Measuring material footprint in the UK: 2008 to 2016

The UK’s material footprint captures domestic and foreign extraction of materials needed to produce products used in the UK. This article presents updated estimates and discusses the methodology.

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1 . Introduction

The UK's material footprint, or raw material consumption, captures the amount of domestic and foreign extraction of materials needed to produce the products used by households, governments and charities in the UK in one year. Such information can be used to examine which products have the largest impact on material extraction.

Estimates of material footprint are provided as part of the UK's Environmental Accounts. These are "satellite accounts" to the main UK National Accounts and are compiled in accordance with the United Nations (UN) System of Environmental Economic Accounting (SEEA), which closely follows the UN System of National Accounts 2008: SNA 2008. This means they are comparable with other economic indicators such as gross domestic product (GDP).

Estimates of material footprint are used in two (8.4.1 and 12.2.1) of the United Nations Sustainable Development Goals and as a strategic indicator in the Department for Environment, Food and Rural Affairs (Defra) strategy for England "Our waste, our resources".

This article presents updated estimates for material footprint and discusses some of the methodological issues surrounding its measurement.

2 . Background

In developing estimates of material footprint, the Office for National Statistics (ONS) initially produces material flow accounts (MFA), which look at how materials (such as biomass, metal ores, non-metallic minerals, fossil energy materials and carriers) flow through the economy. This includes estimating levels of material extraction and levels of imports and exports. From this it is possible to calculate the UK's domestic material consumption (DMC):

DMC = Domestic Extraction + Imports – Exports

One shortcoming of material flow accounts is that the trade flows, that is, the imports and exports, are measured in physical quantities of the good traded and do not consider the raw material that was needed to produce the traded product. For example, if a metal ore is extracted domestically, the total amount of the ore extracted is captured, whereas when metal derived from an ore is imported, only the imported mass of the traded metal (product weight) itself is captured.

To provide a better estimate of how much material is being consumed, measures of raw material equivalent (RME) can be estimated, which include the raw material used to produce a traded product.

By estimating the RME of imports and exports, it is possible to calculate material footprint, often referred to as raw material consumption (RMC).

In 2016, the ONS published the article How much material is the UK consuming?, which included an estimate of material footprint based on the formula:

Material footprint = Domestic Extraction + Imports (RME) – Exports (RME)

The RME of imports and exports was derived using a tool provided by Eurostat.

In 2017, the Department for Environment, Food and Rural Affairs (Defra) consulted extensively with the University of Leeds about developing further environmentally relevant metrics for material use and resource efficiency, particularly in carbon terms. In doing this, the University of Leeds voluntarily reviewed methods to produce estimates of material footprint.

The University of Leeds evaluated several different methods available to the UK and decided it would be best to develop an alternative.

3 . Methods of estimating material footprint

The choice of method used to calculate material footprint has an impact on the final estimates. Section 4.9 of the UN System of Environmental Economic Accounting (SEEA) handbook (PDF, 2.96MB) discusses the options available to countries for reporting this measure but, while it expresses a preference for the approach using "an extended global multi-regional input-output model", it accepts that "these databases have complex underlying methodologies and national statistical authorities cannot easily use or adapt them for their specific needs". A measure of material footprint is also an indicator within two of the UN Sustainable Development Goals (8.4.1 and 12.2.1).

This article discusses two approaches where data have been produced for the UK.

Eurostat method

To estimate the material footprint of the EU, Eurostat use an environmentally extended input-output table (IOT) approach for calculating raw material equivalent (RME) of imports and exports. The methodology is based on an integration of data from IOTs, domestic extraction from MFA and life-cycle-inventory data (that is, flows of final and intermediate goods and services defined according to industry or product, supplemented with information on use of raw materials, energy and emissions).

To aid EU countries in developing these estimates, Eurostat has provided a "Country RME tool". This uses a coefficient approach, where the estimates of RME imports and exports are based on EU-level coefficients for each product. The 2015 version of the model, which assumed that all countries had the same level of production technology, was used to calculate the estimates published by the Office for National Statistics (ONS) in 2016.

Eurostat have since provided an updated version of the tool, where adjusted coefficients allow for country specific differences in production technology. Estimates from this updated model are presented in the Section 5: Results.

University of Leeds method

The University of Leeds has taken a different approach to calculating the UK's material footprint. They have developed a multi-regional input-output (MRIO) approach, using a specifically derived UK MRIO database to underpin calculations.

Rather than calculating imports and exports in their raw material equivalent form, the MRIO approach takes estimates of domestic extraction by world region and reallocates them to measures of UK final demand. The database is constructed using supply and use tables from the ONS.

Imports to intermediate demand are further disaggregated to show which world regions and sectors are involved in UK intermediate demand. Similarly, exports are disaggregated to show which sectors in which world regions are using UK exports for their own intermediate or final demands. This allows for re-imports (where a semi-finished product is exported from the source country, processed abroad and then re-imported), to be accurately accounted for. Information on the origin and destination of trade flows is taken from the EXIOBASE MRIO database.

More details on the methodology used by the University of Leeds are available. Their latest available estimates were published by Defra (PDF, 1.29 MB) and are also presented in Section 5: Results.

4 . Quality aspects of each method

There are both strengths and weaknesses associated with each of the methods described in Section 3: Methods of estimating material footprint. A high-level summary is given in Table 1.

Table 1: Evaluation of methods for calculating material footprint

Criteria[1]	Eurostat method	University of Leeds
Comparability and coherence	Use of the Eurostat "Country RME tool" method ensures comparability across countries that also use this.	The UK-specific multi-regional input-output (MRIO) database developed for estimating material footprint is also used for the estimation of the UK's carbon footprint[2], so allows comparability of these indicators.
Accuracy and reliability	Does not differentiate by source of the imports; the raw material equivalent of a unit of imported product is considered at an EU level only. Does not account for re-imports and exports, that is, where products cross borders several times.	Differentiates by source of the imports and associates these with country specific amounts of raw material equivalent per unit of imported product. Accounts for re-imports and exports (materials embodied in intermediate UK products that are exported to become part of the supply chain abroad but imported back to the UK as a final product).
Relevance	Relevant for users making international or European comparisons (with those countries that have used the tool to produce their material footprint estimates).	Relevant for domestic users, such as, Department for Environment, Food and Rural Affairs (Defra) Resources and Waste Strategy policy indicators.
Accessibility and clarity	Largely constructed using "official" data sources. Generally available on the Eurostat website.	Not constructed from "official" sources, for example, EXIOBASE[2], the source of data regarding worldwide origin and destination of trade flows.
Timeliness and punctuality	Data sources and therefore estimates from this method are likely to be updated annually.	Data sources for this method are not always updated annually. MRIO databases require a lot of resource to update.

Source: Office for National Statistics

Notes

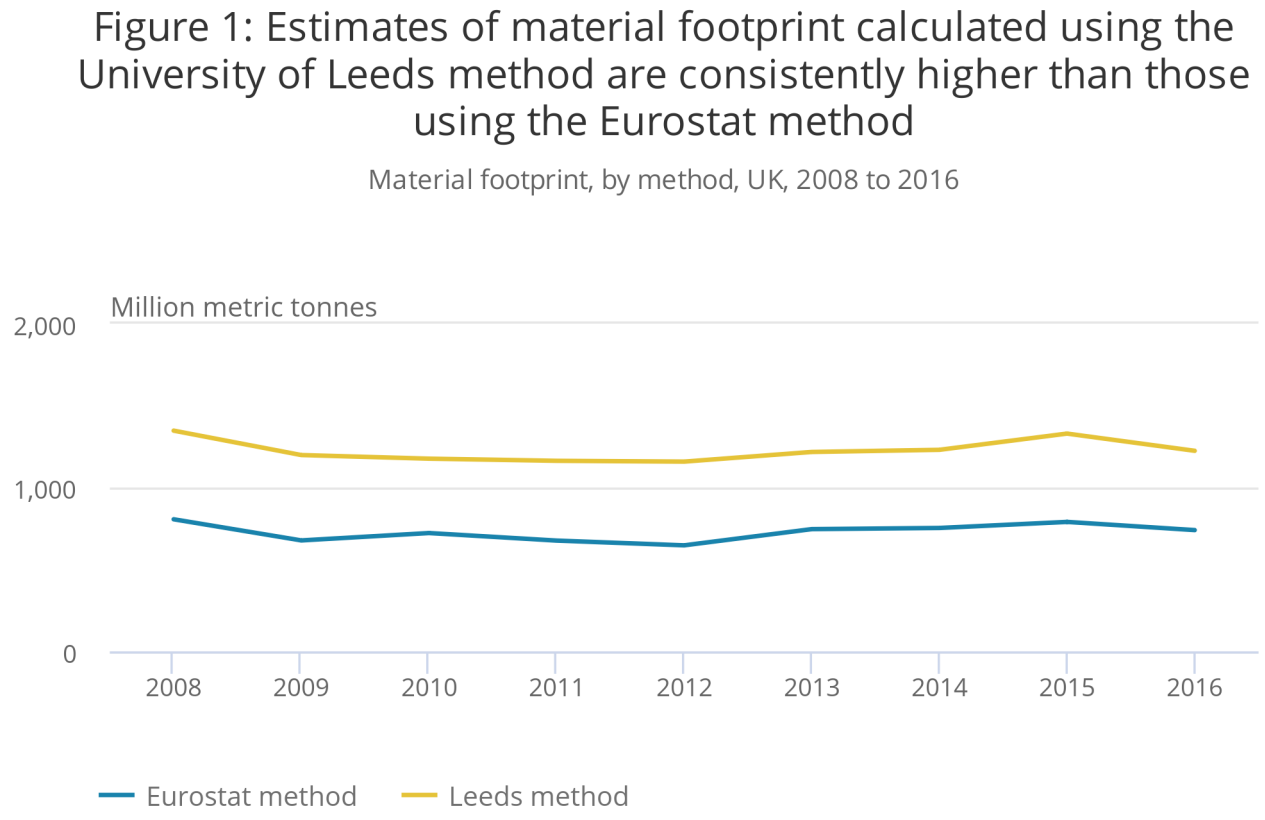
1. Criteria are based on the five European Statistical System quality dimensions. Back to table
2. For more information, see '7. Related links' Back to table

5 . Results

Figure 1 shows both estimates of material footprint for the UK for 2008 to 2016.

Figure 1: Estimates of material footprint calculated using the University of Leeds method are consistently higher than those using the Eurostat method

Material footprint, by method, UK, 2008 to 2016



Source: Office for National Statistics and Eurostat, University of Leeds

Notes:

1. The level of material footprint for the Eurostat approach is shown excluding imports and exports of precious metals. Precious metals (particularly gold) have a high RME factor, so can have distinctive impact on the results. This is particularly true for the UK, who are responsible for more than three quarters of the EU's imports of gold. While the impact is minimal at the total level (Figure 2), it is more evident when looking at the material footprint of metal ores (Figure 4).

Primarily, given the exclusion of re-imports and exports from the Eurostat model, the University of Leeds estimates show a consistently higher level. Estimates of material footprint by category of material (biomass, metal ores, non-metallic minerals, fossil energy materials and carriers) are presented in Section 8: Annex.

6 . Conclusion

Work on developing estimates of material footprint has been carried out on a non-contractual and collaborative basis to date. The University of Leeds calculate estimates of carbon footprint under contract to the Department of Environment, Food and Rural Affairs (Defra). In future, it is likely that the UK government will require both footprints to be updated annually at both a UK and country level. Both metrics form the basis of commitments in the recently published Resources and Waste strategy for England and are used to help the UK fulfil its commitment to reporting Sustainable Development Goals (SDGs).

The Office for National Statistics (ONS) will continue to work with interested parties to help ensure publication of regular estimates of material footprint and explain to users any differences in methodology used in publicly available estimates of material footprint. The ONS will feed into and monitor international decisions as to which method is used for estimating material footprint in the UN SDGs.

7 . Related links

More information on the topic of material footprint is available in the following publications:

Eurostat Raw Material Equivalent (RME) Tool Handbook (PDF, 923KB)

Resource efficiency metrics

Techniques for evaluating the differences in multiregional input-output databases

A review of recent multi-region input–output models used for consumption-based emission and resource accounting, Ecological Economics, Volume 69, Issue 2 (pages 211 to 222)

A method to create carbon footprint estimates consistent with National Accounts

Environmental Accounts, UK

UN System of Environmental Economic Accounting (SEEA) Economy-wide material flow accounts handbook: 2018 (PDF, 2.96MB)

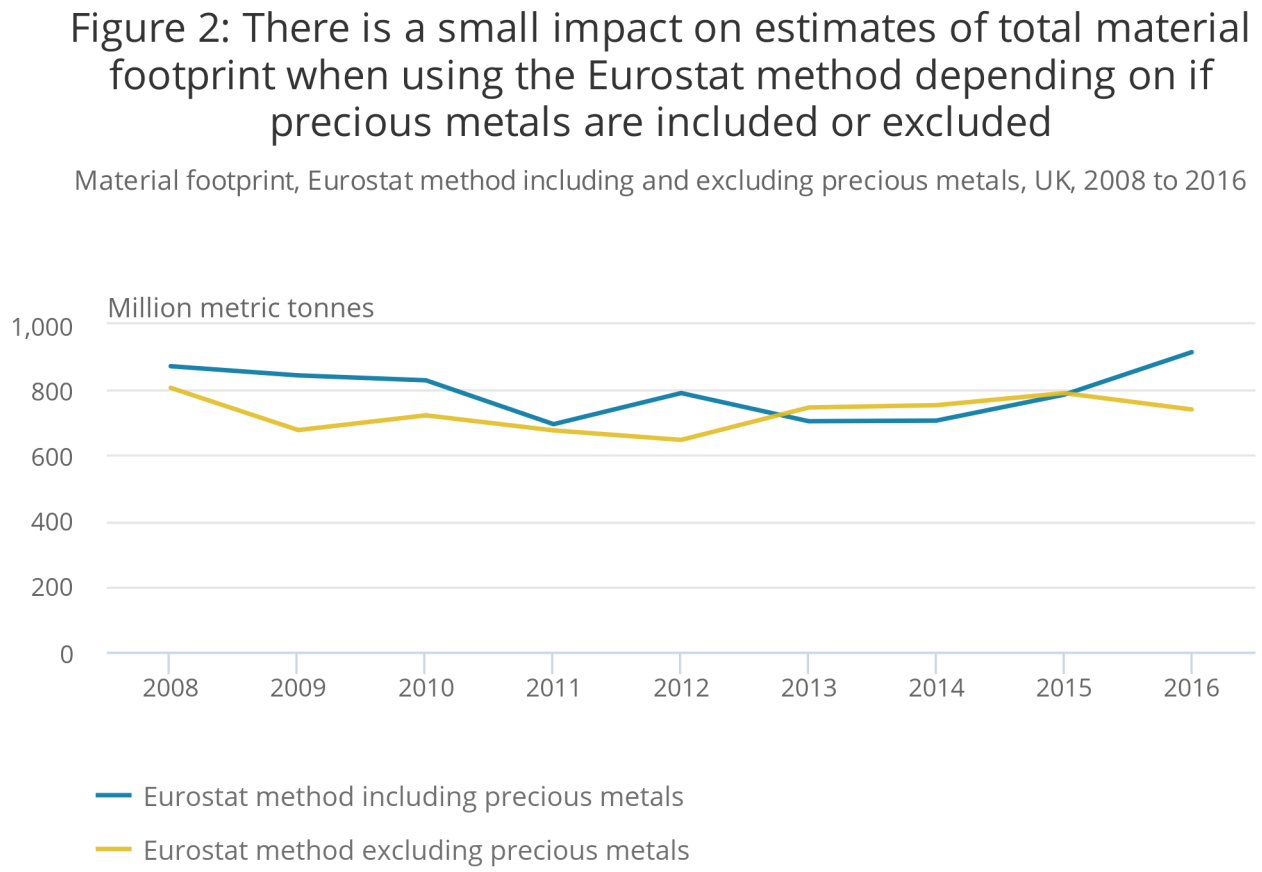
UK's carbon footprint

EXIOBASE

8 . Annex

Figure 2: There is a small impact on estimates of total material footprint when using the Eurostat method depending on if precious metals are included or excluded

Material footprint, Eurostat method including and excluding precious metals, UK, 2008 to 2016



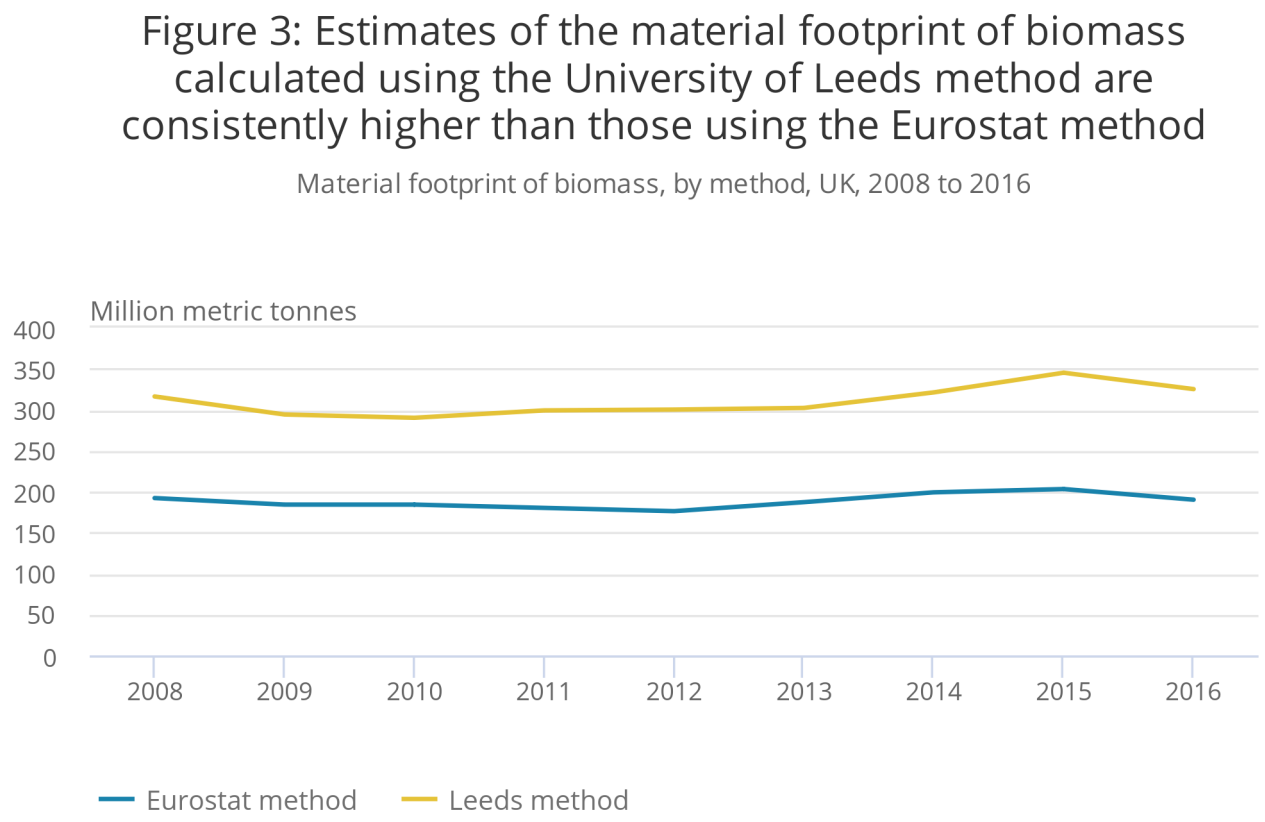
Source: Office for National Statistics and Eurostat

Notes:

1. The level of material footprint for the Eurostat approach is shown including and excluding imports and exports of precious metals. Precious metals (particularly gold) have a high RME factor, so can have a distinctive impact on the results. While the impact is minimal at the total level, it is more evident when looking at the material footprint of metal ores (Figure 4).

Figure 3: Estimates of the material footprint of biomass calculated using the University of Leeds method are consistently higher than those using the Eurostat method

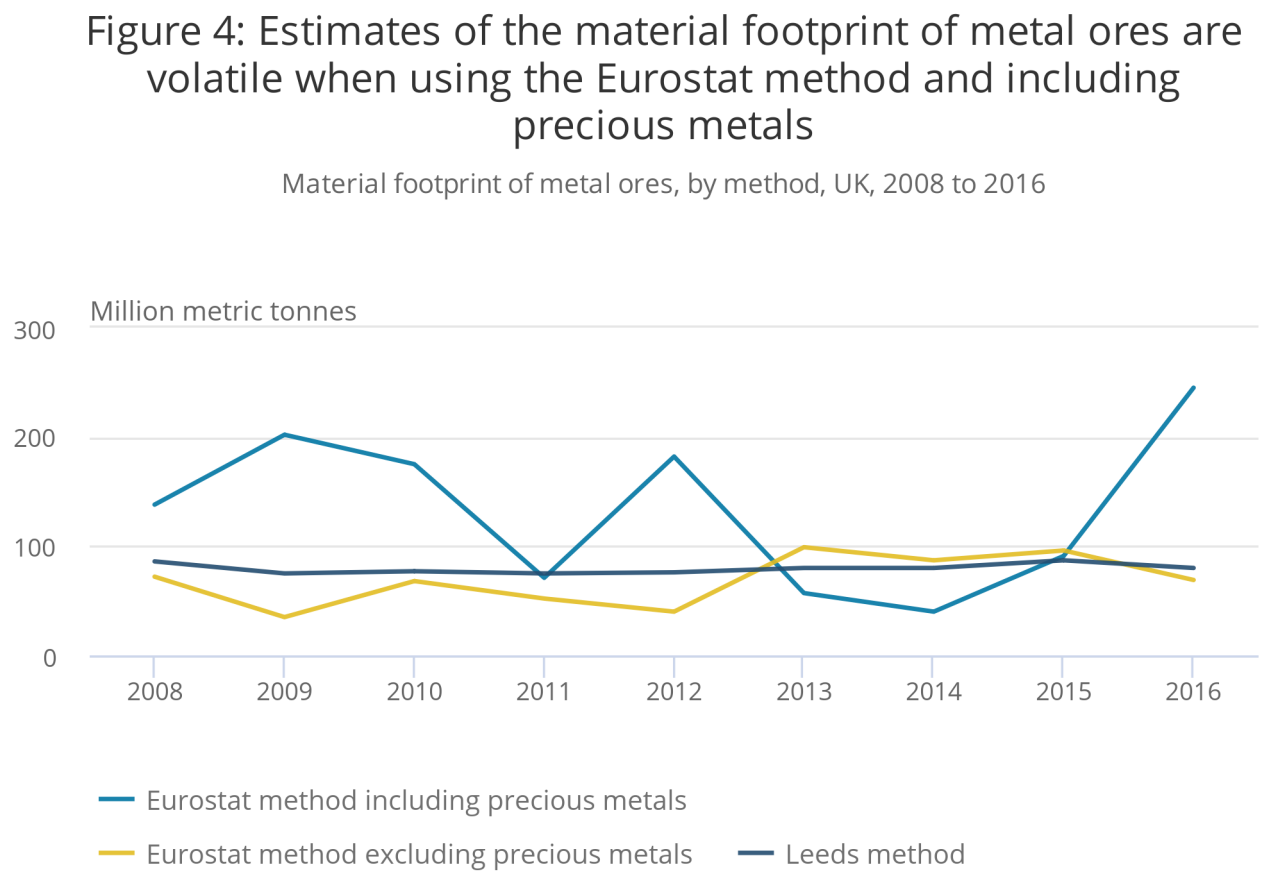
Material footprint of biomass, by method, UK, 2008 to 2016



Source: Office for National Statistics and Eurostat, University of Leeds

Figure 4: Estimates of the material footprint of metal ores are volatile when using the Eurostat method and including precious metals

Material footprint of metal ores, by method, UK, 2008 to 2016



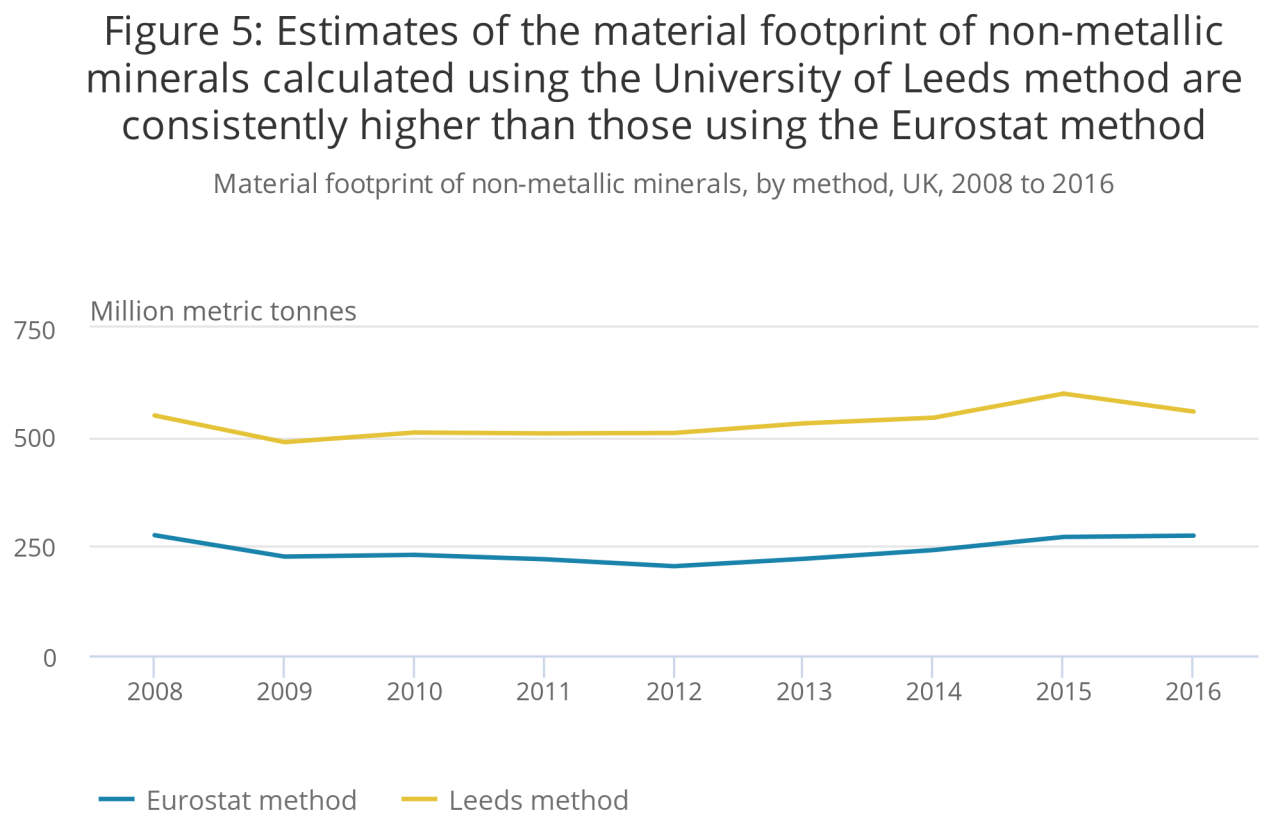
Source: Office for National Statistics and Eurostat, University of Leeds

Notes:

1. The level of material footprint for the Eurostat approach is shown including and excluding imports and exports of precious metals. Precious metals (particularly gold) have a high RME factor, so can have a distinctive impact on the results. While the impact is minimal at the total level (Figure 2), it is more evident when looking at the material footprint of metal ores.

Figure 5: Estimates of the material footprint of non-metallic minerals calculated using the University of Leeds method are consistently higher than those using the Eurostat method

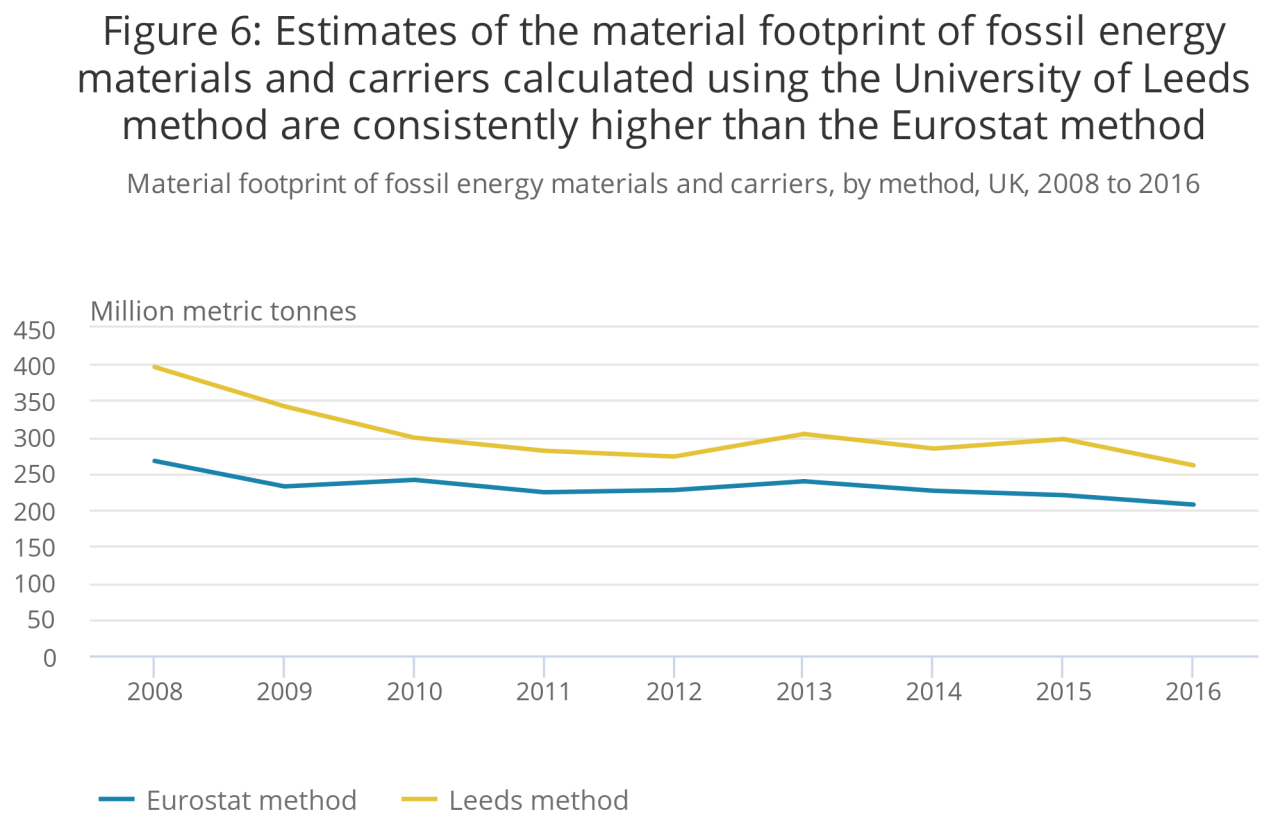
Material footprint of non-metallic minerals, by method, UK, 2008 to 2016



Source: Office for National Statistics and Eurostat, University of Leeds

Figure 6: Estimates of the material footprint of fossil energy materials and carriers calculated using the University of Leeds method are consistently higher than the Eurostat method

Material footprint of fossil energy materials and carriers, by method, UK, 2008 to 2016



Source: Office for National Statistics and Eurostat, University of Leeds