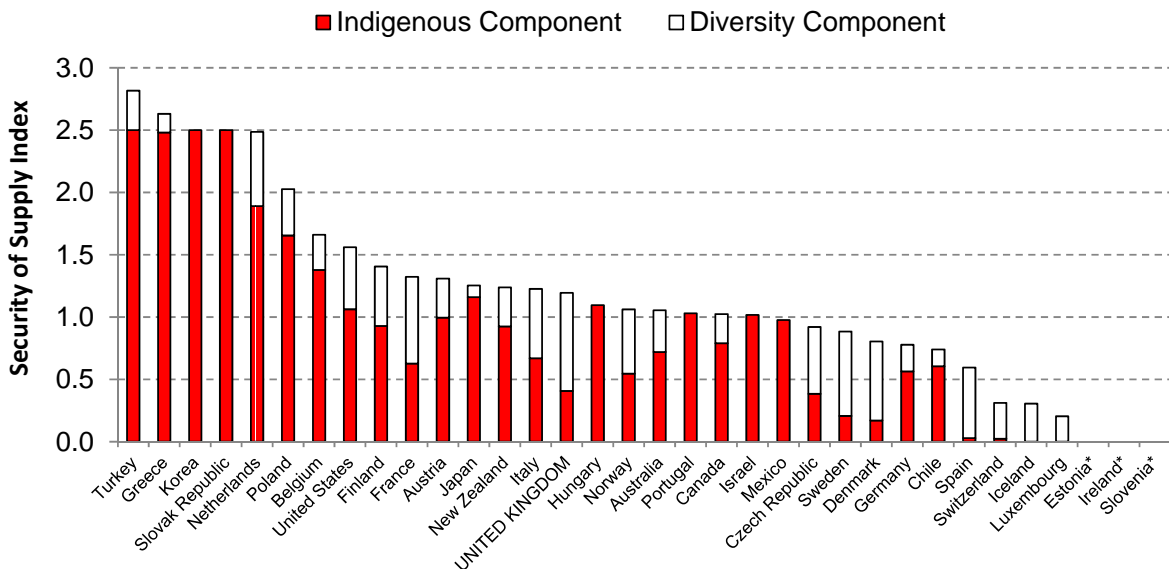
Chart 7 shows that, with a self-sufficiency score of 0.40 and with the second highest demand, the UK was below both the self-sufficient threshold of 1 and the OECD average 0.90 for jet fuel. However, the UK's import diversity score of 0.79 was more than double the average for all OECD countries (0.30) and the highest of all OECD countries.

**Chart 7: Diversity and self-sufficiency of jet fuel for OECD countries 2013**



Many OECD countries have significant production capacity of jet fuel. For instance, Turkey produces two and a half times its demand and requires little imports. The UK's capacity to meet its demand through indigenous production is low: in 2013 the UK was capable of meeting only around half its demand, which is one of the largest deficits in the OECD. However, the UK had the most diverse and stable import sources within the OECD.

**Chart 8: Security of supply of jet fuel for OECD countries 2013**

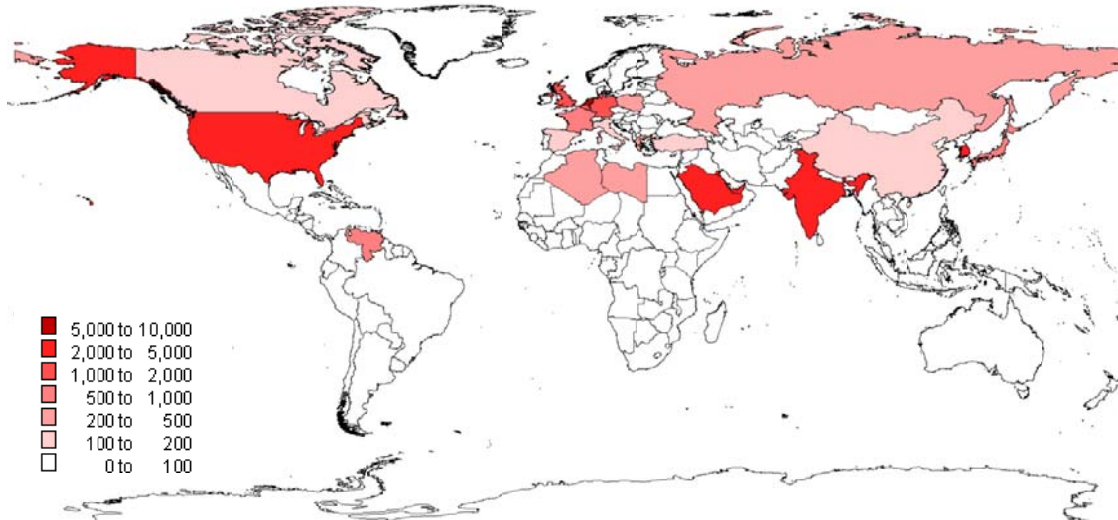


\*Data not available

*Special feature – Supply of oil and oil products*

Jet fuel is only produced in significant quantities in a few countries around the world. Korea, Saudi Arabia, India and the United States produce and export the most (see Chart 9). Europe produces small amounts of jet fuel as well as China, Russia and North Africa.

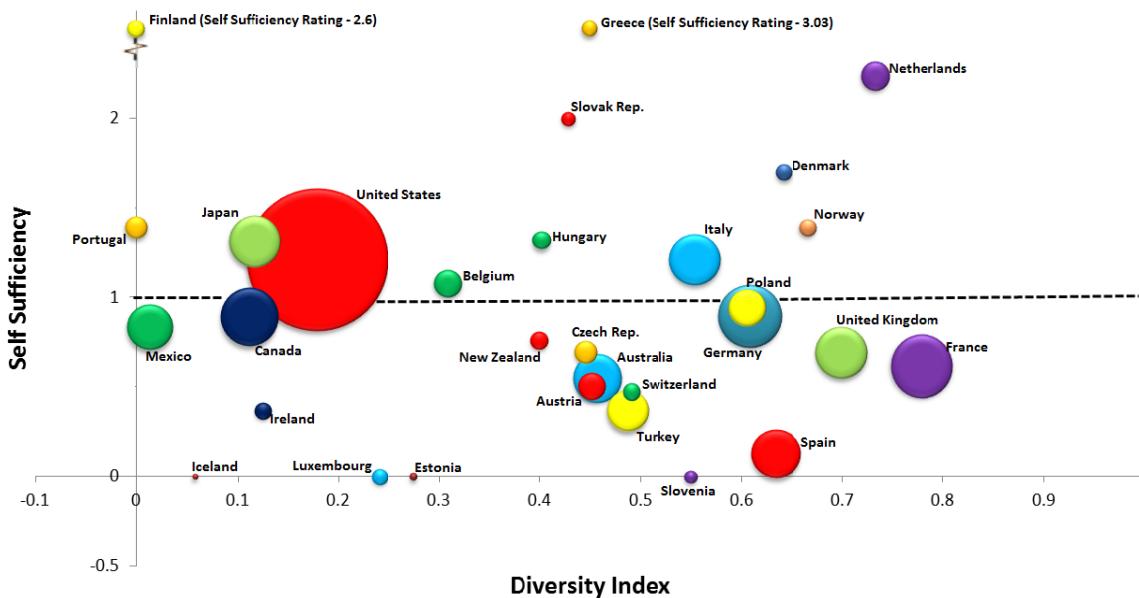
**Chart 9: Worldwide Jet Fuel Exports (kt) 2013**



Diesel Road Fuel

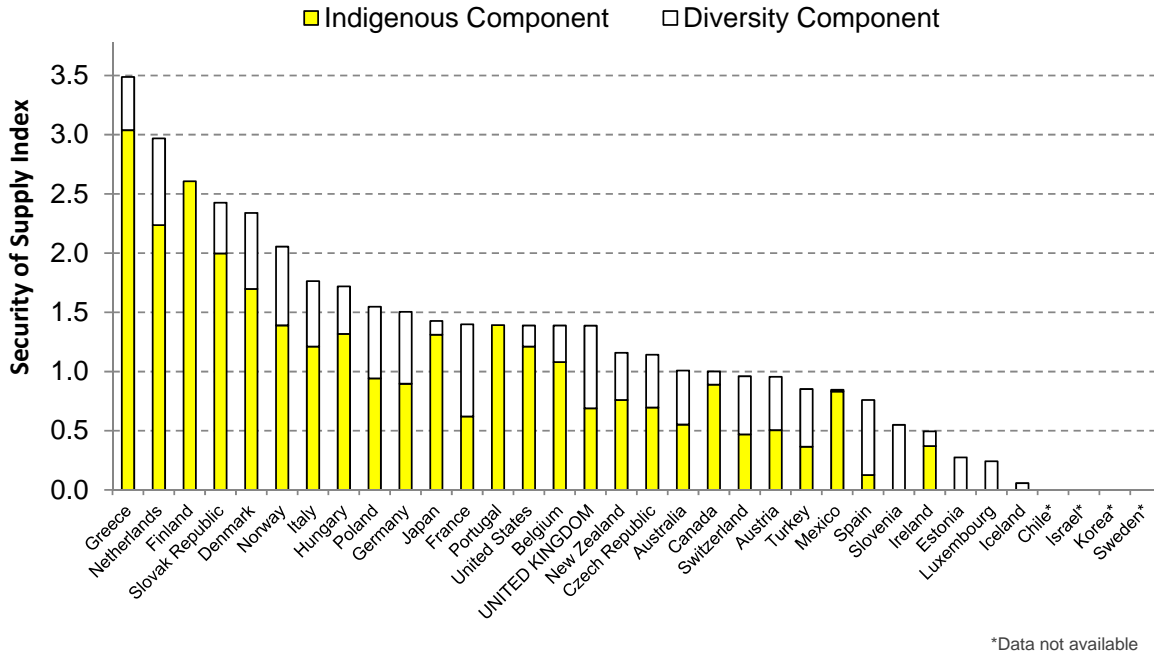
With a self-sufficiency score of 0.69, the UK produces just over two thirds of the diesel it consumes. The UK was below the average OECD self-sufficiency score of 0.86 in 2013. However, the UK is in a favourable position in terms of diversity and political stability of imports; the UK's diversity score of 0.70 was higher than the OECD average of 0.35 and third highest of all OECD countries (Chart 10).

**Chart 10: Diversity and self-sufficiency of diesel for OECD countries 2013**



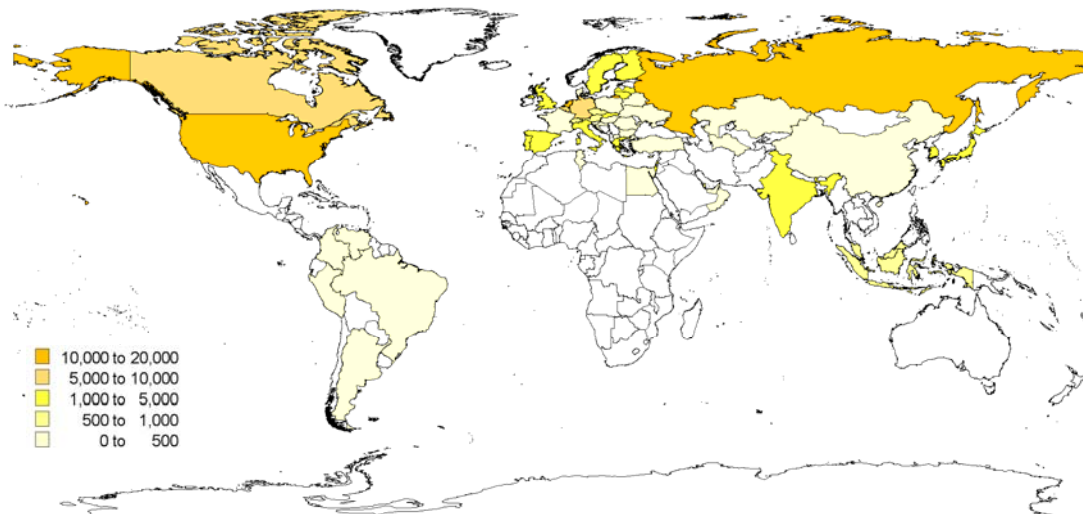
The majority of countries either met demand through indigenous production or by a combination of production and diverse imports. Chart 11 shows how the UK was in the top half of OECD countries.

**Chart 11: Security of supply of diesel for OECD countries 2013**



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

**Chart 12: Worldwide Diesel Exports (kt) 2013**





## **Summary**

### Self-Sufficiency and Import Diversity of OECD Countries

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 (0.38), OECD countries are highly dependent on imports of crude oil to meet refinery demand, compared to average scores of 1.20, 0.88 and 0.86 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 for motor gasoline.

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 of approximately 0.35, jet fuel imports had an average score similar to that of motor gasoline, at approximately 0.3. 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, with a diversity score of 0.79, scored the highest overall, with most north-western European countries also scoring higher than the OECD average of 0.30. This suggests 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

The UK compares well with other OECD countries for both self-sufficiency and diversity, always being in the top half of rankings for both crude oil and oil. The UK could meet around two thirds of its crude oil consumption via indigenous production, putting it sixth out of all the OECD countries. The UK meets its needs for motor gasoline from indigenous production, but conversely, the UK relies on imports to meet its requirements for jet fuel and diesel road fuel as its refineries do not meet demand from increasing air travel and the shift towards diesel road vehicles.

#### **Lewis Marshall**

Oil Statistics

Tel: 0300 068 5053

E-mail: [Lewis.Marshall@decc.gsi.gov.uk](mailto:Lewis.Marshall@decc.gsi.gov.uk)

## Appendix 1 – Provisional Data for 2013

	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	0.63	27,303	0.26	0.76	14,583	0.33	0.72	6,141	0.46	0.55	19,610
Austria	0.50	0.10	8,581	0.34	0.98	1,663	0.31	<b>1.00</b>	657	0.45	0.50	6,381
Belgium	0.53	0.00	27,459	0.14	<b>2.50</b>	1,237	0.28	<b>1.38</b>	1,118	0.31	<b>1.08</b>	6,387
Canada	0.71	<b>2.00</b>	63,642	0.44	0.82	35,144	0.23	0.79	4,446	0.11	0.89	27,462
Chile	0.66	0.03	9,452	0.24	0.92	2,743	0.14	0.60	1,005	0.00	-	3,753
Czech Republic	0.26	0.02	6,664	0.41	0.83	1,564	0.54	0.38	289	0.45	0.70	4,034
Denmark	0.05	<b>1.21</b>	7,172	0.47	<b>1.74</b>	1,285	0.63	0.17	873	0.64	<b>1.70</b>	2,241
Estonia	0.00	-	0	0.46	0.00	223	0.00	-	38	0.27	-	460
Finland	0.23	0.00	11,269	0.04	<b>2.50</b>	1,554	0.48	0.93	720	0.00	<b>2.61</b>	2,415
France	0.76	0.01	55,654	0.55	<b>1.44</b>	7,544	0.70	0.63	6,793	0.78	0.62	33,823
Germany	0.69	0.03	92,454	0.46	<b>1.11</b>	18,422	0.21	0.56	8,435	0.61	0.90	33,447
Greece	0.36	0.00	19,891	0.54	<b>1.62</b>	2,708	0.15	<b>2.48</b>	957	0.45	<b>3.03</b>	2,070
Hungary	0.03	0.10	5,958	0.45	0.88	1,297	0.00	<b>1.10</b>	167	0.40	<b>1.32</b>	2,631
Iceland	0.00	-	0	0.00	0.00	133	0.31	0.00	182	0.06	-	274
Ireland	0.51	0.00	2,840	0.23	0.42	1,201	0.00	-	615	0.13	0.37	2,256
Israel	0.00	0.00	10,951	0.00	<b>1.05</b>	2,673	0.00	<b>1.02</b>	773	0.00	-	0
Italy	0.68	0.09	62,502	0.61	<b>1.83</b>	9,010	0.56	0.67	3,800	0.55	<b>1.21</b>	21,879
Japan	0.77	0.00	159,585	0.05	0.97	41,226	0.09	<b>1.16</b>	10,398	0.12	<b>1.31</b>	20,855
Korea	0.75	0.00	122,816	0.30	<b>1.84</b>	8,220	0.00	<b>3.17</b>	5,187	0.00	-	15,262
Luxembourg	0.00	-	0	0.26	0.00	317	0.20	0.00	360	0.24	-	1,822
Mexico	0.00	<b>2.07</b>	63,129	0.23	0.56	32,878	0.00	0.98	2,842	0.01	0.83	17,777
Netherlands	0.71	0.02	47,707	0.74	<b>1.57</b>	4,041	0.60	<b>1.89</b>	3,397	0.73	<b>2.24</b>	6,974
New Zealand	0.82	0.30	5,215	0.37	0.59	2,279	0.31	0.93	1,047	0.40	0.76	2,540
Norway	0.57	<b>5.06</b>	14,612	0.27	<b>2.50</b>	954	0.52	0.55	885	0.67	<b>1.39</b>	2,440
Poland	0.10	0.04	24,301	0.36	<b>1.10</b>	3,662	0.37	<b>1.65</b>	518	0.61	0.94	11,437
Portugal	0.58	0.00	11,910	0.00	<b>2.08</b>	1,073	0.00	<b>1.03</b>	1,047	0.00	<b>1.39</b>	4,124
Slovak Republic	0.00	0.00	5,793	0.27	<b>2.50</b>	546	0.00	<b>2.60</b>	42	0.43	<b>2.00</b>	1,533
Slovenia	0.00	-	0	0.46	0.00	450	0.00	-	26	0.55	-	1,277
Spain	0.67	0.01	58,143	0.00	<b>1.61</b>	4,652	0.57	0.03	5,133	0.63	0.13	20,465
Sweden	0.52	0.00	16,528	0.39	<b>1.24</b>	2,755	0.68	0.21	812	0.00	-	4,239
Switzerland	0.30	0.00	4,847	0.29	0.50	2,803	0.29	0.02	1,570	0.49	0.47	2,622
Turkey	0.37	0.12	19,925	0.34	<b>2.26</b>	1,909	0.32	<b>2.68</b>	1,337	0.49	0.37	14,692
<u>United Kingdom</u>	<u>0.69</u>	<u>0.65</u>	<u>59,024</u>	<u>0.70</u>	<u>1.42</u>	<u>13,220</u>	<u>0.79</u>	<u>0.41</u>	<u>11,113</u>	<u>0.70</u>	<u>0.69</u>	<u>22,529</u>
United States	0.68	0.49	755,369	0.79	0.89	384,446	0.50	<b>1.06</b>	65,308	0.18	<b>1.21</b>	172,928

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

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

## Appendix 2 – Methodology

### 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 diversity index is a measure of diversity and increases as both the number of countries from which the OECD country imports from increases and the evenness of the size of the import from each country increases. The Shannon-Wiener index is of the form:

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

Where  $x_i$  is the proportion of total fuel 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 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. 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.