Nowcasting of and target setting for resource efficiency indicators

Final Report

Client: European Commission DG Environment

Rotterdam, 14 March 2013

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ECORYS

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Executive Summary

Background

Early estimates and nowcasting are emerging techniques that are increasingly being used as a cost-effective way to bridge the gap between the most recent reported observations of an indicator and its, as yet unreported, or even un measured, current value. The idea is based on using more up-to-date indicators, for example economic indicators such as Gross Value Added or physical production figures, as a predictor of changes in the desired indicator. The idea is to build an intelligent, logical, predictive link, for example energy use as a predictor of emissions to air, which can be used to model how the indicator is likely to have moved to the present (the early estimates and nowcasts) on the basis of more recent data. This can give an advantage over simple extrapolation from historical data as, through the predictor variable, it takes account of real changes that have taken place.

For example a GDP flash estimate is produced by Eurostat within 45 days, i.e. today's GDP figure will be first available in 45 days' time. The third and last revision is produced within three months. Despite the lower accuracy of the first estimate, significant pressures exist to provide timely economic data as soon as possible after the end of the reference period, in order that, for example, better informed private investment decisions can be made.

The purpose of this assignment was to map the current and potential future availability of resource efficiency indicators, assess their potential for early estimates and nowcasts and target setting. Some of these methods were applied to material flow indicators.

The results of this work are of relevance to Commission initiatives such as the Roadmap to a Resource Efficient Europe, beyond GDP communication, and the EU's annual governance cycle, the European Semester. The Resource Efficiency Roadmap envisages the need for indicators and targets as important tools to measure and foster progress towards the 2050 vision, suggesting around 40 indicators in its Annex 6. The Beyond GDP communication highlights the need for more inclusive, timely and understandable indicators. The new economic governance system of the European Commission, the European Semester also asks for timely annual data to allow for up-to-date analysis and policy recommendations. Hence, the need is to provide profiles with existing or soon to be developed indicators and their potential for target setting backed up by robust data coming from the national and international sources that could be used for the Commission's purposes as outlined above. Another need is to provide timely indicators to allow for quick and adequate policy response by policy makers.

Key findings

Resource efficiency indicators & their potential for early estimates and/or nowcasts:

- Development work of various kinds is needed to provide the resource efficiency indicators (REIs) that are needed to monitor progress in meeting the goals of the Roadmap to a Resource Efficient Europe and the beyond GDP Roadmap;
- 66 resource efficiency indicators and their potential for nowcasting and early estimates were assessed in this study;

- It was found, that over half (55%) of the 66 indicators are currently available, with the European Environment Agency (EEA) and Eurostat (ESTAT) being the primary data sources for the indicators;
- A further 20% of the indicators are under development mainly by the EEA, ESTAT, with a limited number under development by other organisations such as the Joint Research Centres, Wuppertal Institute, OECD and the Water Footprint Network;
- Of those that are already published regularly, the majority are generally 2-3 years out of date; some are even more behind the present day than that. This limits their value in providing an evidence base for the European Semester and in more generally measuring progress;
- We have identified a set of 15 REIs, including air, mobility, land and soil and carbon sub groups, for which we believe that at a reasonable cost it is feasible to construct early estimates and nowcasts (EEs and NCs). These would advance the availability of the indicators by at least 12 months. This is achievable by making use of more up-to-date information available for 'predictors' (indicators which are related to the REIs);
- There is a trade-off between *timeliness* and *accuracy*, because more information becomes available to improve estimates of indicators as time progresses. Broadly speaking, as the status of an indicator proceeds from 'very timely but less accurate' through to 'not very timely but more accurate', it becomes more useful for some policy purposes and less useful for others. For the purpose of communication, there is a premium on timeliness; for the purpose of analysis, there is a premium on accuracy; for the purpose of monitoring, an indicator needs to be both reasonably timely and reasonably accurate. Consequently, we believe that EEs and NCs for the REIs will contribute most to the communication and monitoring purposes of policy;
- In order to rank possible methods of producing EE/NCs, we produced a measure of the likely 'value added' of the method, combining the expected improvement in its timeliness with an assessment of its likely accuracy;
- Four indicators have been identified as high priority with regard to being EEed or NCed. This was based on three criteria – policy relevance, value added of being EEed or NCed and cost of implementation. The indicators are:
  - Water Exploitation Index (%);
  - GHG emissions;
  - Carbon footprint;
  - CO_2 emissions in the transport sector ($MtCO_2$).
- For example, by applying EE/NC methods to carbon footprint, we can gain up to four years in timeliness with a relatively good accuracy. Regarding CO_2 emissions from the transport sector, we could gain 1-2 years with a very high accuracy.

Environmental sustainability thresholds:

- It was found that the many of the indicators investigated in this study are related to an environmental sustainability thresholds arising from scientific evidence or established management practices implying a 'safe operating space', i.e. levels below any "danger zone" or "tipping point" (threshold)s that lead to potential long-term or irreversible environmental consequences;
- Of the 23 indicators for which there are relevant environmental thresholds or best management practices, but no targets, 11 are assessed to be related thresholds which are widely accepted by science or are established management practices;
- However, of these 11, only six are related to thresholds of a scale found suitable for EU policy making, of which only three also exhibit a close relation to the threshold phenomenon itself and are assessed to be reasonable practicable for target setting. These three are soil organic matter levels, CO_2 emissions in the transport sector and energy consumption/km driven.

Developing early estimates/ nowcasts for material flow indicators:

- For the REIs that form part of the Material Flow Accounts (which measure the use of resources in terms of the weight of materials used), we have constructed early estimates which advance the timeliness of these indicators by at least 12 months. This includes estimates for the key resource productivity indicator: GDP per unit of material consumed (i.e. per unit of Domestic Material Consumption);
- The same system can be used to produce nowcasts for the current year by taking a view on the likely outturn for the predictors for the current year (informed by monthly data on the predictors);
- For each Member State, the method distinguishes different groups of materials (for example, agricultural, metal ores, building materials, energy products) and associates each group with a relevant predictor of the amount extracted or consumed. Detailed up-to-date data on exports and imports are used to construct estimates of these flows. Other indicators that include the 'hidden flows' (for example, the materials processed in other countries to produce the semi-finished or finished goods imported into Europe) are estimated by 'grossing up' from the figures for extraction, consumption and imports;
- We regard the method as yielding satisfactory results for producing early estimates and nowcasts for the key indicators for the EU as a whole (formed by adding up the results for Member States); in some cases (certain Member States and certain materials) the results are not sufficiently accurate to be published separately. Had this model been available to give an early estimate of the 2009 outturn for Domestic Material Consumption, it would have correctly predicted a sharp fall in 2009 (reflecting the recession), but would have understated somewhat the extent of that fall. The 2010 Early Estimate predicts that the fall in DMC did not continue, due to a return to modest growth in consumption of non-metallic minerals and a sharp increase in consumption of gas. When taken together with the known outturn for GDP growth, the Early Estimate would have supported advice to policy-makers that the sharp fall in 2009 was driven mainly by the fall in demand for materials caused by the recession rather than a sharp increase in resource productivity.

Technical Summary

This study was commissioned by DG Environment to assess the potential for nowcasting and early estimates of resource efficiency indicators. It assessed 66 indicators, selected from the topics and annexes of the Roadmap for a Resource Efficient Europe (RERM) and other sources. The assessment included a detailed classification of the indicator, an assessment of the indicators potential for nowcasting and/or early estimates, an assessment of how the indicators should be prioritised for nowcasting and an assessment of the relevance and suitability of the indicator to environmental sustainability thresholds and target setting. Finally, early estimates and nowcasts were also carried out for a selection of material flow indicators.

By advancing the timeliness of indicators and identifying potential operational environmental sustainability thresholds (ESTs), this study also contributes to the beyond GDP Roadmap outlined in the 2009 European Commission Communication "GDP and beyond: Measuring progress in a changing world".[1] In this communication the Commission commits itself to "… develop more inclusive indicators that provide a more reliable knowledge base for better public debate and policy-making. The Commission intends to cooperate with stakeholders and partners to develop indicators that are internationally recognised and implemented." The beyond GDP Roadmap identifies five key actions to improve our indicators of progress in ways that meet citizens' concerns and make the most of new technical and political developments.[2]

Current availability of resource efficiency indicators

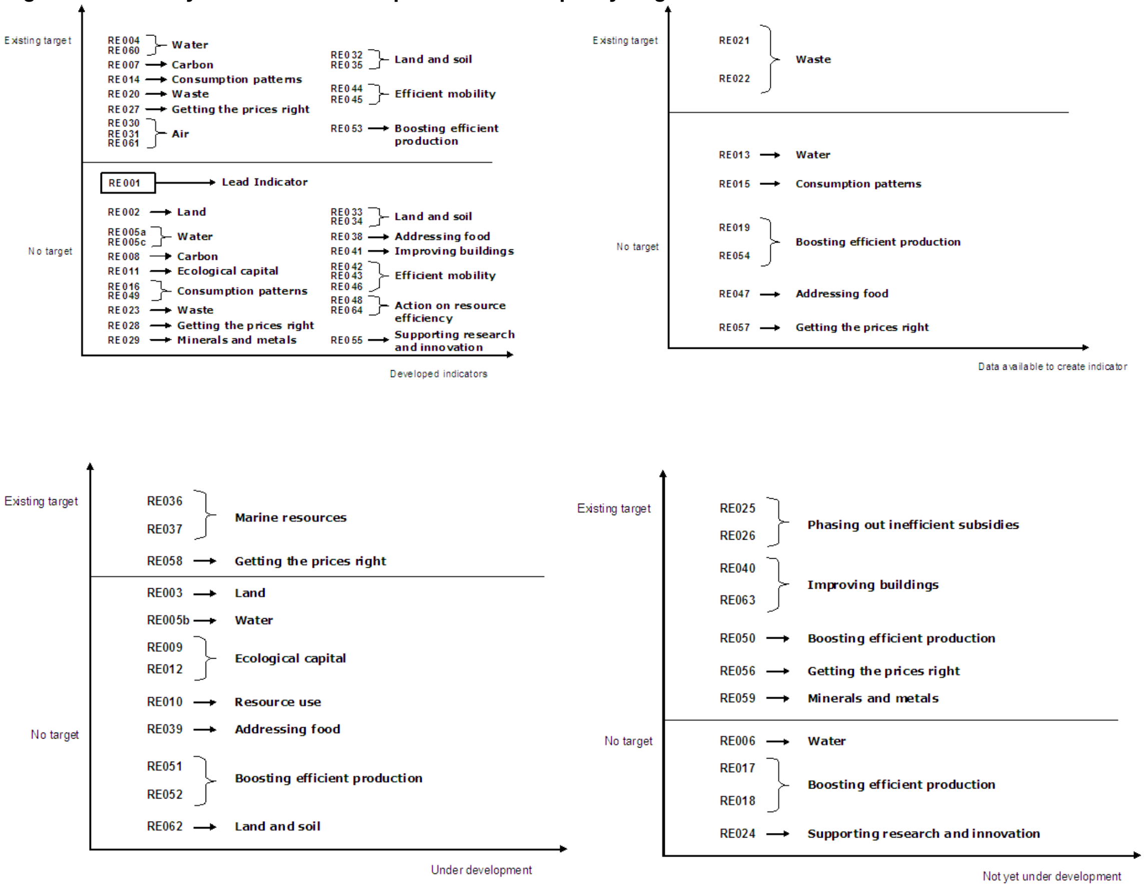
This study identified and assessed 66 resource efficiency indicators, detailed factsheets for each have been provided separately. The following key points can be drawn from our indicator analysis:

- **Over half (55%) of the indicators are currently available:** with a solid basis of data and standardised methodology. A further 20% of the indicators are under development mainly by the EEA, ESTAT and a few by other organisations such as the Joint Research Centres, Wuppertal Institute, OECD and the Water Footprint Network;
- **EEA and Eurostat are the primary data sources for the indicators:** providing 42% and 35% of the data respectively. Private sources and other organisations play a lesser role in data;
- **Air, mobility, land and soil and carbon have a solid indicator base for nowcasting:** indicators are already developed in each of these areas. Water and waste are also developed, but to a lesser extent;
- **Less is available for efficient production, marine resources, ecological capital, environmentally harmful subsidies and improving buildings:** indicators are mostly partial, under-development or not yet under development.

The following figure provides a summary of indicator development and also the existence of a policy target for the indicator. Each code (e.g. RE004) represents a single indicator. The main report contains the references for each of these indicators.

[1] Com(2009)433.
[2] http://eur-lex.europa.eu/Notice.do?checktexts=checkbox&val=499855 (11 January 2011).

Figure 1: Summary of indicator development and their policy targets



Further analysis can be found in chapter 1 of the main report, alongside suggestions on how the indicator factsheets could be digitised and updated.

Nowcasting and early estimate potentials

This part of the study developed and applied a method to assess the potential to produce early estimates (EEs) and nowcasts (NCs) for the indicators. This involved the application of a screening method to reduce the 'long list' of more than 60 indicators to a shorter list of just 16. We then assessed alternative methods to produce EEs and NCs for these indicators, as shown in Figure 2 below.

Figure 2: Initial screening approach

In the initial screening (our high-level assessment), we reduced the long list of indicators to a shorter list based on whether it appeared feasible, in principle, to generate EEs and/or NCs for each indicator. Our criteria for the high-level assessment were:

- whether data for the REI are already being collected and published (if the status of the indicator is currently that it is ‘under development’, it is not currently feasible to develop EEs/NCs for it);
- whether we can identify some predictors available from some existing data source that is available at an earlier date than the official REI data and which is, in principle, likely to show movements over time that are similar to those of the REI.

We then assessed alternative candidate methods to construct EEs and/or NCs for the indicators on the short list. Depending on the availability of the necessary predictor data, some methods were considered suitable to produce EEs only; in other cases, it appeared possible for both EEs and NCs to be produced. We note the suitability of the different methods in this context in our detailed assessment in Annex C.

Our chosen elements of *quality* with which to assess the candidate methods drew on a review of existing criteria in use by various agencies to assess the quality of the statistics and indicators that they themselves publish. For the purposes of this current assessment, we chose to focus on the two following criteria to gauge the ‘value added’ of a method:
- its likely accuracy in predicting the official data;
- the improvement in timeliness that the EE would represent compared with the official data.

We combined these two measures into a single criterion, value added, as shown in Table 1:

Table 1: Combining timeliness and accuracy into a measure of value added

	Number of years by which the published series is extended	1	2	3
Accuracy				
Low		Low	Low	Medium
Unknown		Low	Medium	Medium
Medium		Medium	High	High
High		High	Very high	Very high

The assessment of accuracy was *a priori* and depended on an assessment against the questions: to what extent is the predictor determined by the same forces as the REI, or to what extent does the predictor itself determine the REI? Once an EE method has been selected for implementation, it would be possible to test *empirically* how well, in practice, it predicts outturns for the REI, but that was not within the scope of the study. Consequently, it was not always the case that we were able to comment on the likely accuracy of a method. In such cases, we rated the accuracy as ‘unknown’ and considered it, for now, more promising than a method of *known* low accuracy.

With regard to timeliness, for each of the methods we assessed, we also provided some indication as to *when* in the year it might be possible to produce a reasonable EE or NC. For example, in the case of monthly predictors, it may be the case that data for the first six months might provide enough information on which to base an NC. If the monthly data are published at T+3 months, we thus note in our assessment that an NC could be produced in September (Month 9) of the year.

The cost of implementation is based on judgement as to the work that would be required to develop (and subsequently maintain) an EE method. Once the method has been implemented, those estimates of the work required can, of course, be improved, but here we are concerned with what can inform a decision whether or not to proceed with implementation. In our cost estimates we use the categories ‘low’, ‘medium’, ‘high’ and ‘prohibitively high’. By ‘low’ cost, we mean that a budget of up to 50 person days should be sufficient to develop the indicator. By ‘medium cost’ we mean that 50-100 person days will be required. By ‘high’, we mean that 80-100 person days plus some purchase of external data will be required.

An example assessment: Economy-Wide Material Flow Accounts

As an illustration of our assessment method, we developed methods to project DEU and DMC (which are related, by accounting identity, through Imports and Exports). Chapter 4 details the full and final method to produce EEs and NCs for EW-MFA variables. For the illustration here, we simply compare two broad methods, one of which follows the recommendations of Agilis (2011)[3], which follow quite closely the methods used to construct the final EW-MFA indicators, and the second of which is less data-intensive and uses predictors that measure ‘production’ or ‘demand’ for materials.

Table 2: Example EE & NC assessment for EW-MFA

		Requires more recent:		Value added			May help detect a change in trend?	Suitable for
		Economic data?	Materials data?	Expected accuracy	Improvement in timeliness	Cost		
1	Recreate DEU using the same methods used when constructing the published indicators	N	Y	High	High (from T+21 months to T+9 months)	High (prohibit-ively so)	Y	Monitoring, Analysis
2	Estimate DEU/DMC using production/ demand predictors	Y	N	Medium	High (from T+21 months to T+10 months)	Low	Y	Communication, Monitoring

The timeliness of EW-MFA data

As previously mentioned, we divide value added into two components: timeliness (the value of updating a particular REI in terms of the number of periods gained) and accuracy (the precision with which the methods predict the underlying indicator).

At present, material flows data are three years behind in terms of their availability i.e. in 2012, the most recent year of material-flows data is 2009[4]. Thus, the estimation of EW-MFA data could yield up to three years of additional data, which would allow the production of:

- Two EEs (for two previous years);
- One NC (for the current year).

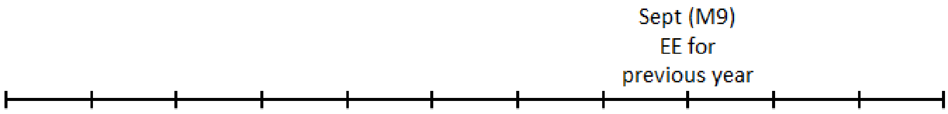
Method 1: Recreate DEU using the same methods used when constructing the published indicators

In the case of EW-MFA data, one candidate dataset to inform estimates of domestic extraction is the US Geological Survey (USGS), which reports world mine production by country based on information aggregated from a wide range of sources including government publications, company

[3] Agilis (2011), ‘Methodology for the now-casting of Material Flow Accounts’.
[4] A small number of Member States have provided figures for 2010.

reports and academic articles. In fact, the EW-MFA compilation guidelines actually recommend the USGS as one source of input data into the official EW-MFA for metal ores and non-metallic minerals. The predictors (from the USGS) and the REI (European EW-MFA) are influenced by the same factors because they are measures of the same quantities, both in principle and in practice. This is an example of a direct relationship between an REI and an alternative dataset, on practical grounds.

However, depending on the time of year when new estimates are required, the USGS data may not extend the REI series by very much. The USGS data become available at around T+9 months: before that month, there are only data to estimate the period two years before the current one, whereas, after that month, there are now data to estimate the previous year (improving the timeliness of the data by 12 months, from T+21 months to T+9 months) as we illustrate in the timeline below:



As a reproduction of the compilation method recommended by Eurostat, the expected accuracy of this method is 'High'. By our value-added criterion, a High accuracy method that brings the series up to date by one or two years offers high value added. However, the compilation process is laborious, involving substantial data extraction and processing; therefore the method is 'High' in cost; so high, in fact, that it is difficult to recommend this method as suitable for a regular EE.

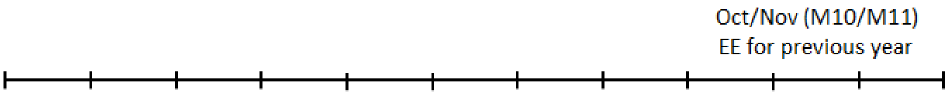
Material-flow data compiled by this method is about as detailed as is possible and the method thus produces indicators suitable for analysis. Owing to the high level of accuracy of the method, the indicators are somewhat suitable for monitoring, although the lack of timeliness limits their usefulness for this purpose and, rules out the method for communication purposes.

Method 2: Estimate DEU/DMC using production/ demand predictors

In the case of EW-MFA, the supply-side approach of Method 1 relies on other data that are influenced by the same factors as the REI because the two datasets measure the same quantity. There is a direct relationship between the two. An alternative approach could begin by estimating domestic consumption using indicators for demand (e.g. using construction output measured in real, inflation-adjusted, terms) as an indicator for the demand for building materials) or estimate domestic extraction using indicators of production. In the case of the consumption method we are relying on a relationship, derived from theory, between activity in one or more key sectors and their use of materials. In the case of the production method we are relying on the use of an indicator that measures a concept related to the EW-MFA REI (how close the relationship is depends on how precisely the indicator comes to the EW-MFA REI in definition). This method fares better in terms of timeliness because it relies on frequently-updated economic and production data (and nowcasts for those indicators, supporting construction of NCs for the REI).

The value added of the method is high because it combines medium accuracy with an extension of 2-3 years. The cost of this method is quite low (it requires the predictor series to be gathered and the model-based estimation to be applied). The production-based method is capable of detecting a change in trend, although if the user's interest focused on resource productivity (value added per unit of materials used) then the consumption-based approach would not detect a change in trend.

Annual economic data become available 10-11 months after the period they refer to (i.e. T+10/T+11 months) and, consequently, it is possible to produce an EE for the previous year in October/ November of each year. This is not a substantial loss in timeliness relative to Method 1, especially because of the lower associated cost:



Because they have some empirical content that goes beyond pure extrapolation, and because they are capable of producing timely indicators, the two kinds of approach used in Method 2 are deemed suitable for communication and monitoring, but because they include some element of model-based estimation, there is a penalty in terms of accuracy and they are not suitable for analysis.

Further analysis and examples can be found in chapter 2.

Prioritising indicators for nowcasting

This part of the study sets up a priority list for indicators to be EEed and NCed based on a transparent methodology and criteria. The methodology chosen is a “three-dimensional ranking system”, which plots two dimensions, value added of an EE/NC method and cost of implementation, on x- and y-axis. The third dimension, policy relevance, is represented by a point size characteristic (bubble size). The selection of indicators to be prioritised as well as their scoring on value added and costs are based on the results reported in Chapter 2 - nowcasting and early estimates potentials.

Method & criteria

Each dimension has a scoring system from 0-10 (where 10 is the highest score), with a score assigned to each category ranging from ‘low’ to ‘very high’ (including ‘none’), for example ‘very high’ value added receives a score of 10. Each indicator then receives a score on these three dimensions out of 30 possible points. Assessed indicators and their potential methods are thus ranked based on their total scores, and visually represented on a graph.

The two dimensions are:

1. X-axis – cost – this is cost of implementation of an EE/NC method and its maintenance. The categories range from ‘none’ to ‘very high’ cost;
2. Y-axis - value added of EE/NC.- this dimension scores indicators according to the benefit incurred through nowcasting or early estimates in terms of gained timeliness as well as accuracy of such a method. The categories range from ‘none’ to ‘very high’ value added.

The size dimension is:

3. Policy relevance – this dimension is based on the existing categorisation of indicators in the RERM, i.e. lead indicator, dashboard and thematic indicators. Additional indicators not included in the RERM are categorised as supplementary indicators. The categories hence range from ‘lead’ to ‘supplementary’.

Results

Applying this method and criteria, the following results were obtained (for more detail see Chapter 3):

- *The four indicators ranked first in the priority list to be EEed or NCed are*:
  - Water Exploitation Index (%);
  - GHG emissions (Method 1);
  - Carbon footprint;
  - CO_2 emissions in the transport sector ($MtCO_2$) (Method 1).

The first three scored high on policy relevance dimension (all belong to the dashboard), they had medium/high – high value added and low to low/medium cost. The last of the four indicators belongs to the thematic indicators for transport (scoring medium on policy relevance), but had high/very high added value and low cost. This result is not very surprising given three out of four indicators are related to CO_2 emissions, whose statistics are well documented and highly politically relevant, hence the priority to be EEed or NCed:

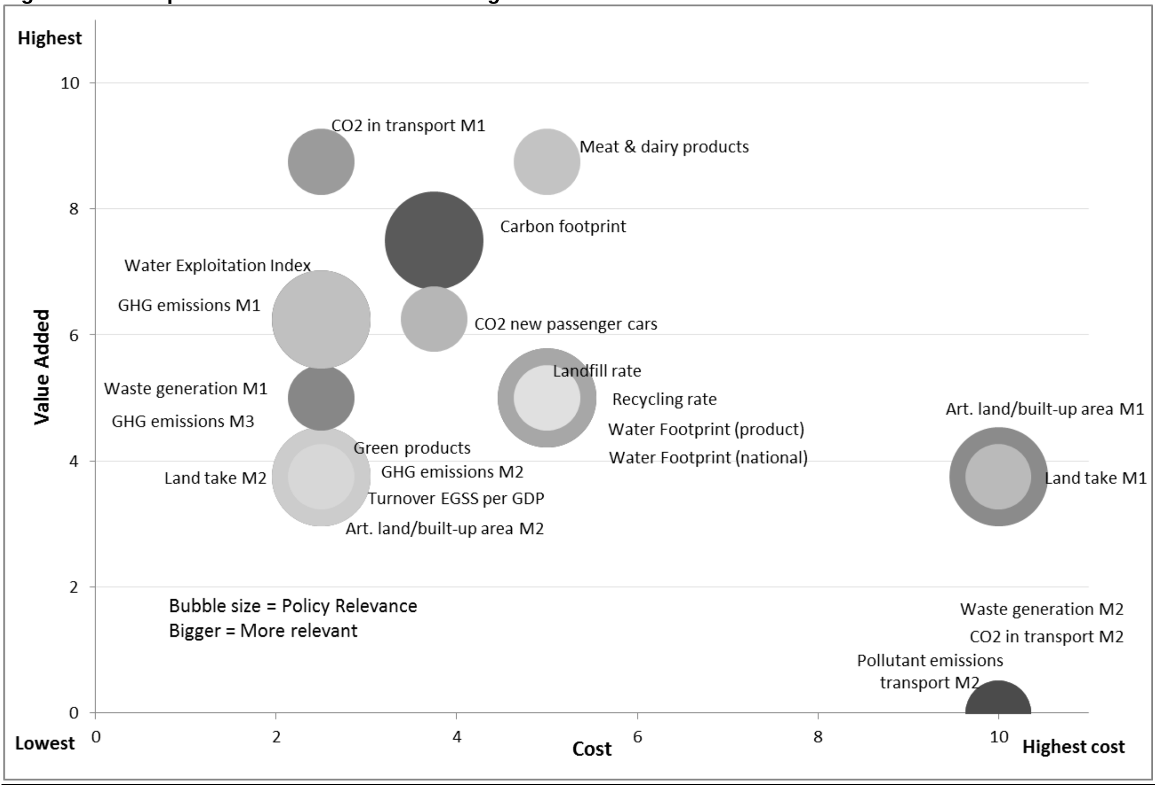
- The Lead indicator, Resource Productivity would rank only the 8th on the priority list for EE/NC, if this method and criteria were applied.

This relatively low score is mainly due to the high cost of producing and maintaining timely data for this indicator, as well as its medium value added compared to current timeliness and accuracy of this indicator. The fact that EE/NC methods are being applied to this indicator within this study shows the importance of political relevance. Rank 8 is shared with two indicators on water footprint, total waste generation and average CO_2 emissions per km for new passenger cars:

- Artificial land or built-up area would score the 6th on the priority list due to its high policy relevance, low/medium value added and low cost of method 2. Rank 6 is shared with the indicator measuring the development in consumption of different meat and dairy products, which has medium policy relevance and cost but high/very high value added;
- Waste indicators related to overall recycling rate and landfill rate are the second last on the priority list to be EEed or NCed due to their medium scores for all three dimensions;
- The last indicator according to this method and criteria to be EEed or NCed is the additional indicator to the RERM on the turnover from environmental goods and services sector per GDP mainly due to its low policy relevance and low/medium value added compared to current timeliness of this indicator.

Figure presents visually the rankings of all indicators. The size of the bubble indicates policy relevance, with a large size illustrating higher relevance.

Figure 3: Visual presentation of indicator ranking

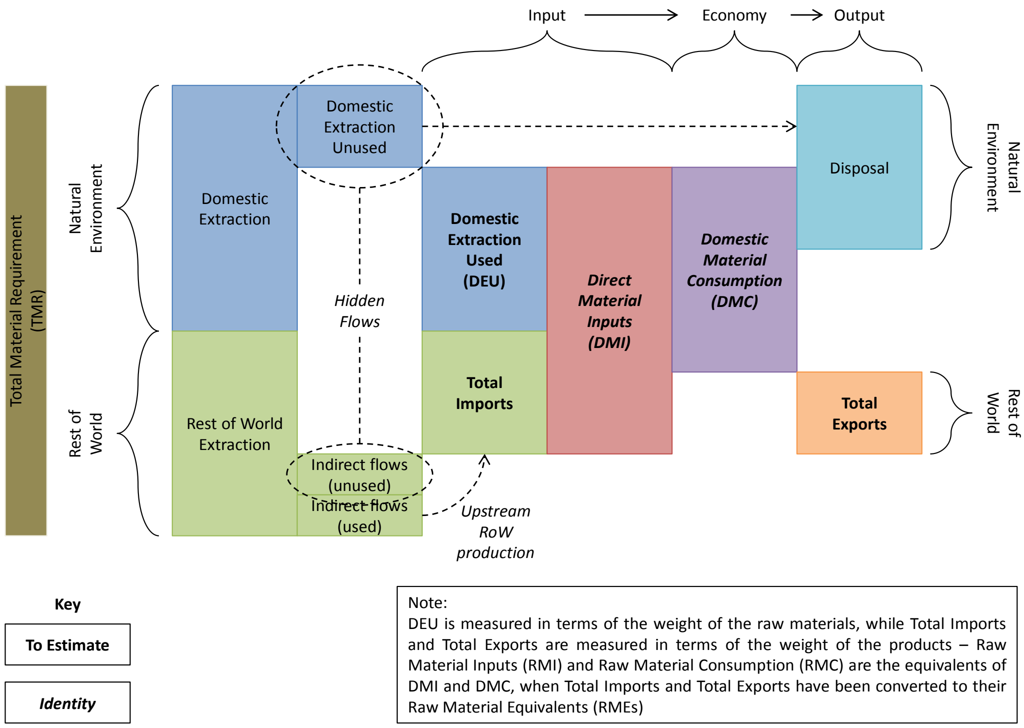


Source: Cambridge Econometrics assessment and Ecorys own calculations.

Nowcasts of material flow indicators

The following figure shows the accounting structure of the Material Flow Accounts and shows the relationship between the indicators.

Figure 4: Accounting structure of the Material Flow Accounts



Our approach to constructing EEs/NCs is:

- distinguish the main different materials that are covered in the MFAs;
- for each material:
  - identify suitable predictors for Domestic Extraction Used (DEU) and Domestic Material Consumption (DMC);
  - for each Member State, estimate simple econometric relationships for these two indicators and their predictors;
  - review the results and choose, for each Member State and material, a preferred equation (which predicts either DMC or DEU);
  - construct estimates of imports and exports from the COMEXT trade data;
  - derive the EE/NC for the indicator for which an equation was *not* chosen (either DMC or DEU) from the accounting identity;

    DMC = DEU + imports - exports

  - construct estimates of the indicators that include 'hidden flows' by applying coefficients to gross up from the extraction, consumption and trade EEs/NCs.
- aggregate across materials to obtain estimates for 'total materials';
- aggregate across Member States to obtain estimates for EU27.

The following table shows the predictors for DEU and DMC for groups within the MFAs. The choice of predictors balances the need for an indicator that is closely related to the material of interest, with the need for an indicator for which data are likely to be available in a reasonably timely manner (including forecasts/nowcasts). All of the predictors shown in the table are available less than a year after the end of the calendar year to which they refer (that is, their timeliness is better than T+12), and in some cases there are monthly data which can inform a nowcast for the current year.

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
MF11-12	Crops and crop residues	22.0	7.6	Agriculture value added (cvm[5])	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), Sector A01	T+3 (March)	Eurostat Agricultural Production Data (Harvested production:1000s tonnes)	Crops Production Database (apro_cpp_crop). Crop codes: C1040, C1360, C1390, C1370, C1300, C1410, C1500 Fruits and Vegetables Database (apro_cpp_fruveg). Crop codes: C2230, C2450, C1610, C1660, C1750, C1761, C1766, C1780, C1790, C1799, C1800, C1885, C1910, C1920, C2992, C1771, C1777, C2090, C2095, C2170,	T+4 (April)

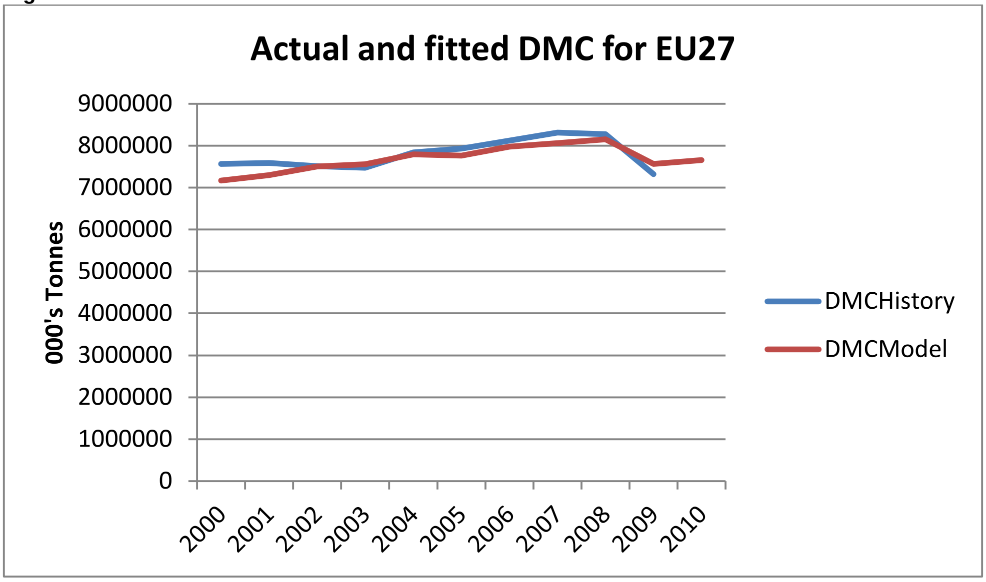
[5] 'Chained volume measure': a measure which adjusts for the effects of price changes and which therefore should correspond to the physical use of materials.

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
								C2250, C2260, C2270, C2300, C2410, C2993	
MF13	Wood	2.4	6.4	Forestry value added (cvm)	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), Sector A02.	T+3 (March)	Forestry production data	Eurostat database: for_remov. All species of tree, roundwood, under bark, thousands of cubic metres.	T+11 (November)
MF21-22	Metal ores	2.3	14.0	Basic metals value added (cvm)	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), sector C24.	T+3 (March)	Production volume ('000 tonnes) for selected detailed product codes	PRODCOM Codes: 07101000, 07291100, 07291200, 07291300, 07291400, 07291500, 07291900.	T+7 (July)
MF3	Non metallic minerals	47.2	5.0	Construction value added (cvm) or Construction production	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), sector F.	T+3 (March)	Production volume ('000 tonnes) for selected detailed product codes	PRODCOM Codes: 08111133, 08111136, 08121250, 08111233, 08111236, 08111290, 08121290, 08113010, 08911100, 08113030, 08114000, 08931000, 08112050, 08112030, 08121190, 08122140, 08122160, 08122210,	T+7 (July)

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
								08122230, 08122250, 08121210. 08121230.	
MF41	Coal and other solid energy materials/carriers	10.1	3.4	Gross inland consumption of solid fuels ('000 tonnes of oil equivalent).	Eurostat database: tsdcc320. Total solid fuels.	T+11 (November)	Eurostat Energy Statistics – Solid Fuels	Eurostat database: nrg_101a. Primary production of all solid fuels (product code: 2000) in 1000s tonnes.	T+11 (November)
MF42	Liquid and gaseous energy materials/carriers	15.4	2.5	Gross inland consumption of petroleum products ('000 tonnes of oil equivalent) plus Gross Inland Consumption of Natural Gas ('000 tonnes of oil equivalent).	Eurostat database: tsdcc320. Total petroleum products plus total natural gas.	T+11 (November)	Eurostat Energy Statistics – Liquid and Gaseous Fuels ('000 tonnes).	Eurostat Energy databases, (nrg_102a, nrg_103a). Primary production (B_100100) of total petroleum products (3000) and total gas (4000). Gas converted from TJ (GCV) to 1000 tonnes using conversion factor = 1/50.	T+11 (November)

Because equations are estimated for each of DMC and DEU for each MFA group and for each Member State (data permitting), there are over 300 equations. Where there two equations (one for DMC and one for DEU) available, the equation with the better record in predicting past changes is retained for use in forming EEs and NCs. While some equations (for particular materials in particular Member States) are not sufficiently accurate for their predictions to be published separately, taken together the system produces reasonable results for the EU as a whole. The prediction for DMC for EU27 is compared with the historical data in the following figure. It can be seen that the model correctly captures the sharp downturn in 2009.

Figure 5: Actual and fitted DMC for EU27



Further analysis can be found in chapter 4.

Indicators, targets and sustainability thresholds

This part of the study assessed the suitability and feasibility of setting targets for each of the identified indicators, based on environmental sustainability thresholds (ESTs) stemming from science and/or good management practices of the resources in question. ESTs are not only useful for target setting, but also for estimating the size of the potential environmental problem, level of actions to be taken, and reference values in benchmarking exercises to name a few. The RERM, beyond GDP Communication, other policies and many stakeholders call for target setting for various environmental and resource efficiency indicators. Target setting that takes into account the relevant political, economic, social and environmental factors is essential so that the indicators to measure progress can be put to practical policy use to encourage greater resource efficiency.

Thresholds in the literature

A literature review was carried out, reviewing various work in this area such as that carried out by Rockstrum[6], Bringezu[7] and others, to identify the most important scientific and good management environmental thresholds relevant to the indicators. The following list highlights the most important

6 Rockström et al, 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society 14(2): 32. and Rockström et al, 2009. A safe operating space for humanity. Nature, Vol 461|24 September 2009.

7 Bringezu, 2011. Key Elements for Economy-wide Sustainable Resource Management. Responsabilité & Environnement N° 61 Jan. 2011.

areas where scientific and management derived thresholds that were identified (full details can be found in chapter 5):

- **Water use (quantity);**
- **Ocean acidification;**
- **Maximum sustainable yield of fish stocks;**
- **Global land conversion to cropland;**
- **World biocapacity;**
- **Sustainable amount of protected forest land;**
- **Land use change to biofuels (indirect land use);**
- **Soil degradation and erosion;**
- **Chemical pollution;**
- **Nitrogen cycle;**
- **Phosphor cycle;**
- **Waste management;**
- **Material consumption and productivity.**

The review concluded, that the level of uncertainty is still quite high for individual thresholds, and even more uncertain is the co-causality between them in complex Earth Systems. Often, even though it is clear that there is likely to be a threshold, it is very difficult to find where it is exactly and many systems are so complex that it is impossible to really measure their resilience, whereas an indication of a 'safe operating space', meaning, can we identify how much of a resource can we safely use can be provided based on scientific evidence or established management practices.

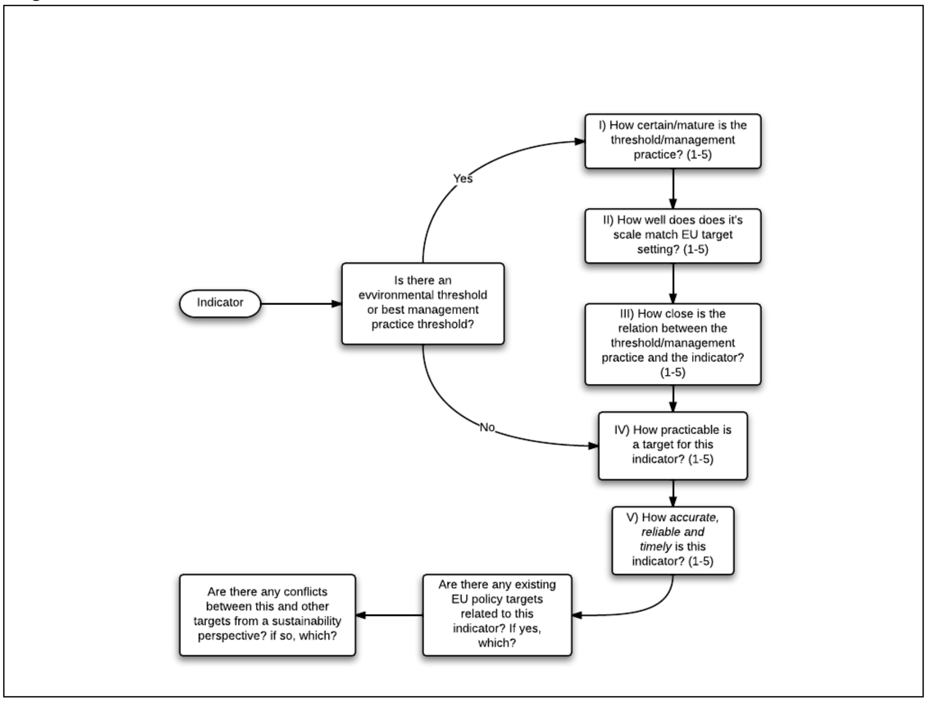
The research on these thresholds and planetary and local boundaries is important to identify critical boundaries[8]. It needs to be kept in mind that these can move over time and as science and technology progresses and therefore the safe or danger zones need to be re-assessed at appropriate intervals. Nevertheless it remains important for policy to have defined 'safe and dangerous zones' for indicator interpretation and around which policy and targets can be set. This is especially true in uncertain cases, as it is important to be alert to dangers before actual tipping points are reached.

Assessing thresholds for the identified indicators

The following method was used to make an assessment of the suitability and feasibility of setting targets for each of the identified indicators. This uses yes/no, and 1-5 scores, the criteria for which are clear and transparent and are set out in the main report:

8 See website of Stockholm Resilience Institute: Tipping towards the unknown.

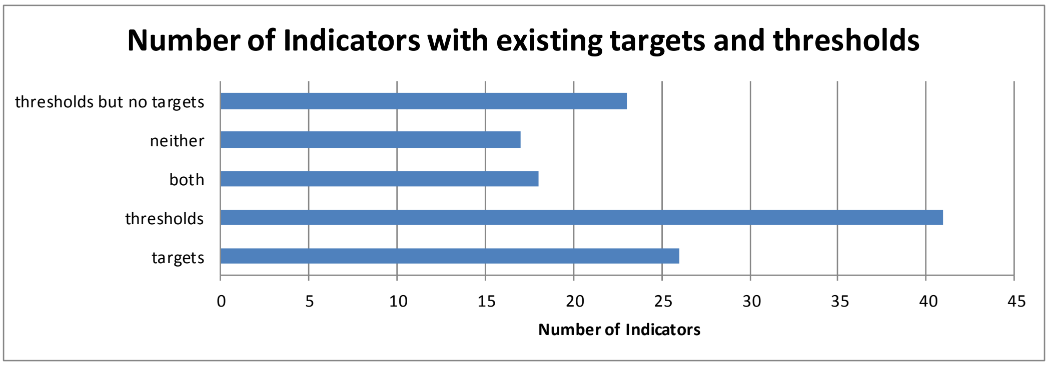
Figure 6: Method to assess thresholds for the identified indicators



Findings

The following provides a summary of the result of the analysis and identifies indicators of particular relevance for target setting or further development.

Figure 7: Number of indicators with existing targets and thresholds



The majority of the indicators are related to environmental sustainability thresholds stemming either from science and/or established management practices, but not necessarily directly illustrating the related threshold.

Approximately one quarter of the assessed indicators is related to neither targets nor thresholds and a similar number had both.

More interesting in the context of this analysis is that 23 indicators *are* related to environmental thresholds or best practices, but *are not* yet related to a policy target. Taking into account the maturity, suitability and relevance to thresholds and the indicator quality only the following 2 indicators were assessed to be reasonable and practicable for additional target setting:

- CO_2 emissions in the transport sector);

- Total energy consumption/km driven as a proxy for energy efficiency in transport).

The following points were also of relevance:

- **Around half of the indicators have poor data quality, three are suggested for prioritization:** A total of 30 indicators were assessed to be of poor quality, 11 of which are associated to a certain/mature environmental sustainability thresholds or management practices. Of these the following 3 were assessed to be particularly practicable and related to existing targets or obligations such that further development could be considered a priority:
  - **RE025 – A6-25** (Annual value of all Environmentally Harmful Subsidies (EHS) provided);
  - **RE026 – A6-26 (**The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate);
  - **RE040 – A6-40** (The rate of nearly zero-energy new buildings).
- **Of indicators with thresholds, over half have mature/certain thresholds:** these are most often climate related. Less mature thresholds are primarily in the areas of material flows and scarcity estimates. Four indicators were assessed to be unsuitable for target setting based on thresholds:
  - **RE010 - A6-10** (Environmental impacts of resource use);
  - **RE045 - A6-45** (Pollutant emissions (NO_x, VOC, PM) from the transport sector);
  - **RE050 - Add2** (Substitution of dangerous chemicals);
  - **RE052 - Add4** (Environmentally weighted material consumption (EMC)).
- **Threshold scales are typically suitable for EU-level policy making:** 25 (of 41) indicators were assessed to be related to thresholds that occur at a scale perfectly suited to the formulation of EU policy targets. Those judged to be poorly suited to EU target setting are related to footprint type indicators. Those moderately suited to EU policy targets deal with material flows and scarcity;
- **Indicators have some, but rarely a direct, relationship to thresholds:** the majority of indicators exhibit at least a moderate relationship with their identified thresholds, but only six have a direct relation. Four have little or no relation to thresholds, with three of these concerned with water scarcity;
- **All indicators have some practicability for target setting:** although over one third of indicators were assessed to measure phenomena that are difficult to influence through policy, primarily because of the number of competing drivers. Of 11 indicators for which target setting was deemed particularly practicable and which are related to a threshold or best practice.

Further analysis can be found in chapter 5 and in related sections of the factsheets that have been supplied in Annex B.

Abbreviations & Glossary

Add	additional
BGS	British Geological Survey
cap	capita
C&D	Construction & Demolition
CO_2	Carbon dioxide
CN	Common Nomenclature
DEU	Domestic Extraction Used
DMC	Domestic Material Consumption
DMI	Domestic Material Inputs
DPSIR	Driving forces, Pressures, States, Impacts, Responses
ECHA	European Chemicals Agency
ECU	European Currency Unit
EE	Early estimates
EEA	European Environment Agency
eHANPP	Embodied Human Appropriation of Net Primary Production
EHS	Environmentally Harmful Subsidies
ELV	End of Life Vehicles
EMC	Environmentally weighted material consumption
EPBD	Energy Performance of Buildings Directive
EPUE	Ecosystem Potential Unit Equivalents
EST	Environmental sustainability thresholds
ESTAT	Eurostat
ETC	European Topic Centre
EW	Economy-Wide
gCO_2	Grams of carbon dioxide
GDP	Gross Domestic Product
GFN	Global Footprint Network
gha	Global hectare
GHG	Greenhouse gas emissions
GJ	Giga joule
Go4	Group of 4 (ESTAT, DG ENV, EEA, JRC)
GVA	Gross Value Added
ha	hectare
HS	Harmonised system
IMF	International Monetary Fund
IOT	Input-Output Tables
JRC	Joint Research Centre
$ktCO_2e$	Kiloton of carbon dioxide equivalent
kWh	Kilowatt hour
LUCAS	Land cover and land use, landscape
MF	Material Flow
MFA	Material Flow Accounts
MFI	Material Flow indicator
MPA	Marine Protected Areas
MS	Member State

MSY	Maximum Sustainable Yield
$MtCO_2$	Metric Tonne Carbon Dioxide Equivalent
NAS	Net addition to stock
NC	Nowcasting
NECD	National Emission Ceilings Directive
NO_x	Nitrogen oxide
PESERA	Pan-European Soil Erosion Risk Assessment
PgC	Petragrams of carbon
PM_{10}	Particulate Matter
ppm	Parts per million
PR	Policy relevance
PTB	Physical Trade Balance
PWC	Pricewaterhouse coopers
RACER	Relevant, accepted, credible, easy to monitor, robust
RE	Resource efficiency
REI	Resource efficiency indicator
RERM	Roadmap for a Resource Efficient Europe
RMC	Raw Material Consumption
RME	Raw Material Equivalents
RMI	Raw Material Inputs
RoW	Rest of the world
RP	Resource Productivity
RUSLE	Revised Universal Soil Loss Equation
SCP	Sustainable Consumption & Production
SRI	Sustainable and Responsible Investments
SVHC	substances of very high concern
T + number	Time + number
TMC	Total Material Consumption
TMR	Total Material Requirement
TOE	Tonnes of oil equivalent
UDE	Unused Domestic Extraction
USGS	US Geological Survey
µg	microgram
VOC	Volatile Organic Compounds
WEEE	Waste Electrical and Electronic Equipment Directive
WEI	Water Exploitation Index
WFD	Water Framework Directive

Introduction

Context of study

Resource efficiency is a key objective for the European Union and increasingly important in this era of increasing resource prices, environmental pressures and global competition. The Roadmap for a Resource Efficient Europe (RERM)[9] sets out the importance of this and the steps that will be taken to become more resource efficient. A critical element of this plan is measurement, to be able to quantitatively understand, communicate and measure progress against visions, objectives and – if agreed – on targets, yet there are several problems with measurement. Currently, several of the proposed indicators remain under development and further work is needed to introduce them, in some others coverage is partial over time or country.

This issue of a need for improvement of 'timeliness' of indicators has previously been recognised in the European Commission Communication "GDP and beyond: Measuring progress in a changing world" on 20 August 2009.[10] This communication set out a beyond GDP roadmap with five key sets of actions and also stressed the importance of having timely indicators for evidence based policy making.

This study should help policymakers improve the timeliness of the more complete indicators, which sometimes lag behind the present day by 2, 3 or 4 years. Significant changes can, and have, occurred in these lag periods, for example indicators charting only to 2009, such as material flow indicators, will show very little of the impact of the financial crisis and economic recession that has hit most of Europe in 2009-2012. It is clear that these physical changes are important in resource efficiency terms and that policy decisions made on the basis of 2009 data could result in poor choices being made. Timeliness of data is particularly important as it enables problems to be recognised at an early enough stage to enable policy makers to make a positive change. Timeliness is also important given the competition for priority on the policy agenda, with priority most often given to the most immediate needs, and these needs being based on recent and compelling data. Data that lags by years from the present does not provide such a compelling case for action, it provides a more compelling case to wait-and-see if the effect or other previous policy may have an impact, this can lead to wasted years and worse than necessary outcomes and increased costs as early action is often more cost-effective. In environmental terms this is particularly important if environmental sustainability thresholds are passed and irreparable damage is done.

These problems are recognized in the RERM as well as in the aforementioned beyond GDP roadmap and this is why producing timely indicators that are robust, easily understandable and widely accepted is an important objective.

> "By 2020 stakeholders at all levels will be mobilised to ensure that policy, financing, investment, research and innovation are coherent and mutually reinforcing. Ambitious resource efficiency targets and robust, timely indicators will guide public and private decision-makers in the transformation of the economy towards greater resource efficiency." (RERM, emphasis by authors).

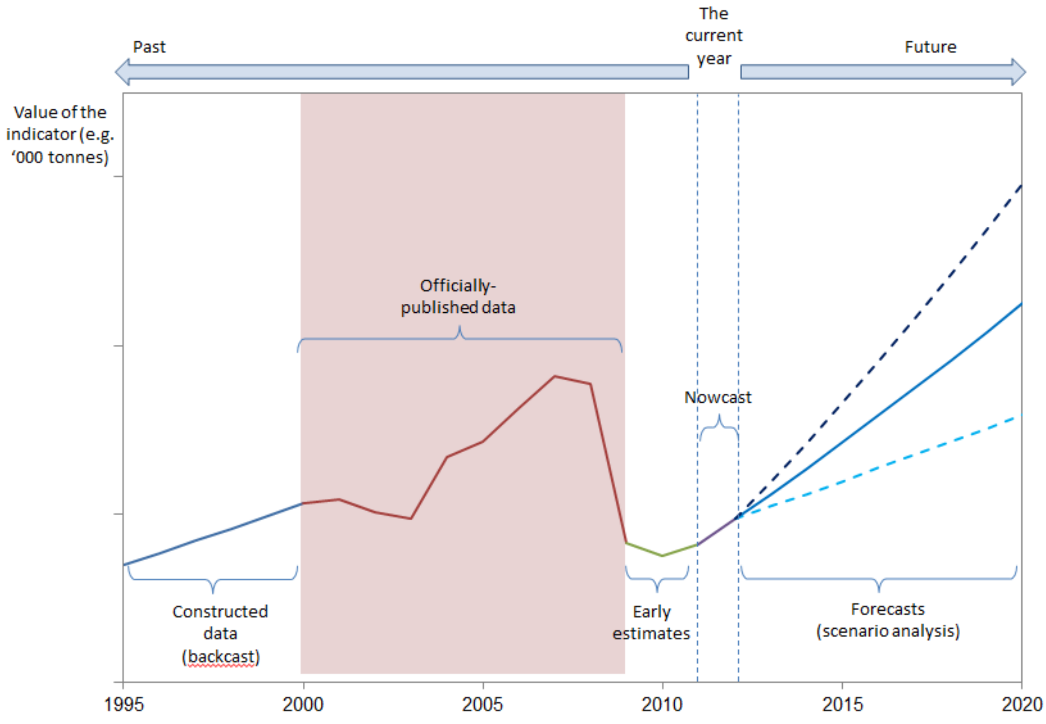
[9] Com(2011)571.
[10] COM(2009)433.

The beyond GDP roadmap also addresses the need to identify thresholds for environmental sustainability. The reason behind it is that "for policymaking it is important to know the "danger zones" before the actual tipping points are reached, thereby identifying alert levels."[11]

This study is intended as a first step in addressing the timeliness of indicators and explores the possibility of setting benchmarks and targets or relate communication and analysis of indicator developments to naturally existing sustainability thresholds while also keeping the other principles of robustness, acceptability and understandability in mind.

Early estimates and nowcasting are emerging techniques that are increasingly being used as a cost-effective way to bridge the gap between the last reported observations of an indicator to the present. The idea is based on using more up-to-date indicators, for example economic indicators such as Gross Value Added or physical production figures, as a predictor for changes in the desired indicator. The idea is to build an intelligent, logical predictive link, for example energy use as a predictor of emissions to air, which can be used to model how the indicator is likely to have moved to the present (the early estimates and nowcasts) on the basis of more recent data. This can give an advantage over simple extrapolation from historical data as, through the predictor variable, it takes account of the real changes that have taken place. Figure 0-1 visualises the concepts used in early estimates and nowcasting.

Figure 5-1: Concepts used in Early Estimates and Nowcasting



Study objectives

Based on this, the **main objective** of this study assignment was to:

- Map the current and potential future availability of resource efficiency indicators; and
- Assess their potential for short-term (early) estimates and "now-casting";
- Environmental Sustainability Thresholds/ target setting.

[11] COM(2009)433.

More **specifically**, the goals were to:

- Set up a priority list for indicators for which short-term estimates and “now-casting” methods should be developed and applied;
- Assess the potential of these selected indicators for target setting, benchmarking, and relation to ESTs;
- Further develop, test and apply short-term estimate and potentially “now-casting” methods for material flow indicators.

Structure of this report

To achieve these objectives 5 tasks were defined in the terms of reference:

1. Map the availability of resource efficiency indicators: this task was to create a map of relevant resource efficiency indicators (REIs), using the base of 40 listed in Annex 6 of the Resource Efficiency Roadmap (RERM) and with ~15-20 further additions on important RE topics. The results of this work are completed fact-sheets for each indicator detailing the key features and attributes of each. These factsheets are supplied as a separate file (Annex B) and a short review is presented in this report in chapter 1;
2. Assess the potential of these indicators for short term (early) estimates and now-casting: this task was to investigate each indicator in task 1 to assess their potential for early estimate (EE) or nowcasting (NC) using relevant criteria such as accuracy, quality, timeliness and cost. This would take into account the benefits over simple trend extrapolation and the trade-offs and synergies that may exist. The assessment is presented in chapter 2;
3. Setting up a priority list for indicators to be early estimated and now-casted: this task was to expand on task 2, to add a dimension for policymakers to prioritise indicators for NC and EE. This was to focus more clearly on the political and analytical usefulness of the EEs and NCs of the indicators. The assessment is presented in chapter 3;
4. Target or benchmark setting according to environmental sustainability thresholds (ESTs): quite separate from the EE and NC work but a crucial step to policy targets and actions. This task was to focus on how suitable the selected indicators were for policy target setting based on environmental sustainability thresholds coming from science or good sustainable management. The assessment is presented in chapter 5, with supporting summary factsheets (separate file);
5. Further develop early estimates and potentially now-casts for material flow indicators: this task was to actually apply the EE and NC methods to a subset of the REIs reviewed in this report: the material flow indicators (MFIs). This was to demonstrate the value of the method compared to trend extrapolation and provide a structure and process that could be repeated by the Commission. The results of this task are presented in chapter 4.

In addition to reporting on these tasks the report contains the following annexes:

- Annex A: Review of a previously-developed nowcasting method for material flow indicators – this summarises a nowcasting method applied on behalf of Eurostat prior to this study;
- Annex B: Indicator fact sheets;
- Annex C: Assessment of nowcasting and early estimates potential.

It is also supplemented by the following supporting documents:

- Excel sheet that can be adjusted on all relevant elements for the final priority list of indicators (chapter 3);
- Excel file that brings together the history and projections for the all Member States and MFA groups from the work done for Task 4;
- Word file with the completed set of evaluation on target setting - a page fact sheet for all the indicators.

Methodology

This study was highly focused on methodological development. Therefore, the main methodological processes are explained in the relevant chapters of the report or as separate annexes when appropriate.

1 Availability of Resource Efficiency Indicators

This chapter provides information on the methodology, implementation and further maintenance of factsheets developed under Task 1. It provides an outline of the issues that undermine data availability and how these could be overcome, with a view to the use of data in now-casting and early estimates and it also discusses and presents a process by which the fact sheets could be updated, together with a potential IT solution to facilitate the process. It is not the purpose of this project to cover the implementation of any such system.

The section concludes with a summary of the main findings on the indicators in terms of their availability, development status, sources of data and indicator information and preliminary findings on environmental thresholds and target setting. The factsheets supplementing this chapter have been supplied separately and are the Annex B to this project report.

1.1 Background

The Roadmap to a Resource Efficient Europe (RERM)[12] is accompanied by the Commission staff working paper[13] "Analysis associated with the Roadmap to a Resource Efficient Europe Part II", which includes in total eight annexes outlining the scientific background in support of the Roadmap. In Annex 6, a set of indicators is presented which are either already – at least partially – available or under development. Their relevance and need is discussed, in parallel with their scope and limitations, in the staff working paper.

1.2 Objectives of Task 1

The purpose of Task 1 was to map the availability of resource efficiency indicators in relation to the RERM and prepare an indicator fact sheet on each indicator identified in order to support decisions related to the other Tasks of the project and to contribute to the discussion on which indicators are most relevant and available to monitor the implementation of the RERM.

The objective of task 1 is to define the basis for the rest of the study, by mapping and selecting the indicators to be analysed and then building up a clear picture of the indicators timeliness, frequency, length of time-series and availability. By producing factsheets for each indicator this task also produces a database of the attributes of resource efficiency indicators, which will be of use in later tasks and beyond the bounds of this study. The fact sheets do not repeat information available from other metadata sources, but link to them as appropriate.

1.3 Methodology for indicator identification

In order to identify the indicators needed to measure the progress of the Roadmap to a Resource Efficient Europe, all the indicators already introduced in Annex 6 had to be taken into consideration. The preliminary lead indicator identified by the Commission, "Resource Productivity" (GDP/DMC expressed in euro/tonne), is accompanied by a dashboard of complementary indicators along with

12 COM(2011) 571 final.
13 SEC(2011) 1067 final.

a selection of specific thematic indicators deriving directly from the different thematic sections of the Roadmap.

After mapping and including all the indicators of Annex 6 into the indicator list for the Commission and in order to make sure that no aspect of the Roadmap is overlooked, a complementary screening of the RERM was deemed necessary.

This screening suggested that there was a case for the possible inclusion of some additional relevant indicators, which derived directly from the RERM text and could be considered as additions to the existing set of indicators presented in Annex 6.

The list of indicators produced by our consortium was reviewed and complemented by DG Environment, resulting in a final list of indicators to be put forward for implementation.

The indicators selected for factsheets were selected on the basis of their inclusion in the RERM and its annexes. Implicit within this was an assumption that the areas of highest policy importance and need for indicators were identified and highlighted in the RERM. Additional indicators were also selected based on consultant and client judgement. Important quality criteria and descriptors to be covered by the factsheets were:

- Policy relevance – links;
- Scale – geographical;
- Type – e.g. production, lifecycle, DPSIR, EEA;
- Current status – development, implemented?
- Quality – as understood by timeliness, frequency, length of time-series and data availability.

In total, a list of 64+2 indicators has been prepared in cooperation between the Consultants and the Commission. The final list comprises of indicators derived directly from the Annex 6 including 48 (with an ID from [Resource Efficiency] RE 001 A6-1 to RE048 A6-48, including 3 sub-indicators on RE005 A6-5 Water footprint) plus an additional set of 16 indicators (with an ID from RE049 Add1… RE064 Add16) complementing those. The following table presents these indicators.

Table 1-1: Final list of indicators

Internal ref. No.		Indicator name	RERM reference	Unit
RE001	A6-1	Resource Productivity (GDP/DMC)	Lead Indicator of RERM	EUR/tonne
RE002	A6-2	Artificial land or built-up area	Dashboard complementary to the Lead Indicator (land)	km²
RE003	A6-3	Indirect land use / embodied land for agricultural and forestry	Complementary to the Lead Indicator (land)	km²
RE004	A6-4	Water exploitation index (WEI, %)	Complementary to the Lead Indicator (water)	% (based on m³)
RE005	A6-5a	Water footprint NATIONAL LEVEL	Complementary to the Lead Indicator (water)	m³
	A6-5b	Water footprint COMPANY LEVEL	Complementary to the Lead Indicator (water)	m³
	A6-5c	Water footprint PRODUCT LEVEL	Complementary to the Lead Indicator (water)	various units depending on the product (e.g. m³/tonne, m^3 /GJ, etc.)
RE006	A6-6	Embodied water (under development)	Complementary to the Lead Indicator (water)	m³/tonne
RE007	A6-7	GHG emissions (Kyoto basket + Fluorinated gases)	Complementary to the Lead Indicator (carbon)	tonnes of CO_2-eq
RE008	A6-8	Carbon footprint	Complementary to the Lead Indicator (carbon)	tonnes of CO_2-eq
RE009	A6-9	Natural ecological capital (under development)	Complementary to the Lead Indicator	Ecosystem Potential Unit Equivalents (EPUE)

Internal ref. No.		Indicator name	RERM reference	Unit
			(ecological capital)	
RE010	A6-10	Environmental impacts of resource use (under development)	Complementary to the Lead Indicator (environmental impacts of resource use)	impact scores
RE011	A6-11	Landscape Ecosystem Potential (under development)	Complementary to the Lead Indicator (ecological capital)	points from 0-255
RE012	A6-12	Ecosystem Degradation (under development)	Complementary to the Lead Indicator (ecological capital)	points from 0-100, weighted by hectare
RE013	A6-13	Raw Material Consumption (RMC) (under development)	Supplementary to resource use indicators	tonnes
RE014	A6-14	Percentage of the value, and number, of public procurement contracts that include GPP criteria.	3.1.1. Improving products and changing consumption patterns	% (based on EUR or number)
RE015	A6-15	Number and value of green products purchased by households	3.1.1. Improving products and changing consumption patterns	number and EUR
RE016	A6-16	Output or share of green products in total output	3.1.1. Improving products and changing consumption patterns	EUR or % (based on EUR or number)
RE017	A6-17	Proportion of companies using environmental footprint, by sector and size class, within priority sectors, for: measuring, managing and meeting benchmarks	3.1.2. Boosting efficient production	% (based on EUR or number)
RE018	A6-18	Number of companies, by sector and size class, benefiting from advisory assistance from Member States or regional government on improving their environmental performance.	3.1.2. Boosting efficient production	number
RE019	A6-19	Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list.	3.1.2. Boosting efficient production	number
RE020	A6-20	Total waste generation	3.2. Turning waste into a resource	tonnes
RE021	A6-21	Overall recycling rate	3.2. Turning waste into a resource	% (based on tonnes)
RE022	A6-22	Landfill rate	3.2. Turning waste into a resource	% (based on tonnes)
RE023	A6-23	Proportion of secondary raw material used in the EU economy compared to primary raw material (under development)	3.2. Turning waste into a resource	% (based on tonnes)
RE024	A6-24	Number and value of funding (EUR/year) of research and innovation projects promoting mainly resource efficiency and sustainable environmental management, allocated through European financial support programmes.	3.3. Supporting research and innovation	number and EUR
RE025	A6-25	Annual value of all Environmentally Harmful Subsidies (EHS) provided (under development)	3.4.1. Phasing out inefficient subsidies	number of EHS provided and EUR
RE026	A6-26	The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate	3.4.1. Phasing out inefficient subsidies	number of EHS removed and EUR
RE027	A6-27	Environmental taxes as share of total taxes and social contributions	3.4.2. Getting the prices right and reorienting the burden of taxation	% (based on EUR)
RE028	A6-28	Total value of environmental taxes paid	3.4.2. Getting the prices right and reorienting the burden of taxation	EUR
RE029	A6-29	Resource productivity of minerals and metals (GDP/DMC minerals+metals)	4.3. Minerals and metals	EUR/tonne

Internal ref. No.		Indicator name	RERM reference	Unit
RE030	A6-30	Concentrations of Particulate Matter (PM10) in ambient air	4.5. Air	µg/m³
RE031	A6-31	Percentage of urban population in areas with PM10 concentrations exceeding daily limit values	4.5. Air	% (based on area and population)
RE032	A6-32	Average annual land take on the basis of the EEA Core Set Indicator 14 Land take	4.6. Land and soils	km²
RE033	A6-33	Soil erosion on the basis of the EEA indicator Soil erosion by water and the PESERA and/or RUSLE models of the JRC	4.6. Land and soils	tonnes/ha
RE034	A6-34	Soil organic matter levels, e.g. on the basis of LUCAS results	4.6. Land and soils	% (organic carbon content by weight)
RE035	A6-35	Share of contaminated sites on which remediation actions have started in the previous year on the basis of the EEA Core Set Indicator 15 Progress in management of contaminated sites	4.6. Land and soils	various units, (e.g. number of remediated contaminated sites, % of public/private expenses for remediation of contaminated sites)
RE036	A6-36	Share of fish and shellfish populations within safe biological limits	4.7. Marine resources	% (based on population size)
RE037	A6-37	The number and area of Marine Protected Areas (MPAs)	4.7. Marine resources	Number and km²
RE038	A6-38	Development in consumption of different meat and dairy products per capita per year based on ETC/SCP Indicator 13.2 for the EEA	5.1. Addressing food	g/capita/day
RE039	A6-39	Share of edible food waste in households, retailers and catering.	5.1. Addressing food	% (based on kg)
RE040	A6-40	The rate of nearly zero-energy new buildings (under development)	5.2. Improving buildings	% (based on m²)
RE041	A6-41	Energy consumption per m2 for space heating, per dwelling and for total housing stock alongside growth in m2 of living space per capita based on ETC/SCP Indicator 16.1 for the EEA (to be further developed)	5.2. Improving buildings	Tonnes of oil equivalent (TOE)/m² OR [kWh/m²]
RE042	A6-42	CO2 emissions in the transport sector	5.3. Ensuring efficient mobility	tonnes of CO_2-eq
RE043	A6-43	Total energy consumption/km driven as a proxy for energy efficiency in transport	5.3. Ensuring efficient mobility	litres/100 km
RE044	A6-44	Average CO2 emissions per km for new passenger cars	5.3. Ensuring efficient mobility	g/km
RE045	A6-45	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD)	5.3. Ensuring efficient mobility	tonnes and µg/m³ (depending on the pollutant)
RE046	A6-46	Energy consumption by fuel type (transport)	5.3. Ensuring efficient mobility	tonnes oil equivalent (TOE)
RE047	A6-47	Share of total budget spent on the environmental and resource efficiency measures	6.1. New pathways to action on resource efficiency	% (based on EUR)
RE048	A6-48	Capitalisation of 'Core' and 'broad' Sustainable and Responsible Investments (SRI) in Europe (billion/€) based on ETC/SCP Indicator 24.1 for the EEA (to be further developed)	6.1. New pathways to action on resource efficiency	EUR
RE049	Add1	Ecological footprint	3.1.1. Improving products and changing consumption patterns	gha
RE050	Add2	Substitution of dangerous chemicals	3.1.2. Boosting efficient production	number, tonnes
RE051	Add3	Total Material Consumption (TMC)	3.1.2. Boosting efficient production	tonnes
RE052	Add4	Environmentally weighted material consumption (EMC)	3.1.2. Boosting efficient production	impact scores

Internal ref. No.		Indicator name	RERM reference	Unit
RE053	Add5	Energy dependency (all energy sources, incl. renewables, nuclear, electricity (with source split) based on final energy consumption	3.1.2. Boosting efficient production	% (based on energy content)
RE054	Add6	Material dependency	3.1.2. Boosting efficient production and 3.2. Turning waste into a resource	% (based on tonnes)
RE055	Add7	Eco-innovation index	3.3. Supporting research and innovation	
RE056	Add8	External costs – getting the prices right	3.4.2. Getting the prices right and reorienting the burden of taxation	% (based on EUR)
RE057	Add9	Resource prices	3.4.2. Getting the prices right and reorienting the burden of taxation	EUR/tonne
RE058	Add10	Fossil fuel EHS	3.4.2. Getting the prices right and reorienting the burden of taxation	EUR
RE059	Add11	Recycling rates of metals	4.3. Minerals and metals and 3.2. Turning waste into a resource	% (based on tonnes)
RE060	Add12	Nutrient leaking to water bodies	4.4 Water	mg/L
RE061	Add13	Life years lost due to PM 2.5	4.5. Air	years
RE062	Add14	eHANPP	4.6 Land and soils	g Carbon/m²
RE063	Add15	Share (in area) of new and renovated buildings with energy label A	5.2. Improving buildings	% (based on m²)
RE064	Add16	Turnover from env. goods and services sector per GDP	6.1. New pathways to action on resource efficiency	% (based on EUR)

1.4 Indicator fact sheet template

The final version of the fact sheet template developed and used for providing information on each of the indicators listed above is provided below.

The template has been developed from a template used by DG Environment for gathering suggestions for Resource Efficiency relevant indicators from European institutions during late 2010.

Developments have included the following broad changes:

1. Considerable expansion of the template to provide further information that is felt to be essential/useful for a) the remainder of the project in terms of assessing each indicators potential for target –setting and now-casting and b) future use by DG Environment and its data providers, including EEA, ESTAT and the JRC, in assessing the availability and usefulness of each indicator for possible inclusion in a final set of indicators for the RERM;
2. Restructuring of the template into 3 distinct areas a) the indicator definition and relevance b) the current implementation of the indicator and finally c) alternative data sources. The characteristics and uses of each area are discussed in more detail below;
3. Improving the logic and clarity of the template within each distinct area to avoid overlaps and potential misunderstandings.

The template evolved further through an iterative process of trial and error during the collection and input of information for each indicator. Practical use of earlier versions revealed weaknesses and problems which were subsequently corrected. The template shown below is the final version.

INDICATOR DEFINITION AND RELEVANCE	
Internal indicator Number	*Fixed reference number*
Original Indicator Name & Organisation	*As used by the original publisher*
Similar indicators under different name	*As used by other publishers+ links*
Indicator Short name	*Where necessary to aid discussion and communication*
Short Descriptor	*One sentence in simple lay/wo/men's terms describing what the indicator is telling us*
Proxy for	*If relevant, what is this indicator being used as a proxy for?*
RERM reference	*Relevance to the RERM/to what parts of the RERM does this indicator inform on. List particular sections and milestones, but also lead indictor and dashboard*
Original policy link	*The policy to which the indicator was originally directly linked if at all* *+ other relevant policies*
Detailed description	*More technical description of indicator – including link to standard meta data or handbook or ...*
Unit	*Unit of measurement used in the indicator – if indexed, also provide to what year*
Operational scale (tick as many as apply)	*☐EU, ☐Member States, ☐regions, ☐economic sector(s) ☐product (group) ☐other:______________________* *This indicates the functional unit of the indicator.*
Perspective	*Production/territorial perspective☐OR consumption/product perspective ☐ ☐N/A* *Position in lifecycle: ☐Extraction, ☐Production, ☐Transport/distribution ☐Products, ☐Consumption, ☐End of life, --- ☐Full lifecycle, ☐Other_________, ☐N/A* *Position in DPSIR: ☐Driver, ☐Pressure, ☐State, ☐Impact, ☐Response ☐N/A* *Indicator type based on EEA indicator Typology (link):* *☐N/A* *☐Type A - Descriptive Indicator:* *☐Type B – Performance Indicator:* *☐Type C – Efficiency indicator:* *☐Type D – Welfare indicator:*

INDICATOR DEFINITION AND RELEVANCE	
Type of figure	*☐Map only* *☐Map and tabular data* *☐Graph*
Thresholds	*Can the indicator be related to an environmental threshold phenomenon?* *☐No ☐Yes (please specify):*
Target setting	*Has this indicator been used in connection with policy targets?* *☐No ☐Yes: If yes, note both targets and policy document.* *If no, would you consider this indicator suitable for target setting?* *☐No ☐Yes (please indicate):*

CURRENT INDICATOR IMPLEMENTATION	
State of play	*Is the indicator already ☐developed and☐produced and ☐published?* *If at least one yes, fill in the sections below (under CURRENT INDICATOR IMPLEMENTATION)* *☐under development ☐not yet under development* *If either under development or not under development please provide a short description about the current state of play here*
Owner (compiled by)	*Organisation publishing indicator if any*
Indicator location	*Direct link to indicator (or organisation) where possible.* *If no direct link possible, describe step-by-step how to access*
Current geographical Coverage	*- Is the indicator available for all EU-27 Member States individually: Yes/no* *- If not, what percentage of EU-27 is covered – (choose one most relevant)* *___ ☐% total population ____ ☐% total land area* *______☐% total GDP _* *- Is available aggregated at EU-27: Yes/no* *- Is also available in ☐Croatia, ☐Norway, ☐Switzerland, ☐Iceland, ☐Turkey, ☐some or ☐all OECD countries*
Planned geographical Coverage	*To what extent and when will this indicator's geographical coverage be expanded*
Status	*☐ongoing since ____ ☐discontinued since ____* *☐under development and expected by______ with coverage indicated above* *Indicate data years not the years e.g. of the project producing the indicator*

INDICATOR DEFINITION AND RELEVANCE	
Time series	*For the geographical coverage indicated above, what is the currently available time series? Highlight country to country differences. To be shown in a table format: rows: EU28, 27, 25, 15 as appropriate, years in columns, black for available, grey for weak quality, white for missing, black with white dots for EE, half-half for NC, white with black dots for forecasts*
Timeliness	*For the geographical coverage indicated above, the indicator is available _____months after reporting period.*
Periodicity	*Indicator available every _______months*
Contributing data sets	*List of data sets used to compile indicator. With direct links where possible. If no direct link possible, describe step-by-step how to access. This is a starting point for exploring alternative data sets and gauging which, if any, data set is the time limiting factor in delivery of the indicator.*
Collection method	*☐EEA Eionet ☐National stats office ☐Consumer survey, ☐Business survey, ☐Other____________* *☐Mandatory OR ☐voluntary OR ☐paid/purchased*
Remarks/ ongoing development	*comments*
Further Details	*[if necessary, e.g. weblink]*
*ALTERNATIVE DATA FOR INDICATOR – **for internal use***	
replacement for	*For which of the above list of contributing data sets could the following data source act as an alternative or proxy indicator?*
With what	*Name of potential replacement dataset*
Grounds for replacement	*Will typically provide more timely and/or wider geographical coverage*
Data owner	*Organisation publishing data/origin of data source*
Data set	*Direct link to data set / source (or organisation) where possible.* *If no direct link possible, describe step-by-step how to access*
Geographical Coverage	*- Is the indicator available for all EU-27 Member States individually: Yes/no* *- If not, what percentage of EU-27 is covered – (choose one most relevant)* *☐% total GDP ____ ☐% total population ____ ☐% total landcover______* *- Is available aggregated at EU-27: Yes/no* *- Is also available in ☐Croatia, ☐Norway, ☐Switzerland, ☐Iceland, ☐Turkey, ☐some or ☐all OECD countries*
Operational scale	*☐ Member States, ☐ regions, ☐ economic sectors, ☐ product (group), ☐ other: [e.g. grid for maps] This indicates the functional unit of the data.*
Status	*☐ongoing since ____ ☐planned for ____ ☐discontinued since ____ indicate data years*
Time series	*What time series is available for the geographical coverage cited above? Highlight country to country differences? See instructions in section Current Indicator Implementation*
Timeliness	*Indicator available for above geographical coverage____ months after reporting period.*

INDICATOR DEFINITION AND RELEVANCE	
Periodicity	*Data available every ____________ months*
Comments	*remarks and ongoing developments.*
Further Details	*[if necessary, e.g. weblink]*

FACTSHEET META DATA	
Created	*Date*
Author(s)	*Name + organisation*
Last updated	*date*
Author(s)	*Name + organisation*
reviewed	*date*
ENV	*unit + name*
reviewed	*date*
EEA	*unit + name*
reviewed	*date*
ESTAT	*unit + name*
reviewed	*date*
JRC-IES	*unit + name*
reviewed	*date*
JRC-IPTS	*unit + name*

1.5 Contents of the indicator fact sheets

The template's main areas and some individual fields are now described in more detail in order to clarify which type of information was filled in the first time each fact sheet was prepared, to ensure future updates can be made in a consistent manner.

Indicator Definition and Relevance

The information provided in this part of the fact sheet for each indicator should remain relatively fixed over time. It describes the main characteristics of the indicator and its relevance to the RERM; in other words qualities inherent to the indicator.

The second and third fields require some explanation. The field '*Original name and organisation'* refers to the existing indicator which most exactly fits the name and purpose of the indicator as referred to in Annex 6 of the RERM. This is the indicator which is described in detail in the remainder of the fact sheet. Under the field *'similar indicators under different name*' similar but different indicators developed by other organisations are identified but are not described further in the rest of the fact sheet.

For this study, in some cases it was quite clear which indicator was being referred to directly in Annex 6. In other cases it was not so obvious. Where there were several possibilities a decision was made about which should be included in the original name field and described in detail in the remainder of the fact sheet. The one that most closely fits the name and purpose given in Annex 6, as judged by the team, was selected.

For indicators which are yet to be developed the indicator name was taken directly from Annex 6 and no organisation was given as maintainer. In these cases various different indicator development processes by different institutions may be described further down in the fact sheet (see under *Current Indicator Implementation* below).

The '*operational scale*' field should not be misinterpreted as concerning the geographical coverage currently covered by the indicator. Rather this is the scale at which the indicator *is or can* be usefully applied.

The '*perspective'* field includes a number of different elements all of which can be considered as key characteristics of environmental and resource efficiency indicators.

The production/territorial or consumption/product perspective distinction is mostly relevant for environmental pressures or impacts 'caused' or 'induced' by whole economies. For other types of indicators the N/A box should be ticked.

A general rule is that if pressures associated with imports are included and those associated with exports excluded then the indicator takes a consumption perspective. This can also be described as a 'footprint' type indicator. If imports are excluded and exports included then it is taking a production perspective. However, for a few indicators, for example Total Material Requirement, both imports and exports are included.

The second element reflects the life-cycle approach which is increasingly used in resource efficiency and sustainable consumption and production policy. An indicator can be relevant to a single or various different elements of the life cycle/production chain.

The DPSIR and Indicator typology definitions are by now widely understood[14].

For all these elements there will be indicators for which it is not clear which boxes should be ticked or for which a particular characteristic has no relevance: especially economic indicators with no direct environmental dimension. For these cases an N/A box has been provided.

Current Indicator Implementation

In contrast to the Indicator Definition and Relevance area, the information provided under this area has to develop over time. These represent transitional characteristics of the indicators application – not characteristics of the indicator itself.

The first field – *state of play* - is of most importance identifying the current status of the indicator's development. For indicators under development, or yet to be developed, the current state of play is described in some detail including information on different alternative possibilities for development. The remaining fields in this area of the fact sheet are then omitted.

For operational indicators, all the fields are filled in for the indicator named in the *Original Indicator Name & Organisation* field at the top of the fact sheet. The fields are quite obvious and need no further description here.

Alternative Data for Indicator

This area is for use by the project team for the now-casting assessment.

[14] From the EEA: "The EEA assesses the "state" (S) of the environment using the "DPSIR methodology". Namely, the state (S) is the result of specific drivers (D) and pressures (P), positive or negative, which impact (I) the environment. The responses (R) represent the solutions (e.g. policies, investments) for what should then be done to improve or maintain that state." See EEA, 1998. Guidelines for Data Collection and Processing – EU State of the Environment Report. Annex 3.

Some indicators have a number of contributing data sets to allow for their production. These will already have been listed in the field ‘Contributing data sets’ earlier in the Fact Sheet. In such cases there may be alternative datasets which are less appropriate for indicator calculation when looking into the past due to accuracy/robustness issues, but may be collected on a more regular basis and with shorter reporting time lags and therefore better lend themselves to use in now-casting exercises. These may include datasets used for the ‘similar indicators’ identified earlier in the fact sheet.

Where such data sets are identified, they are included here along with information on their source, geographical and temporal availability etc. in the remaining fields in the shaded grey section of the factsheets.

1.6 Methodology for collecting indicator information

The methodology for identification of relevant indicators was described in Section 1.4. This section briefly describes how information was obtained for the identified indicators in order to complete the fact sheet.

The methodology was highly dependent on the status of the indicator.

For operational, maintained and published indicators the process was rather straightforward. Each institution has its own system for hosting and reporting on indicators. However, in most cases, the information necessary for completing the fact sheets could be readily downloaded from the information hosting site.

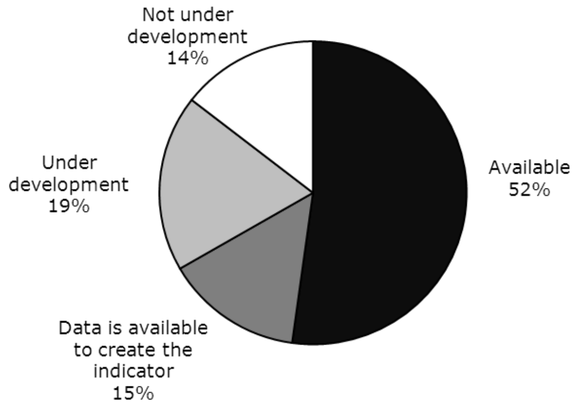
The information that presented most problems was that required: for the ‘detailed description’ field in the first area of the fact sheet, which ideally required links to methodologies and meta-data information; *Contributing data sets* and; *Collection method* for the data sets. Institutions such as Eurostat and EEA have meta data files which detail this information. For indicators hosted by other institutions report(s) could typically be found that described the methodology. Where no information could be downloaded directly from metadata files or reports, direct contact was made with the institution.

Obtaining information on indicators under development was more problematic. Here online and database searches were carried out to identify the relevant research papers and reports related to these indicators. In a number of cases members of the team had earlier been involved in stakeholder consultations during the development of these indicators and therefore, already had the relevant information. Where necessary, direct contact was made with institutions to obtain information on the current status of development of the indicator.

1.7 Findings from the fact sheets - summary on status of indicator development

The status of the indicator development is apparent from the factsheet. Approximately half (52%) of the 66 identified indicators, including the proxy lead indicator and most of the dashboard indicators, are already developed and available. A solid data basis and a standardised methodology are available for these indicators mainly through EEA, ESTAT and a few private organisations such as the Footprint Network. For 15 of the 36 existing indicators, alternative methods or data sets are provided, to consolidate a sufficient data basis for now-casting of the indicators. At the moment 19% of the indicators are under development mainly by the EEA, ESTAT and a few by other organisations such as the Joint Research Centres, Wuppertal Institute, OECD and the Water Footprint Network.

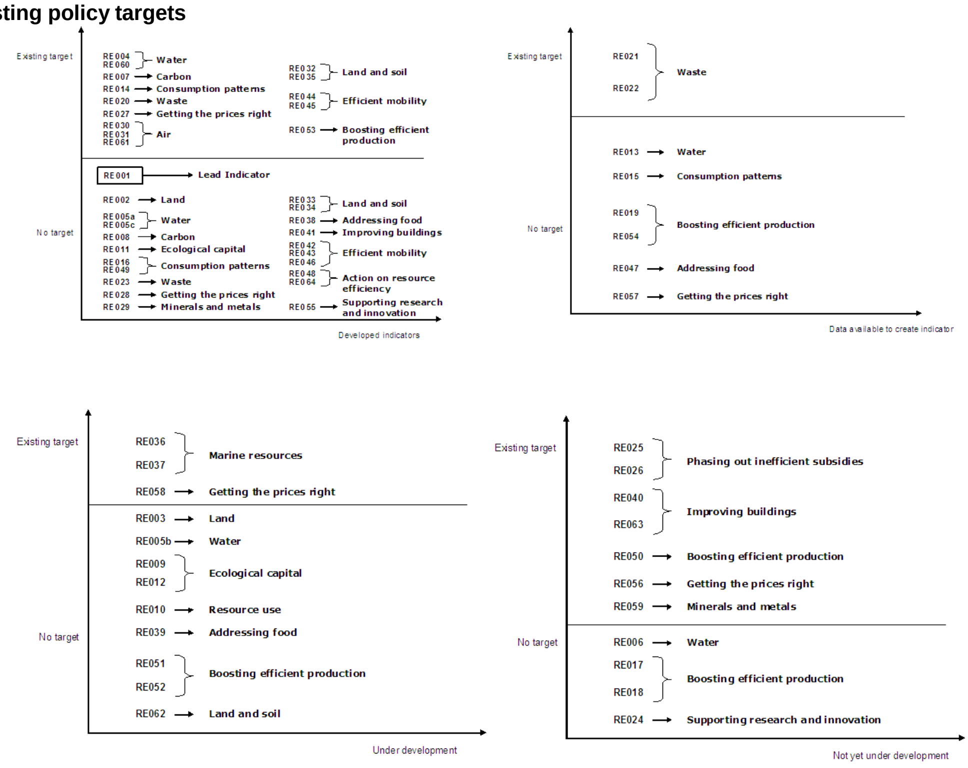
Figure 1-1: Status of development



Status of development and thematic coverage of indicators

Looking at the group of indicators under development, the level of development varies greatly. Some indicators have a well-developed methodology, but have not yet been applied due to e.g. lack of adaptation by intended users or lack of engagement of involved parties.

Figure 1-2: Detailed overview on status of development and thematic area of indicators in relation to existing policy targets



An example of this is the water footprint of companies (RE005 A6-5b) and fossil fuels EHS (RE058 Add-10). For some indicators the methodology is still under development, e.g. for Embodied land use (RE003 A6-3), and for other indicators very few studies have been conducted and more need to be carried out or applied to another scale, e.g. for natural ecological capital (RE009 A6-9), green public procurement (RE014 A6-14), TMC (RE051 Add-3), EMC (RE052 Add-4) and eHANPP (RE062 Add-14). Data constraints are observed on the food waste indicator (RE039 A6-39). A time frame for the development is applied for the indicators; environmental impacts of resource use (Re010 A6-10) and RMC (Re013 A6-13). For embodied land (RE003 A6-3) and green public procurement (RE014 A6-14) further recent development can be expected from the EEA and DG Environment.

39%, of the indicators are not yet under development. However an adequate and solid data basis is available for 15%, though the indicator is not developed and directly available. The source data is available through national statistics, institutions, such as ECHA, or can be aggregated through various data sets from ESTAT. For the indicators with a solid data basis a methodology or collection method has to be developed and standardised.

Out of the total set, 26 of the indicators, including the lead indicator, are proxy indicators. These indicators are mainly applied in the areas of water and marine, land and soil, improving buildings and a few on efficiency, where direct measurability is not available. These can provide a sufficient basis for now-casting, but could be further developed in a long term perspective.

Based on the factsheets, for the categories of air, efficient mobility, land and soil, carbon and action on resource efficiency, indicators are already developed and a solid base for now-casting is present. This also applies to some indicators developed for the water category. However, it should be noted that the main share of the water and land and soil indicators are proxy indicators. For the category; boosting efficient production, there is a lack of developed indicators, but some data is available and development is on-going. Indicators on marine resources and ecological capital are under development. In the waste category some indicators are already available, but more data is available and further development of indicators needs to be conducted. A lack of indicator development on phasing out environmentally harmful subsidies and improving buildings can be identified.

Indicator and data sources

Looking at the data sources, from where the indicators are available or data can be extracted, EEA is the main provider, contributing with information on approximately 46% of the indicators. ESTAT is responsible for providing information on approximately 33% of the indicators. On 33% of the indicators other organisations and private companies have provided information.

Figure 1-3: Indicator and data sources

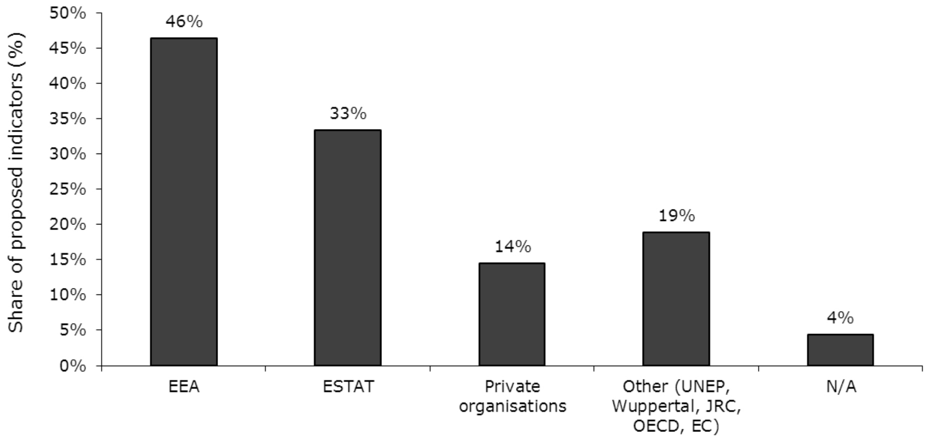


Table 1-2: List of indicators with overview on status of responsibility and institutions [as of September 2012]

Indicator information			Status of Development			
Internal ref. No.		Indicator name	Available	Data is available to create the indicator	Under development	Not under development *
RE001	A6-1	Resource Productivity (GDP/DMC)	ESTAT			
RE002	A6-2	Artificial land or built-up area	ESTAT			
RE003	A6-3	Indirect land use / embodied land for agricultural and forestry products (under development)			EEA Wupppertal and JRC-IES (Ispra)	
RE004	A6-4	Water exploitation index (WEI, %)	EEA			
RE005	A6-5a	Water footprint NATIONAL LEVEL	EEA and Water Footprint Network			
	A6-5b	Water footprint COMPANY LEVEL			EEA and Water Footprint Network	
	A6-5c	Water footprint PRODUCT LEVEL	EEA and Water Footprint Network			
RE006	A6-6	Embodied water (under development)		EEA and Water Footprint Network		+
RE007	A6-7	GHG emissions (Kyoto basket + Fluorinated gases)	EEA			
RE008	A6-8	Carbon footprint	EEA and ETC/SCP based on ESTAT data			
RE009	A6-9	Natural ecological capital (under development)	No info		EEA	
RE010	A6-10	Environmental impacts of resource use (under development)			JRC-IES Ispra	
RE011	A6-11	Landscape Ecosystem Potential (under development)	EEA			
RE012	A6-12	Ecosystem Degradation (under development)			EEA	
RE013	A6-13	Raw Material Consumption (RMC) (under development)			ESTAT	
RE014	A6-14	Percentage of the value, and number, of public procurement contracts that include GPP criteria.	Price Waterhouse Coopers, Significant and Ecofys		EC DG ENV	

Indicator information			Status of Development			
Internal ref. No.		Indicator name	Available	Data is available to create the indicator	Under development	Not under development *
RE015	A6-15	Number and value of green products purchased by households		ESTAT, national initiatives and labelling initiatives		
RE016	A6-16	Output or share of green products in total output	ESTAT			
RE017	A6-17	Proportion of companies using environmental footprint, by sector and size class, within priority sectors, for: measuring, managing and meeting benchmarks				+
RE018	A6-18	Number of companies, by sector and size class, benefiting from advisory assistance from Member States or regional government on improving their environmental performance.				+
RE019	A6-19	Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list.		ECHA		
RE020	A6-20	Total waste generation	ESTAT			
RE021	A6-21	Overall recycling rate		ESTAT		
RE022	A6-22	Landfill rate		ESTAT		
RE023	A6-23	Proportion of secondary raw material used in the EU economy compared to primary raw material (under development)	EEA (ETC/SCP)			
RE024	A6-24	Number and value of funding (EUR/year) of research and innovation projects promoting mainly resource efficiency and sustainable environmental management, allocated through European financial support programmes.				+
RE025	A6-25	Annual value of all Environmentally Harmful Subsidies (EHS) provided (under development)				+
RE026	A6-26	The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate				+
RE027	A6-27	Environmental taxes as share of total taxes and social contributions	ESTAT			

Indicator information			Status of Development			
Internal ref. No.		Indicator name	Available	Data is available to create the indicator	Under development	Not under development *
RE028	A6-28	Total value of environmental taxes paid	ESTAT			
RE029	A6-29	Resource productivity of minerals and metals (GDP/DMC minerals+metals)		ESTAT		
RE030	A6-30	Concentrations of Particulate Matter (PM10) in ambient air	EEA			
RE031	A6-31	Percentage of urban population in areas with PM10 concentrations exceeding daily limit values	EEA			
RE032	A6-32	Average annual land take on the basis of the EEA Core Set Indicator 14 Land take[15]	EEA			
RE033	A6-33	Soil erosion on the basis of the EEA indicator Soil erosion by water and the PESERA and/or RUSLE models of the JRC	EEA and JRC			
RE034	A6-34	Soil organic matter levels, e.g. on the basis of LUCAS results	JRC			
RE035	A6-35	Share of contaminated sites on which remediation actions have started in the previous year on the basis of the EEA Core Set Indicator 15 Progress in management of contaminated sites	EEA			
RE036	A6-36	Share of fish and shellfish populations within safe biological limits			EEA	
RE037	A6-37	The number and area of Marine Protected Areas (MPAs)		EEA		
RE038	A6-38	Development in consumption of different meat and dairy products per capita per year based on ETC/SCP Indicator 13.2 for the EEA	EEA (ETC/SCP)			
RE039	A6-39	Share of edible food waste in households, retailers and catering.			ESTAT	
RE040	A6-40	The rate of nearly zero-energy new buildings (under development)				+
RE041	A6-41	Energy consumption per m2 for space heating, per dwelling and for total housing stock alongside growth in m2 of living space per capita based on ETC/SCP Indicator 16.1	EEA (ETC/SCP)			

15 RE032 is showing change in all land cover types, while RE002 is showing only the increase in artificial land cover i.e. roads buildings etc. They also use two different source data sets. RE032 is using CORINE and RE002 LUCAS data.

Indicator information			Status of Development			
Internal ref. No.		Indicator name	Available	Data is available to create the indicator	Under development	Not under development *
		for the EEA (to be further developed)				
RE042	A6-42	CO2 emissions in the transport sector	EEA			
RE043	A6-43	Total energy consumption/km driven as a proxy for energy efficiency in transport	EEA			
RE044	A6-44	Average CO2 emissions per km for new passenger cars	ESTAT			
RE045	A6-45	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD)	EEA			
RE046	A6-46	Energy consumption by fuel type (transport)	ESTAT			
RE047	A6-47	Share of total budget spent on the environmental and resource efficiency measures		ESTAT		
RE048	A6-48	Capitalisation of 'Core' and 'broad' Sustainable and Responsible Investments (SRI) in Europe (billion/€) based on ETC/SCP Indicator 24.1 for the EEA (to be further developed)	EEA (ETC/SCP)			
RE049	Add1	Ecological footprint	Global Footprint Network			
RE050	Add2	Substitution of dangerous chemicals				+
RE051	Add3	Total Material Consumption (TMC)			EEA (ETC/SCP) and ESTAT	
RE052	Add4	Environmentally weighted material consumption (EMC)			CML, Leiden University	
RE053	Add5	Energy dependency (all energy sources, incl. renewables, nuclear, electricity (with source split) based on final energy consumption	EEA			
RE054	Add6	Material dependency	EEA (ETC/SCP)	ESTAT		
RE055	Add7	Eco-innovation index	Eco-innovation Observatory			
RE056	Add8	External costs – getting the prices right	EXIOPOL			

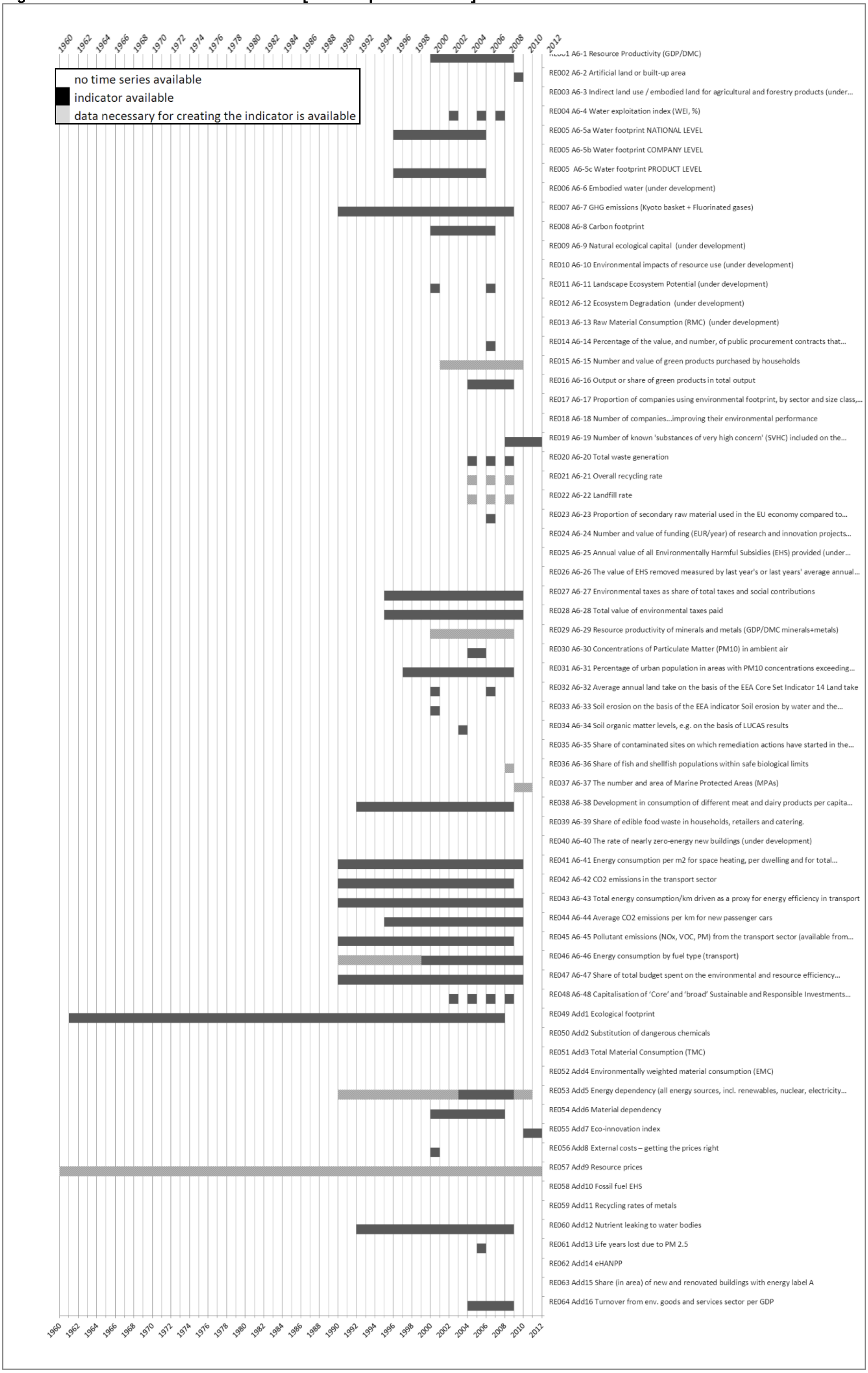
Indicator information			Status of Development			
Internal ref. No.		Indicator name	Available	Data is available to create the indicator	Under development	Not under development *
RE057	Add9	Resource prices		World Bank, IMF, USGS, BGS, ESTAT, OECD, Thomson Reuters, CRU etc.		
RE058	Add10	Fossil fuel EHS			OECD and ESTAT	
RE059	Add11	Recycling rates of metals				+
RE060	Add12	Nutrient leaking to water bodies	EEA			
RE061	Add13	Life years lost due to PM 2.5	EEA			
RE062	Add14	eHANPP			EEA	
RE063	Add15	Share (in area) of new and renovated buildings with energy label A				+
RE064	Add16	Turnover from env. goods and services sector per GDP	ESTAT			

* For further information, see factsheets.

Indicator and data time series

Looking at the time series of indicators and/or necessary data for creating the indicators, one can find that only two indicators can be retrieved for pre-1990 time series. Approximately a quarter of the indicators are available for several years or have continuous time series post-1990. Still, many indicators are only available for a few 'sample' years, and many are not available even though they might be under development.

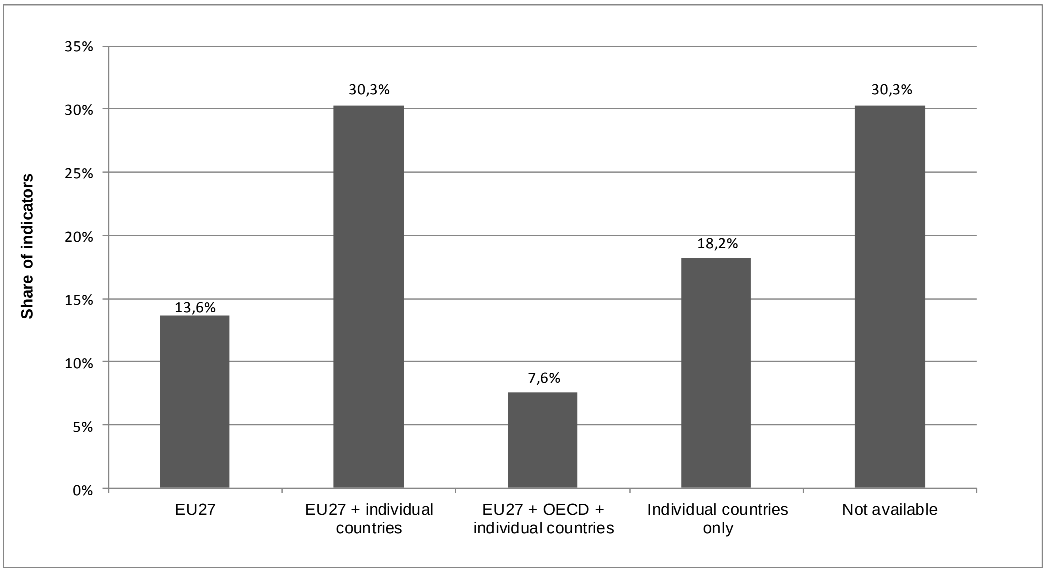
Figure 1-4: Indicator and data timelines [as of September 2012]



Geographical coverage

Geographical coverage of the indicators (or full data coverage necessary for creating the indicators) is typically limited to the EU and OECD countries, while some indicators are also available for the OECD countries as well. In total, 51.5% of the indicators are available for all EU-27 countries. Yet, 18% of the indicators are only available for a limited number of countries and 30% of the indicators are currently not available.

Figure 1-5: Indicator and data geographical coverage [as of September 2012]



Environmental thresholds and existing policy targets

Detailed assessment on environmental thresholds, existing policy targets and potential for further target settings are discussed in details in Chapter 5.

1.8 Potential technical solutions for the maintenance of fact sheets

Introduction

The indicator fact sheets capture a changing landscape of information, and as such, to retain value to the Commission, other European institutions and potentially Member States, researchers and stakeholders, it is essential that they are updated as and when new information becomes available; they should be considered living documents.

It is assumed that the factsheet will be maintained, updated and published (perhaps to a limited audience) though some form of web solution. The Online Resource Efficiency Platform would be one possible and obvious host for the fact sheets.

This short outline and discussion of potential technical solutions for the maintenance of the factsheets does not describe in detail the organisational structure nor attribute responsibilities necessary for an update platform to succeed. However, it is important to underline that both of these issues must be resolved to maintain the factsheets in a useful state in the longer term. In this respect, a short discussion of pertinent issues follows the technical discussion.

Technical considerations

The following criteria have been used when considering what the system should deliver:

- **Online**: to provide ease of access for both retrieving and submitting information;

- **Secure**: the factsheets may (at the discretion of the Commission) be made publicly available, but they would certainly not be publicly editable. As such, some form of closed and potentially moderated system is required;
- **Text based (active text rather than fixed image)**: the content of the factsheets is predominantly text. While it would be possible to simply post static versions of the factsheets through a portal (for example, as .pdf, .jpg, .tif etc.) this would require more resources for the central editor/moderator and would result in a far less flexible and responsive online factsheet;
- **Editable**: allowing a group of editors/contributors to update/ maintain the factsheets would reduce the resources required from the publisher, and facilitate more responsive and, in all likelihood, more up-to-date factsheets. In addition, providing key partners with the ability to update the factsheets directly (with editorial control maintained by the Commission), could potentially foster "ownership" of the factsheets and the update system among partners;
- **Structured**: the fact sheets as they currently stand provide a solid structure that is easily translated to web format. It would be advisable to base a web-based maintenance tool on this structure. Regardless of the final structure agreed upon, it is advisable to hold to the chosen structure and avoid free-form editing.

The above list of functional criteria is necessary for the definition of a system for maintaining and updating the resource efficiency fact sheets. However, it is essential to bear in mind that the exact role the Commission anticipates the factsheets to play in coming years and, subsequently, the amount of resources the Commission anticipates committing to such a project also have a huge influence on the type of online implementation that could be employed.

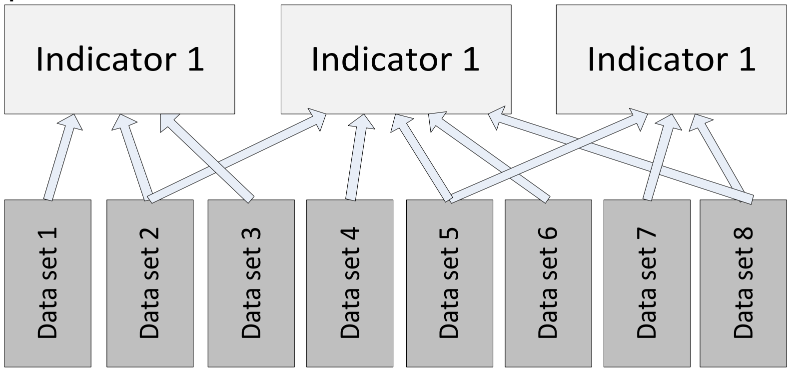
One solution that, given a clean starting point, would require minimal resources and would fulfil all of the criteria above is a wiki-style system such as that employed by Eurostat for their Environmental Data Centre on Natural Resources and on Products. A wiki-style system presents a series of interlinked static pages and allows a user group to add, edit and delete content within a web browser using either simple mark-up language or a text editor. It is also easy to maintain strict editorial control over such a system, particularly one focused on a narrow subject with only a limited number of users.

Such a system would be relatively easy to implement and could adequately present and manage the information contained within the fact sheets. There is scope within the approach to enforce templates and it can be scaled as necessary. A variety of wiki engines are available; it is beyond the scope of this project to assess which would be the most appropriate for the task of online updates to the factsheets.

However, wiki-style systems are not particularly adept at actively combining content from different source components on a single page. This functionality could be beneficial for both users (those using the factsheets for reference) and editors.

For example, it would be beneficial to be able to treat "indicators" and their underlying "data" as two different classes of objects on the system. This would allow a single "data" object (a description of a data source and brief metadata, as described in the factsheets) to be associated with multiple indicators. Updated information on the data source could then be fed to the pages for the relevant indicators. This is common practice in information management and there are a multitude of web tools and programming languages suitable to implement such functionality. The EEA's Indicator Management System, while far more advanced than is required for this task, is an example of such a system.

Figure 1-6: Separation of ”indicators” and ”data”



Separating the information on indicators and data could well prove useful for a more comprehensive assessment of the potentials for now-casting indicators from existing data, as well as facilitate timelier publication or construction of indicators; for many of the indicator implementations detailed in the factsheets, the underlying data is actually available for a longer and often more recent time series than illustrated in the most recent published version of the indicator. A system based on the above description could help alleviate this problem with automatic notification when a dataset contains newer data than that currently implemented in the indicator, and notification when *all* data sets used in the indicator contain more recent data than the currently implemented indicator. In addition, such a system would reduce the costs involved in keeping the system updated, and also reduce the potential for inconsistencies between different entries. Incidentally, such an approach would also help define the differences between these two entities - indicators and data sets - which are currently often used synonymously.

Organisational issues

In terms of the practicalities of maintaining an updated set of indicator fact sheets, there are a few issues that must be considered. Much of the information held within the current factsheets pertains to data and/or indicators produced by European institutions. As such, it makes sense to work in collaboration with these institutions for the process of maintaining the factsheets. How this could be achieved in practice is largely dependent on the resources available for the process. However, a useful point of departure would be to further assess each indicator (and data set) that emerges from European institutions to establish a more accurate timeline for indicator/data publication. This could then be used to guide the process of updating the factsheets.

It is advised that a single entity or person within DG Environment hold overall responsibility for the maintenance of the online factsheets. This person would be responsible for overall Quality Assurance an organising user right to edit/view the factsheets. This permission should also be granted on the basis of the responsible organisation for a given indicator or data set. Of the 37 available indicators:

- EEA is responsible (or jointly responsible) for 22;
- Eurostat is responsible for 10;
- One each from JRC, PWC, GFN, Eco-innovation observatory and EXIOPOL.

Ideally, the publishing authority would be responsible for updating the information for their respective indicators. This can be foreseen to be relatively easily accomplished for the Go4 members, but could be more problematic for those indicators and data sets originating outside the Go4. As such, a pragmatic approach, and one most lightly to result in updated factsheets, may be to assign responsibility for keeping the information about these indicators to DG Environment; coordinating input from these “external” contributors alone would entail maintenance costs.

The underlying data for these indicators, those under development and those that can be created from existing data sets, are detailed in the individual fact sheets. Responsibility for keeping these data sources updated should be similarly assigned. Again, where they originate from outside of the Go4, the most pragmatic course would be to assign responsibility to DG Environment.

An institutionalisation of the indicator fact sheets will be necessary to ensure that they are maintained. In other words, maintenance of the fact sheets must be built into the working programmes of the responsible institutions within the Go4. After initial online implementation, only minimal resources need by deployed to maintain the factsheets. It is worth noting, however, that if the work of updating the factsheets is not built into the working practices of the responsible institutions and as a result they are not maintained as and when new information becomes available, significantly more resources may be required to verify the information (for example, if a user consults a fact sheet and discovers information that they know to be out dated, this seeds doubt about the veracity of the information in all factsheets). As such, it is suggested that a process of on-going updating and maintenance is preferable to periodic update and maintenance, as the latter would inevitably include verification of existing information.

2 Nowcasting and Early Estimate Potentials

In this chapter we:
- present criteria to decide for which Resource Efficiency Indicators (REIs) it might be worth constructing Early Estimates (EEs) and Nowcasts (NCs);
- present a method for assessing possible methods for producing EEs and NCs;
- apply these to score the benefits and costs of constructing EEs and NCs for a shortlist of REIs so as to inform the prioritisation undertaken in the next chapter of the report.

We have based our assessment approach on the systems that have been developed for assessing the quality of statistical indicators by the agencies which publish these indicators. The focus of our assessment approach is on the potential methods to produce EEs and NCs, which gives a slightly different emphasis compared with traditional quality systems.

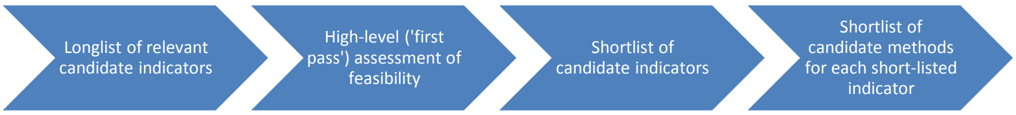
2.1 Overview of the assessment approach

There are two stages in the assessment approach.

Stage 1

In the first stage, we undertake a screening exercise to rule out indicators for which it seems unlikely to be feasible to produce EEs and NCs that would improve on the timeliness of the official data.

Figure 2-1: Stage 1 - Identifying shortlisted indicators and candidate methods for assessment



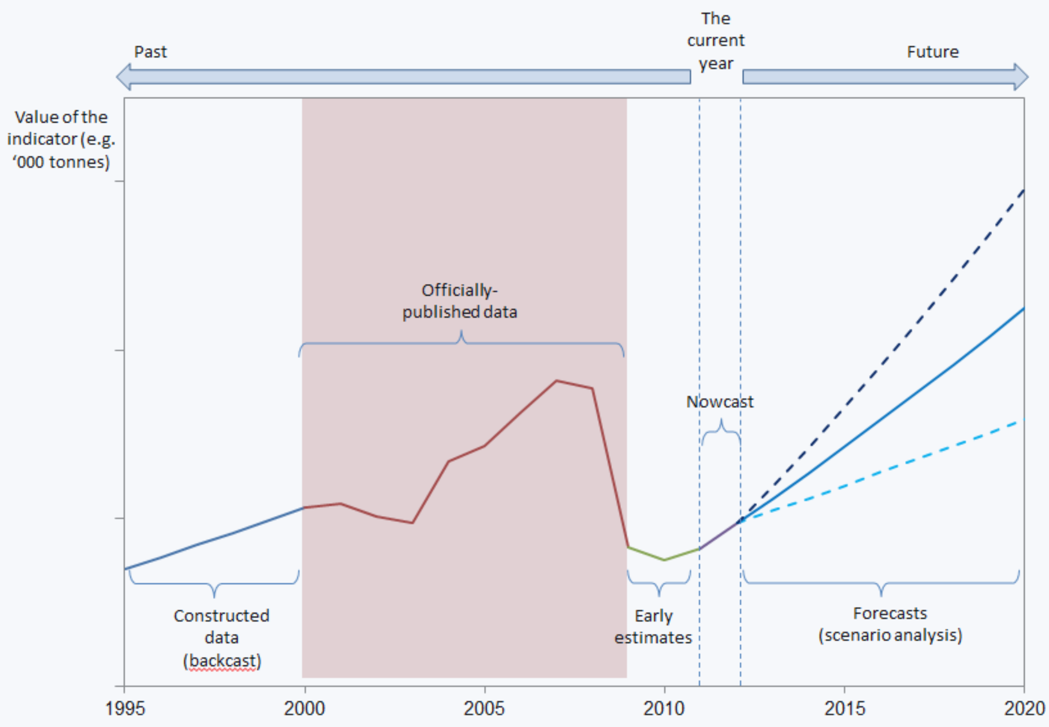
The starting 'long list' is the set of indicators presented in Chapter 1. They have already passed a 'relevance' test, in the sense that the REIs on that list are the indicators that have been selected to support monitoring of the Roadmap to a Resource Efficient Europe. In the high-level assessment of feasibility we focus on:
- whether data for the REI are already being collected and published (if the status of the indicator is currently that it is 'under development', it is not currently feasible to develop EEs/NCs for it although it may be feasible to assess the likelihood that EEs/NCs could be developed in future);
- whether we can identify one or more predictors available from some existing data source that is available at an earlier date than the official REI data and which is, in principle, likely to show movements over time that are similar to those of the REI.

Box 1: Backcasts, Official Data, Early Estimates, Nowcasts, Forecasts and Scenarios

We define here the terms that we use to describe data that are intended to measure the same indicator but which have different kinds of status depending on the extent to which estimation methods have been used in their construction.

The figure below shows a single time series for an indicator, but different time periods in the data have different kinds of status. In this example, official data are available for the period 2000-09. The series has been extended backwards by some estimation method to produce 'Backcasts' for 1995-99. The series has been extended forwards by methods that produce Early Estimates for 2010-11. During the current year (which is 2012 in the figure), an estimate that is based partly on published data and partly on forecasts produces a Nowcast. Finally, a forward looking method can produce a Forecast (representing a view of the future that the author considers plausible) and Scenarios (alternative views of the future, typically representing the consequences of a change to a key assumption used to form the Forecast.

Figure 2-2: Concepts used in Early Estimates and Nowcasting



Box 2: Adapting the quality criteria used in statistical agencies

Statistical agencies typically publish their own criteria by which to assess the quality of the statistics and indicators that they publish. Here we review briefly some examples of these criteria and draw lessons for the assessment of indicators and methods to produce Now-casts and Early Estimates.

Eurostat

The Eurostat quality assessment framework[16] system identifies six key components of quality:

- relevance
  - the extent to which the statistics meet (a variety of) users' current and potential needs

    The indicators reviewed in this study all pass the relevance test in that policy-makers have already decided to use them for monitoring (and other purposes). Relevance includes the extent to which an indicator adequately measures the concept that is of interest for policy.

    For NCs and EEs, the other test of relevance is whether the statistics are available at the appropriate time for the intended purpose (see Box 3).
- accuracy
  - the extent to which the data might be prone to systematic bias or a high degree of variability (sampling errors)

    In this study, the accuracy of the EEs and NCs depends on the underlying accuracy of the predictor and the extent to which the predictor is correlated with the official indicator. If the main use for EEs/NCs is monitoring, we typically require sufficient accuracy to detect a change in trend (because, in the absence of a more sophisticated EE/NC, it is typically assumed that the indicator will have continued its previous trend). What kind of change is significant to the user depends upon the indicator: if a long-term target has been set for the indicator, we are interested in whether the change in trend is consistent with meeting the target. In practice, whether a change in trend can be detected will depend on the noise in the underlying indicator and the accuracy of the EE/NC.
- timeliness and punctuality
  - timeliness: the length of time between the date of publication of an indicator and the period or date to which it refers
  - punctuality: the extent to which the actual release date conforms to the disseminating organisation's announced publication timetable

    See Box 3 for an explanation of the importance of these criteria.
- comparability
  - the extent to which the statistics support valid comparison over time, between geographical areas, and between domains

    For this study, if the EE/NCs are accurate, they will be comparable if the indicators to which they refer are comparable. But weak comparability may be introduced if the predictors on which the EE/NCs are based are not comparable (or only available for selected countries).
- coherence
  - adequacy to be reliably combined in different ways and for various uses (for example, when forming a ratio of two indicators)

    Again, if the EE/NCs are accurate, they will be coherent if the indicators to which they refer are coherent. For some REIs, a coherence question may arise as to geographical

[16] http://epp.eurostat.ec.europa.eu/portal/page/portal/quality/documents/HANDBOOK%20ON%20DATA%20QUALITY%20ASSESSMENT%20METHODS%20AND%20TOOLS%20%20I.pdf and http://epp.eurostat.ec.europa.eu/portal/page/portal/quality/documents/QAF%20leaflet.pdf.

boundaries (for example, indicators that compare resource use to GDP but neglect 'leakage' that is reflected in the resource use in countries from which imports are sourced).

- accessibility and clarity
  - how easily users can obtain and interpret the statistics

    For EE/NCs, the main issue here is the extent to which the presentation communicates to users the basis on which the estimates have been produced (so as to avoid drawing conclusions that merely reflect the way that EE/NC was produced).

Other agencies/systems of assessment

The OECD[17] identifies a further component:

- credibility[18]
  - the confidence users have in the statistics and the organisation that produces the statistics.

    For EE/NCs this raises the question as to which organisation should have responsibility for producing (and hence quality-assuring) the estimates, but this goes beyond the scope of this study.

The EEA does not publish a separate quality assessment procedure for its statistics, but the 'balanced scorecard' which it uses to monitor its effectiveness as an organisation includes some of the same criteria as Eurostat (relevance, quality/transparency, timeliness)[19].

The RACER criteria that impact assessment indicators are expected to follow in the European Commission's Impact Assessment Guidelines[20] (relevant, accepted, credible, easy to monitor, robust against manipulation) are largely covered by the criteria already discussed above. 'Easy to monitor' is a matter of cost rather than quality. The RACER criteria put particular emphasis on the confidence that non-expert users have in the indicators. In the context of EE/NCs we regard this as being largely a matter of accuracy: if the logic of the method suggests that the estimate is likely to be accurate, and if after implementation it is shown empirically to be accurate, the method should command confidence.

Trade-offs, synergies, and composite indicators or quality

To date, the success of attempts to compile composite indicators of overall data quality has been limited, because of the difficulty in choosing weights for the individual components which may differ according to the requirements of different types of user. Consequently, measures of overall quality tend to be quite basic. The Eurostat Quality Profiles that accompany published series provide an overall assessment based on a letter grade (A, B or C, with A as the best). This grade is, loosely, based on the number of sub-criteria (accuracy, comparability across countries, comparability over time) scored as 'High' (as opposed to 'Restricted'). We adopt a similar broad qualitative categorisation for our overall quality assessment (which we label 'value added').

Conclusions for Early Estimates and Now-Cast Statistics

We conclude from this review that the key elements of quality assessment for EEs/NCs (as opposed to quality assessment of the official *indicators* for which EEs/NCs are being produced) are:
- accuracy
- timeliness

and we combine these to form a single measure of 'value added' (see main text).

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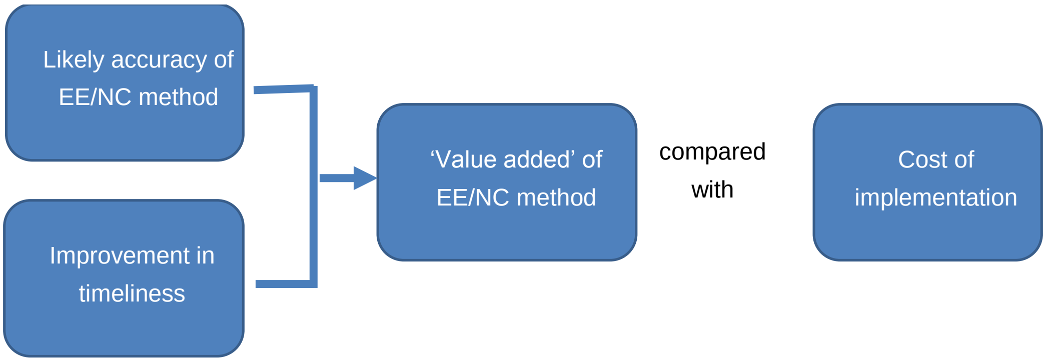
17 http://stats.oecd.org/glossary/detail.asp?ID=5163.
18 The IMF has the similar concept of 'integrity' (see http://stats.oecd.org/glossary/detail.asp?ID=2216).
19 http://www.eea.europa.eu/about-us/documents/administrativedocuments/annual-management-plan-2012.
20 http://ec.europa.eu/governance/impact/commission_guidelines/docs/ia_guidelines_annexes_en.pdf.

Stage 2

In Stage 2 we assess the 'value added' of alternative candidate methods for constructing EE/NCs and compare this with the cost of implementation.

Figure 2-3: Stage 2 - Assessing candidate methods for EE/NCs of shortlisted indicators



Value added

For any REI that passes the high-level assessment to the shortlist of candidate indicators, there may be one or more candidate method for constructing EEs/NCs. In Stage 2 we assess the 'value added' of each method according to:

- its likely accuracy in predicting the official data;
- the improvement in timeliness that the EE would represent compared with the official data.

We use the term 'value added' here because these two criteria together capture the motivation for producing EEs. There is typically a trade-off between timeliness and accuracy because more information becomes available as time goes by. Methods that lie on different points of the timeliness-accuracy spectrum are suitable for different purposes, as discussed in Box 3.

We distinguish four categories of accuracy:

- high;
- medium;
- unknown;
- low.

We distinguish 'unknown' accuracy from 'low' accuracy. A low accuracy method is one we expect to perform poorly in the production of an EE or NC. In contrast, if the accuracy of a method is unknown, we are unable to assess the method's accuracy without testing the method. We consider a method of unknown accuracy to be more promising than one of low accuracy.

The assessment of accuracy is, at this stage, *a priori*, and depends on an appeal to theory: to what extent is the predictor determined by the same forces as the REI, or to what extent does the predictor itself determine the REI? Once an EE method has been selected for implementation, it is possible to test *empirically* how well, in practice, it predicts outturns for the REI.

When combining accuracy and timeliness to produce an assessment of value added, we adopt a four-category classification of value added:

- very high;
- high;
- medium;
- low.

and apply the following rules for evaluating the value added of a proposed method, combining the two components discussed above.

Table 2-1: Combining accuracy and timeliness to produce an assessment of value added

	Number of years by which the published series is extended	1	2	3
Accuracy				
Low		Low	Low	Medium
Unknown		Low	Medium	Medium
Medium		Medium	High	High
High		High	Very high	Very high

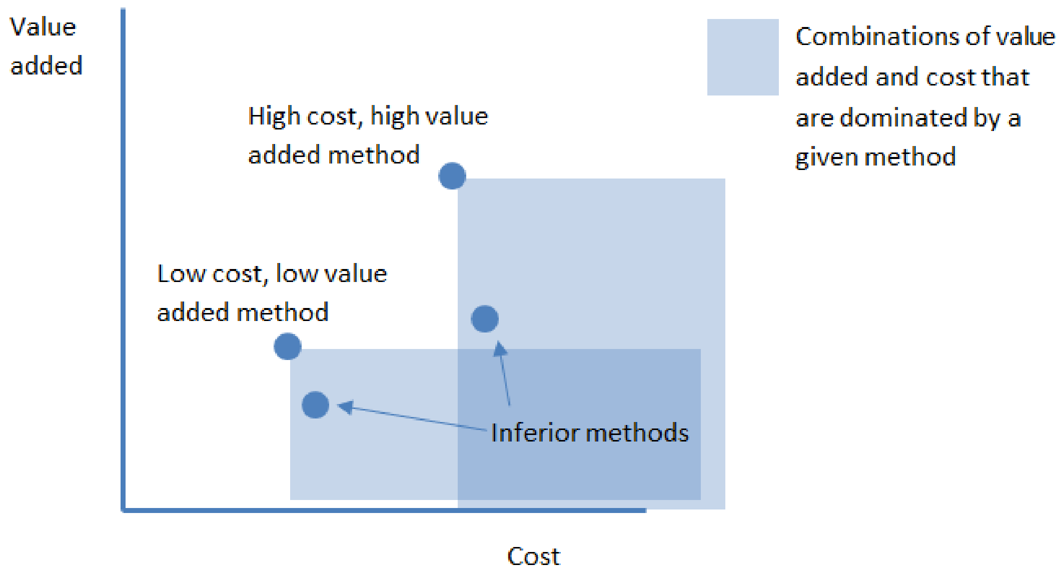
Cost of implementation

The cost of implementation is based on judgement as to the work that will be required to develop (and subsequently maintain) an EE method. Once the method has been implemented, those estimates of the work required can, of course, be improved, but here we are concerned with what can inform a decision whether or not to proceed with implementation.

Comparing methods with different scores for value added and cost

The following figure illustrates the point that some methods may be ruled out of consideration because they offer no improvement in value added but cost more. But more than one method may remain in consideration if they offer, say, low cost-low value added and high cost-high value added alternatives.

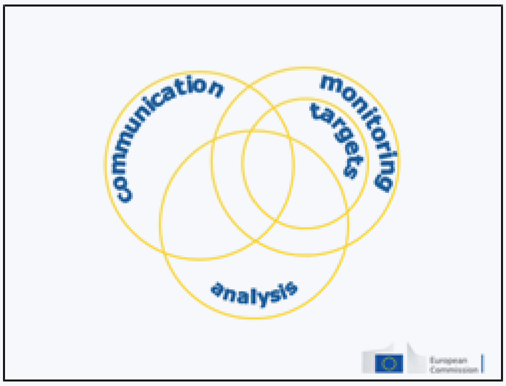
Figure 2-4: Evaluating alternative methods for EE/NCs for a given indicator



Box 3: Timeliness, accuracy and the purpose for which a statistic is to be used

The weight that should be given to timeliness versus accuracy in the choice of statistic depends on the purpose for which the statistic is to be used.

The following figure notes four key purposes for statistical indicators, and its design is intended to highlight the fact that these purposes can overlap, and the same statistic may be useful for more than one purpose.



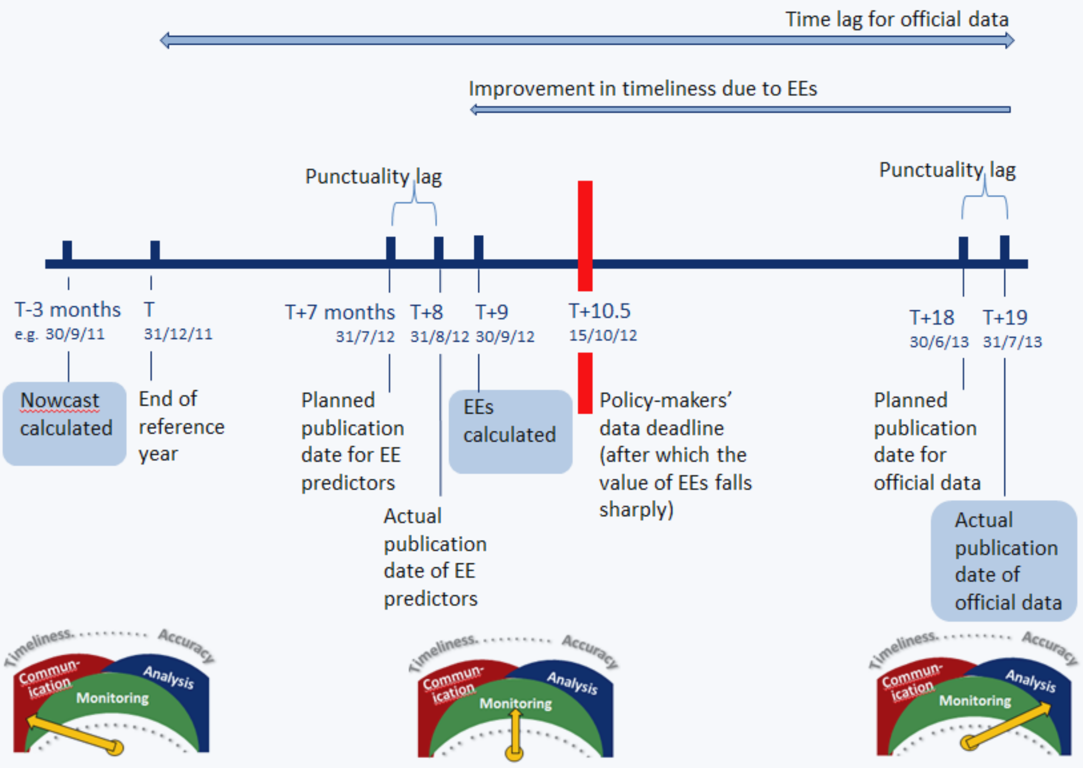
Here, we focus on the requirements that the purposes place on the timeliness versus accuracy trade-off. A statistic that is used for *communication* must be timely, to provide information about the state of things at present or in the recent past. The impact for communication falls away quite sharply the more out-of-date the indicator is. In contrast, the level of detail is much less important, and the weight given to accuracy is also lower than for other purposes (see below).

A statistic that is used for *monitoring* must be able to provide information about how the situation differs from period to period according to the information available in each period. Monitoring may also extend to a measurement of performance against *targets*, benchmarks or sustainability thresholds. Timeliness is important for monitoring, since we typically wish to adjust policy in response to outcomes that fall short of what is desired: the longer the time-lag between the monitoring period and the reported outcome, the more time has been lost before adjusting course, which normally increases the cost of a correction of course. But accuracy is also important because wrong decisions based on inaccurate monitoring information can also be costly.

A statistic that is used for *analysis* informs interpretation of what has happened, usually to provide the empirical evidence to confirm or challenge a theoretical explanation or conceptual/strategic approach. Analysis places great emphasis on the accuracy (and supporting detail) of an indicator, and requires that the indicator have substantial independent empirical content: there is no point in using indicators to confirm a theory if, say, the theory itself has been used at least in part to generate the estimate of the indicator. In contrast, timeliness is of less importance for analysis compared to communication or monitoring, particularly if the purpose of the analysis is to interpret medium and long-term trends and identify interlinkages.

The following figure shows a typical calendar of publication of statistics for a given indicator and highlights (in the shaded boxes) the three key stages of data: NCs, EEs and publication of the official data.

Figure 2-5: Timeliness, accuracy and purpose for which a statistic is to be used



The figure assumes that official data for the indicator only become available 19 months after the end of the year to which the data refer (including, for illustrative purposes, an assumed delay of 1 month between the planned and actual publication dates). The timeliness-accuracy graphic indicates that the official data have the greatest value for analysis, rather less value for monitoring, and no value for communication. At the other extreme, a Nowcast for the indicator is available 3 months before the end of the year of reference. This has high value for communication because of its immediacy. It has rather less value for monitoring and no value for analysis because of the sacrifice of accuracy. Between these two lie Early Estimates that rely on predictors published 8 months after the end of the year of reference. The timeliness-accuracy mix in such estimates has highest value for monitoring. The diagram also postulates a 'data deadline' set by the policy-makers' annual schedule.

2.2 High-level ('first pass') assessment of feasibility

The high-level assessment of feasibility is presented in Table 2-2 (the list of indicators from the Resource Efficiency Road Map) and Table 2-3 (a list of additional indicators proposed during this project). In both cases, the tables list the number of each indicator, as we identify it in this study (e.g. RE001), and the external reference number, which corresponds to the indicator's status either as one that appears in the Road Map (e.g. A6-1), or as an additional indicator proposed during this study (e.g. Add1).

In the tables we provide contextual information on the motivation/role of each indicator in the Road Map and the units of each. We also present the timeliness of each indicator, expressed as the number of months between the end of the period the data refer to and the date of publication e.g. T+55 months indicates that the data on a particular indicator, for year T, are made available 55 months after the end of year T.

The right-hand side of each table presents the results of the high-level feasibility assessment. The first of these columns ("Suitability in principle for EE/NC") states whether we are able to identify a predictor that could, at least in principle, inform an EE or NC. Where the suitability is deemed "Unknown", this generally refers to an indicator for which data have yet to be collected and published. In these cases, it is not yet feasible to develop an EE/NC.

For indicators that we have identified as possibilities for EEs and NCs, we then state whether or not we have assessed this feasibility in more detail as part of the study (and, where we have, we direct the reader to the relevant part of this report). The final, right-most column provides additional information on our decision.

Table 2-2: High-level assessment of EE and NC feasibility – Road Map indicators

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE001	A6-1	Resource productivity (GDP/DMC)	Lead Indicator of RERM	euros/tonne	T+55 Months	Yes	Yes (see Ch 4)	DMC is estimated as part of this study; it is straightforward to derive the indicator using these figures and figures for GDP.
RE002	A6-2	Artificial land or built-up area	Complementary to the Lead Indicator (land)	km^2	T+12 Months	Yes	Yes (see Annex C)	Requires more timely spatial data or information on spatial features that are classified as built-up areas.
RE003	A6-3	Indirect land use / embodied land for agricultural and forestry products	Complementary to the Lead Indicator (land)	km^2	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.
RE004	A6-4	Water exploitation index	Complementary to the Lead Indicator (water)	% (ratio of abstraction to freshwater resources)	T+36 Months	Yes	Yes (see Annex C)	Can be estimated using more up-to-date water abstraction data, under the assumption that (long-term) freshwater resources are unchanged.
RE005	A6-5a	Water footprint (national level)	Complementary to the Lead Indicator (water)	m^3/year	T+72 Months	Yes	Yes (see Annex C)	Can be estimated by applying historical coefficients to data in later years.
RE005	A6-5b	Water footprint (company level)	Complementary to the Lead Indicator (water)	m^3/year	NA	Unknown	No	The indicator is relatively new and the current implementation/availability of company-level data is unlikely to be at a level for EEs/NCs to be feasible.
RE005	A6-5c	Water footprint (product level)	Complementary to the Lead Indicator (water)	m^3/year	T+72 Months	Yes	Yes (see Annex C)	Can be estimated by applying historical coefficients to data in later years.
RE006	A6-6	Embodied water	Complementary to the Lead Indicator (water)	m^3/tonne	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE007	A6-7	GHG emissions	Complementary to the Lead Indicator (carbon)	$ktCO_2e$	T+24 Months	Yes	Yes (see Annex C)	Energy-related GHGs generally more straightforward to produce EEs/NCs for.
RE008	A6-8	Carbon footprint	Complementary to the Lead Indicator (carbon)	$ktCO_2$	T+48 Months	Yes	Yes (see Annex C)	Can be estimated by applying historical coefficients to data in later years.
RE009	A6-9	Natural ecological capital	Complementary to the Lead Indicator (ecological capital)	Ecosystem potential unit equivalents	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.
RE010	A6-10	Environmental impacts of resource use	Complementary to the Lead Indicator (environmental impacts of resource use)	Impact scores	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.
RE011	A6-11	Landscape ecosystem potential	Complementary to the Lead Indicator (dashboard)	Points from 0-255 where a decrease of the indicator reflects degradation of the land potential and an increase reflects and	T+36 Months	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
				improvement				
RE012	A6-12	Ecosystem degradation	Complementary to the Lead Indicator (dashboard)	Points from 0-100, weighted by hectare.	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.
RE013	A6-13	Raw Material Consumption (RMC)		(thousand) tonnes	NA	Yes	Yes (see Ch 4)	RMC is estimated as part of this study, by converting the imports and exports figures into Raw Material Equivalents.
RE014	A6-14	Percentage of the value, and number, of public procurement contracts that include GPP criteria	3.1.1. Improving products and changing consumption patterns	%	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. In any case, no obvious candidate predictor.
RE015	A6-15	Number and value of green products purchased by households	3.1.1. Improving products and changing consumption patterns	Number of units, value, percentage share of market	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. Some data already available on EU Flower eco-labels, but this is likely to be just one component of green products.
RE016	A6-16	Output or share of green products in total output	3.1.1. Improving products and changing consumption patterns	Thousands of Euros (from 1/1/1999) / Thousands of ECU (up to 31/12/1998)	T+24 Months	Yes	Yes (see Annex C)	Depends on the extent to which green products can be identified within existing economic accounts.
RE017	A6-17	Proportion of companies using environmental footprint, by sector and size class, within priority sectors, for: measuring,	3.1.2. Boosting efficient production	%	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
		managing and meeting benchmarks						
RE018	A6-18	Number of companies, by sector and size class, benefiting from advisory assistance from Member States or regional government on improving their environmental performance.	3.1.2. Boosting efficient production	Number of companies	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE019	A6-19	Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list.	3.1.2. Boosting efficient production	Number	NA	No	No	The published indicator is presumably up to date.
RE020	A6-20	Total waste generation	3.2. Turning waste into a resource	tonnes	NA	Yes	Yes (see Annex C)	Can be linked to the production indicators for the key waste-generating sectors, or can be updated using individual MSs' data.
RE021	A6-21	Overall recycling rate	3.2. Turning waste into a resource	%	T+24 Months	Yes	Yes (see Annex C)	Might be possible to update using individual MSs' data.
RE022	A6-22	Landfill rate	3.2. Turning waste into a resource	%	T+24 Months	Yes	Yes (see Annex C)	Might be possible to update using individual MSs' data.
RE023	A6-23	Proportion of secondary raw material used in the EU economy compared to primary raw material	3.2. Turning waste into a resource	%	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE024	A6-24	Number and value of funding (euros/year) of research and innovation projects promoting mainly resource efficiency and sustainable environmental management, allocated through European financial support programmes.	3.3. Supporting research and innovation	Number and euros/year	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE025	A6-25	Annual value of all Environmentally Harmful Subsidies (EHS) provided	3.4.1. Phasing out inefficient subsidies	euros	NA	Yes	No	Unlikely to find a source that would not be used already to form the published indicator but, depending on the definition of environmentally harmful activities/products, it may be possible to use the value/volume of activities combined with known subsidy rates.
RE026	A6-26	The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate	3.4.1. Phasing out inefficient subsidies	euros	NA	Yes	No	Unlikely to find a source that would not be used already to form the published indicator but, depending on the definition of environmentally harmful activities/products, it may be possible to use the value/volume of activities combined with known subsidy rates.
RE027	A6-27	Environmental taxes as share of total taxes and social contributions	3.4.2. Getting the prices right and reorienting the burden of taxation	%	T+9 Months	Yes	No	Unlikely to find a source that would not be used already to form the published indicator. It is still necessary to know total taxes, even if some components of environmental taxation (e.g. fuel consumption) can be identified.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE028	A6-28	Total value of environmental taxes paid	3.4.2. Getting the prices right and reorienting the burden of taxation	euros	T+9 Months	Yes	No	Environmental taxes may be feasibly identified from production/consumption data (fuel, principally) and tax rates, but unlikely to find a source that would not be used already to form the published indicator.
RE029	A6-29	Resource productivity of minerals and metals (GDP/DMC of minerals and metals)	4.3. Minerals and metals	euros/tonne	T+55 Months	Yes	Yes (see Ch 4)	DMC by material category is estimated as part of this study; it is straightforward to derive the indicator using these figures and figures for GDP.
RE030	A6-30	Concentrations of Particulate Matter (PM10) in ambient air	4.5. Air	g/m³	NA	No	No	It would be possible to estimate emissions from fuel consumption data, but the relationship with *concentrations* of particulates is not straightforward.
RE031	A6-31	Percentage of urban population in areas with PM10 concentrations exceeding daily limit values	4.5. Air	%	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator. Available data (e.g. weather patterns) only one element of the system.
RE032	A6-32	Average annual land take on the basis of the EEA Core Set Indicator 14 land take	4.6. Land and soils	km²	NA	Yes	Yes (see Annex C)	In contrast to RE002, this indicator considers more coverage types than just built-up areas. Requires more timely spatial data or information on spatial features that are classified as built-up areas.
RE033	A6-33	Soil erosion on the basis of the EEA indicator Soil erosion by water and the PESERA and/or RUSLE models of the JRC	4.6. Land and soils	tonnes/ha/year	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE034	A6-34	Soil organic matter levels, e.g.	4.6. Land and	% of Organic	NA	No	No	Unlikely to find a source that would not be

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
		on the basis of LUCAS results	soils	Carbon in the topsoil (0-30cm)				used already to form the published indicator.
RE035	A6-35	Share of contaminated sites on which remediation actions have started in the previous year on the basis of the EEA Core Set Indicator 15 Progress in management of contaminated sites	4.6. Land and soils	%	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE036	A6-36	Share of fish and shellfish populations within safe biological limits	4.7. Marine resources	%	T+24 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator. Available data (e.g. fish landings) only one element of the system.
RE037	A6-37	The number and area of Marine Protected Areas (MPAs)	4.7. Marine resources	Number and km²	T+5 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator. May be possible to obtain from other databases (e.g. from NGOs) but the gain is arguably limited.
RE038	A6-38	Development in consumption of different meat and dairy products per capita per year based on ETC/SCP Indicator 13.2 for the EEA	5.1. Addressing food	grams/day per capita	NA	Yes	Yes (see Annex C)	Would likely involve re-production of the indicator using the same sources.
RE039	A6-39	Share of edible food waste in households, retailers and catering.	5.1. Addressing food	%	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. Data quality generally poor and existing

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
								work appears based largely on bespoke research.
RE040	A6-40	The rate of nearly zero-energy new buildings	5.2. Improving buildings	% of new buildings conforming to nearly zero energy criteria	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. It may be possible to obtain this information in the future from construction company statements etc.
RE041	A6-41	Energy consumption per m² for space heating, per dwelling and for total housing stock alongside growth in m² of living space per capita based on ETC/SCP Indicator 16.1 for the EEA	5.2. Improving buildings	Index (Base year = 1990)	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. A model-based method could be envisaged, but that is probably what the published indicator would use.
RE042	A6-42	CO_2 emissions in the transport sector	5.3. Ensuring efficient mobility	$ktCO_2$	T+24 Months	Yes	Yes (see Annex C)	Could be estimated from fuel consumption statistics.
RE043	A6-43	Total energy consumption/km driven as a proxy for energy efficiency in transport	5.3. Ensuring efficient mobility	All values indexed to 1990. Total fuel consumption: litres Total km travelled: km Average specific consumption: l/100km	T+24 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
				Stock of cars: number of cars Co2 emissions: g / passenger km				
RE044	A6-44	Average CO2 emissions per km for new passenger cars	5.3. Ensuring efficient mobility	gCO2 / km	T+24 Months	Yes	Yes (see Annex C)	Some scope for an increase in timeliness using national sources.
RE045	A6-45	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD)	5.3. Ensuring efficient mobility	All values are indexed to 1990 NOx - 1000 tonnes SOx – 1000 tonnes NH3 - 1000 tonnes PM10 - µg/m3 PM2.5 - µg/m3 CH4 - 1000 tonnes CO - 1000 tonnes NMVOC – 1000 tonnes	T+24 Months	Yes	Yes (see Annex C)	Likely to be based on fuel consumption data.
RE046	A6-46	Transport energy consumption by fuel type	5.3. Ensuring efficient mobility	Tonnes of Oil Equivalent	T+24 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator (figures are based on monthly

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
								data).
RE047	A6-47	Share of total state budget spent on the environmental and resource efficiency measures	6.1. New pathways to action on resource efficiency	%	T+24 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE048	A6-48	Capitalisation of ‘Core’ and ‘broad’ Sustainable and Responsible Investments (SRI) in Europe (billion/euros) based on ETC/SCP Indicator 24.1 for the EEA	6.1. New pathways to action on resource efficiency	Billions of Euros (current prices)	T+12 Months	Yes	No	Financial figures available with relatively little delay but value of producing EEs/NCs deemed to be low.

Table 2-3: High-level assessment of EE and NC feasibility – additional indicators

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE049	Add1	Ecological footprint	3.1.1. Improving products and changing consumption patterns	ha (global hectares)	T+36 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator. Indicator is a composite measure and the underlying calculations introduce too much complexity. There may be some scope to relate certain components, e.g. agricultural land use, to certain components, though.
RE050	Add2	Substitution of dangerous chemicals	3.1.2. Boosting efficient production	Millions of tonnes	T+12 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE051	Add3	Total Material Consumption (TMC)	3.1.2. Boosting efficient production	tonnes	NA	Yes	Partially (see Ch 4)	TMR is derived as part of this study but hidden flows associated with exports (required for TMC) were not calculated.
RE052	Add4	Environmentally weighted material consumption (EMC)	3.1.2. Boosting efficient production	impact scores	NA	Yes	No	Indicator production is currently suspended, but the figures could, in principle, be derived from the estimates of material flows.
RE053	Add5	Energy dependency (all energy sources, incl. renewables, nuclear, electricity (with source split)) based on final energy consumption	3.1.2. Boosting efficient production	% (based on energy content)	T+36 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator.

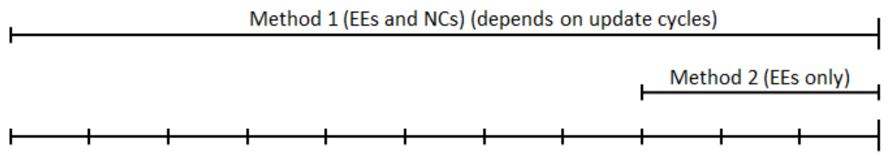
Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE054	Add6	Material dependency	3.1.2. Boosting efficient production and 3.2. Turning waste into a resource	% (based on tonnes)	T+36 Months	Yes	No	The figures could, in principle, be derived from the estimates of material flows.
RE055	Add7	Eco-innovation Index	3.3. Supporting research and innovation	No unit – Score	NA	No	No	In the majority of cases, unlikely to find a source that would not be used already to form the published indicator(s).
RE056	Add8	External costs – getting the prices right	3.4.2. Getting the prices right and reorienting the burden of taxation	Ratio of external costs to market price	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy.
RE057	Add9	Resource prices	3.4.2. Getting the prices right and reorienting the burden of taxation	euros/tonne	NA	Unknown	No	Complete indicator set (and standardisation) is still being developed but the majority of the necessary price data is presumably readily available
RE058	Add10	Fossil fuel Environmentally Harmful Subsidies	3.4.2. Getting the prices right and reorienting the burden of taxation	euros	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. Could be derived by applying subsidy rates to fuel consumption data.
RE059	Add11	Recycling rates of metals	4.3. Minerals and metals	%	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator, although there may be some limited waste business data.

Indicator number	External reference number	Indicator name	RERM ref.	Unit	Timeliness	Suitability in principle for EE/NC	Suitability assessed in this study?	Comments
RE060	Add12	Nutrient leaking to water bodies	4.4. Water	mg/l	T+24 Months	No	No	Unlikely to find a source that would not be used already to form the published indicator. Available data (e.g. fertiliser sold/produced or crops sown) only one element of the system.
RE061	Add13	Life years lost due to PM 2.5	4.5. Air	years	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE062	Add14	Embodied Human Appropriation of Net Primary Production (eHANPP)	4.6. Land and soils	gC/m^2	NA	No	No	Unlikely to find a source that would not be used already to form the published indicator.
RE063	Add15	Share (in area) of new and renovated buildings with energy label A	5.2. Improving buildings	%	NA	Unknown	No	Indicator is still being developed so no history on which to base an EE/NC method or assess its accuracy. May be possible to make use of business data in the future.
RE064	Add16	Turnover from environmental goods and services sector per GDP	6.1. New pathways to action on resource efficiency	% of GDP	T+24 Months	Yes	Yes (see Annex C)	Depends on the extent to which green products can be identified within existing economic accounts.

2.3 Illustrations of how to assess the effectiveness of alternative methods of producing EEs and NCs

In this section we provide examples of how the assessment methodology could be applied to evaluate the effectiveness of two different kinds of indicators, in order to ground the concepts in realistic conditions.

We summarise the timeliness of the candidate estimation methods in the form of a timeline, as shown in the figure below.



In the example above, we identify two possible methods[21] to produce more timely estimates for this particular indicator (taken from our assessment of Artificial land or built-up area). Method 1 generates both EEs and NCs and, in principle, it is possible to generate these at any point in the year, because the method takes advantage of continuously-updated spatial data.

In contrast, Method 2 makes use of data released at certain points in the year and we show that it is only possible to produce EEs in the last quarter of the year. In this case, some data become available for an EE in Month 9 of the year, while additional data that may also inform the assessment become available in Month 12, hence the span of the methods in the example above. Where a method only makes use of a single release of data, we indicate the first month in which an EE or NC is feasible (which corresponds to the release date of that information).

2.3.1 Economy-Wide Material Flow Accounts

As part of this study we produce EEs and NCs of economy-wide EW-MFA data. As an illustration of our assessment method, we focus on methods to project economy-wide DEU and DMC (which are related, by accounting identity, through Imports and Exports). Chapter 4 details the full and final method to produce EEs and NCs for EW-MFA variables. For the illustration here, we simply compare two broad methods, one of which follows the recommendations of Agilis (2011)[22], which follow quite closely the methods used to construct the final EW-MFA indicators, and the second of which is less data-intensive and uses predictors that measure ‘production’ or ‘demand’ for materials.

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[21] If the method to produce the EE/NC is very labour-intensive, the delay between the end of the period of interest and the date of publication of the EE/NC needs to be extended to include the processing time for the method.

[22] Agilis (2011), ‘Methodology for the now-casting of Material Flow Accounts’.

Table 2-4: Example EE & NC assessment for EW-MFA

		Requires more recent:		Value added				
		Economic data?	Materials data?	Expected accuracy	Improvement in timeliness	Cost	May help detect a change in trend?	Suitable for
1	Recreate DEU using the same methods used when constructing the published indicators	N	Y	High	High (from T+21 months to T+9 months)	High (prohibit-ively so)	Y	Monitoring, Analysis
2	Estimate DEU/DMC using production/ demand predictors	Y	N	Medium	High (from T+21 months to T+10 months)	Low	Y	Communication, Monitoring

The timeliness of EW-MFA data

From the previous section, we divide value added into two components: the part common to all estimation methods (the value of updating a particular REI) and the part specific to each of the estimation methods (the accuracy of the methods themselves and the improvement in timeliness). Here we assess the value added of EEs and NCs for the EW-MFA data in general. This is based on the number of years we must estimate to bring the indicator up to date.

In the assessment of methods that follows, we combine this measure with our assessment of the accuracy of the different methods to produce some indication of each method's value added.

At present, material flows data are three years behind in terms of their availability i.e. in 2012, the last year of material-flows data is 2009[23]. Thus, the estimation of EW-MFA data could yield up to three years of additional data:

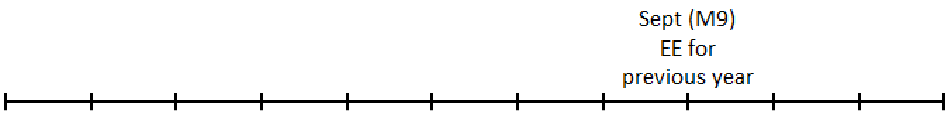
- Two EEs (for two previous years);
- One NC (for the current year).

Method 1: Recreate DEU using the same methods used when constructing the published indicators

In the case of EW-MFA data, one candidate dataset to inform estimates of domestic extraction is the US Geological Survey (USGS), which reports world mine production by country based on information aggregated from a wide range of sources including government publications, company reports and academic articles. In fact, the EW-MFA compilation guidelines actually recommend the USGS as one source of input data into the official EW-MFA for metal ores and non-metallic minerals. The predictors (from the USGS) and the REI (European EW-MFA) are influenced by the same factors because they are measures of the same quantities, both in principle and in practice. This is an example of a direct relationship between an REI and an alternative dataset, on practical grounds.

However, depending on the time of year when new estimates are required, the USGS data may not extend the REI series by very much. The USGS data become available at around T+9 months: before that month, there are only data to estimate the period two years before the current one, whereas, after that month, there are now data to estimate the previous year (improving the timeliness of the data by 12 months, from T+21 months to T+9 months) as we illustrate in the timeline below:

23 A small number of Member States have provided figures for 2010.



As a reproduction of the compilation method recommended by Eurostat, the expected accuracy of this method is ‘High’. By our value-added criterion, a ‘High’ accuracy method that brings the series up to date by one or two years offers high value added. However, the compilation process is laborious, involving substantial data extraction and processing; the method is ‘High’ in cost; so high, in fact, that it is difficult to recommend this method as suitable for a regular EE.

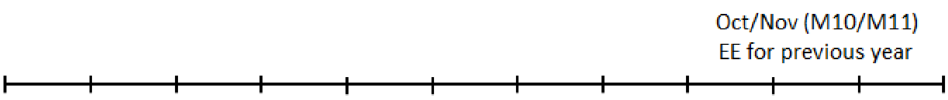
Material-flow data compiled by this method is about as detailed as is possible and the method thus produces indicators suitable for analysis. Owing to the high level of accuracy of the method, the indicators are somewhat suitable for monitoring. The timeliness (T+9) means that the method could be suitable for communication purposes, provided that resources are committed immediately to undertake the extensive processing required.

Method 2: Estimate DEU/DMC using production/ demand predictors

In the case of EW-MFA, the supply-side approach of Method 1 relies on other data that are influenced by the same factors as the REI because the two datasets measure the same quantity. There is a direct relationship between the two. An alternative approach could begin by estimating domestic consumption using indicators for demand (e.g. using construction output measured in real, inflation-adjusted, terms) as an indicator for the demand for building materials) or estimate domestic extraction using indicators of production. In the case of the consumption method we are relying on a relationship, derived from theory, between activity in one or more key sectors and their use of the materials. In the case of the production method we are relying on the use of an indicator that measures a concept related to the EW-MFA REI (how close the relationship is depends on how precisely the indicator comes to the EW-MFA REI in definition). This method fares well in terms of timeliness because it relies on frequently-updated economic and production data (and nowcasts for those indicators, supporting construction of NCs for the REI).

The value added of the method is high because it combines medium accuracy with an extension of 2-3 years. The cost of this method is quite low once the investment has been made to estimate the models and set up a system in which they can be applied (it requires the predictor series to be gathered and the model-based estimation to be applied). The production-based method is capable of detecting a change in trend, although if the user’s interest focused on resource productivity (value added per unit of materials used) then the consumption-based approach would not detect a change in trend.

Annual economic data become available 10-11 months after the period they refer to (i.e. T+10/T+11 months) and, consequently, it is possible to produce an EE for the previous year in October/ November of each year. This is not a substantial loss in timeliness relative to Method 1:



Because they have some empirical content that goes beyond pure extrapolation, and because they are capable of producing timely indicators, the two kinds of approach used in Method 2 are deemed suitable for communication and monitoring, but because they include some element of model-based estimation, there is a penalty in terms of accuracy and they are not suitable for analysis.

A comparison of the estimation methods

For communication and monitoring purposes, Method 2 produces indicators with acceptable accuracy and with a timeliness that is not much worse than Method 1 (particularly if the longer time required to carry out Method 1 is considered). The two methods therefore have similar value added, but Method 2 has a much lower cost and is therefore preferred. For the purpose of analysis, Method 2 is not sufficiently accurate and so its value added in this case is, effectively, zero, which rule it out, regardless of its lower cost.

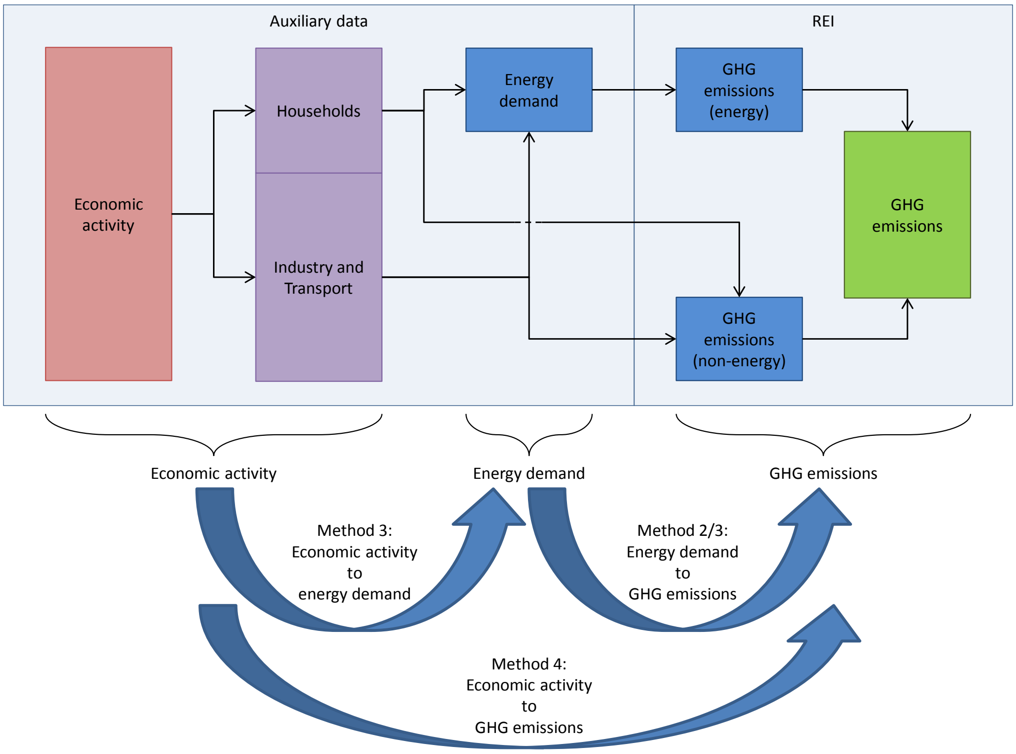
2.3.2 GHG emissions

In this section, we provide a further example assessment, of the scope to generate EEs and NCs for the GHG emissions indicator. We introduce the theoretical framework that links this REI to some possible alternative indicators before we assess the alternative estimation methods themselves.

The theoretical framework to explain and estimate GHG emissions

Figure 2-6 shows the relationships between GHG emissions (the REI) and economic activity and energy demand (two potential alternative predictors). We divide the chart into two: the predictors (economic activity and energy demand) on the left-hand side and the REI (GHG emissions) on the right-hand side. In this example, the additional data are 'upstream' of the REI in the sense that economic activity and energy demand are drivers of GHG emissions.

Figure 2-6: Theoretical framework of GHG emissions possible predictors



The logic of the figure is as follows, reading from left to right:

- Economic activity (e.g. GDP) can be broken down into economic activity from households (e.g. income/expenditure) and economic activity from industry (production);

- Economic activity drives energy demand from households (consumption of energy for appliances, heating and transport) and energy demand from industry (as an input to production);
- Consumption of energy gives rise to energy-related GHG emissions;
- Economic activity also gives rise to non-energy-related emissions e.g. industrial process emissions.

The logic chain above suggests a number of possible ways to produce more up-to-date GHG emissions estimates using alternative predictors. From this, Table 2-5 presents four candidate methods, which we present and discuss in the text that follows.

Table 2-5: Example EE & NC assessment for GHG emissions

		Requires more recent:			Value added				
		Economic data?	Energy data?	GHG emissions data?	Accuracy	Gain in timeliness	Cost	May help detect a change in trend?	Suitable for
1	Construct REI from alternative sources of emissions data	N	N	Y	High	0-1 years (compared with 'final' estimate)	Very high	Y	Monitoring, Analysis
2	Apply emissions coefficients to energy demand data	N	Y	N	Medium	6 months compared with EEA EE. NC available at T-3.	Low	Y	Communication, Monitoring, Analysis
3	Calculate energy demand from economic activity and then apply emissions coefficients to energy-demand data	Y	Y	N	Model-based: Medium Assumption-led: Medium/Low	3-6 months compared with EEA EE. NC available at T-3 to T-6	Model-based: High Assumption-led: Medium	Model-based: Probably Assumption-led: Unlikely	Model-based: Communication, Monitoring, Assumptions-led: Communication, Monitoring
4	Link GHG emissions directly to economic activity	Y	N	N	Low	6 months compared with EEA EE. NC available at T-2	Medium/Low	N	Communication

The timeliness of GHG emissions data

As with the material flows data, data on GHG emissions are around three years behind i.e. in 2012, the last year of emissions data is 2009. However, the EEA now produces its own early estimates for the two missing years (at T+9), so the estimation of GHG emissions would yield one year of additional data (a NC for the current year) and, possibly, an EE at an earlier date than EEA's statistic.

Because the EEA already produces its own early estimate, the value added of more up-to-date GHG emissions data is somewhat lower than for other indicators of the same type[24], which are generally more out of date.

Method 1: Construct REI from alternative sources of emissions data

The first method in the list of candidate methods is to find alternative sources of GHG emissions data, in much the same way the EW-MFA estimation method developed by Agilis[25] seeks to generate EEs and NCs from data that measure the same material-flow quantities. We include this approach in the list of candidate methods out of completeness, but note that these data are unlikely to be any more up-to-date than the REI itself, in the case of GHG emissions. This method is of relatively little use because the timeliness of EEs and NCs would be no better than the data themselves.

Barring discrepancies between the REI and predictors, we expect such a method to be 'High' in terms of accuracy, because the method seeks to update the REI with outturn emissions data. Discrepancies may arise from, for example, differences in sector coverage, definitions, and/or measurement. If the method could extend the REI data by a year, the value added of the method would be 'High', but in practice there might be no extension at all.

In the absence of the necessary data, we rate the cost of this method to be Very high, because it would require additional primary data collection.

If it were possible to implement this method, the indicators so produced would be very suitable for analysis (owing to the high level of detail), somewhat suitable for monitoring (high accuracy but poor timeliness) and not suitable for communication (because of the poor timeliness).

Method 2: Apply emissions coefficients to energy demand data

In the absence of other data that measure GHG emissions, we turn our attention to linkages that are further upstream in the logic chain. Consumption of energy gives rise to GHG emissions and such energy data are generally more up-to-date than emissions data: monthly data are available three months after the reference period, allowing for EEs and NCs soon after the years of interest. Thus, it may be possible to estimate GHG emissions by applying emissions coefficients to the energy series. Since the carbon content of different fuels varies, the method will use data for energy consumption by fuel.

Note that this method only addresses the part of GHG emissions from energy use (combustion); it does not cover non-energy emissions such as those from industrial processes or agriculture. In this sense, the coverage of the predictors is only partial with respect to the REI. There are two possible reasons why partial coverage may not necessarily be a problem for the estimation of EEs and NCs:

1. If non-energy emissions account for a small proportion of total GHG emissions (as they normally do), then the method covers the majority of emissions sources and a failure to cover non-energy emissions is relatively less important;

[24] The RERM classifies the GHG emissions REI as a complement to the lead indicator.
[25] Agilis (2011), 'Methodology for the now-casting of Material Flow Accounts'.

2. If there is reason to believe that non-energy emissions change little in the short term, such that movements in energy-related emissions have relatively more bearing on movements in total GHG emissions. If so, then it may be reasonable to assume non-energy emissions to be unchanged in the EEs and NCs.

Provided the breakdown of energy and non-energy emissions satisfies the above, then we would expect this particular method to be quite accurate. This is because the relationship between energy demand and emissions is quite direct, based as it is on emissions content of the individual fuels, which changes little over time (although the emissions content of energy as a whole may differ). The directness of the relationships involved mean that this method will help to detect a change in trend.

We rate this method as 'Medium' in terms of accuracy, rather than 'High', largely because the method only covers energy-related emissions.

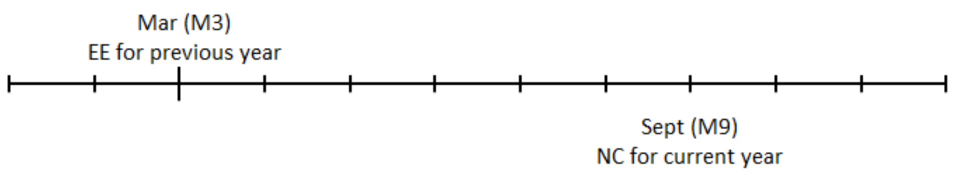
We rate the cost of the method to be low, because the energy data are readily available from Eurostat, as are the emissions coefficients. The estimation involves a straightforward conversion of energy to emissions and, possibly, aggregation.

This method makes use of direct relationships between energy demand and emissions. Since it scores well on timeliness and accuracy, it would be suitable for communication, monitoring and analysis.

The data we identify as a suitable predictor variable for this method is monthly fuel consumption data from Eurostat. Monthly figures, disaggregated by fuel group (solid fuel, oil and gas) and further broken by product (e.g. within oil: kerosene, diesel, naphtha etc.) are available at T+3 months i.e. in March of each year, the data for fuel consumption the previous December become available, generating a complete year of fuel-consumption data. As such, it is possible to produce an early estimate of (energy-related) GHG emissions at T+3.

The timeliness of the monthly data also means that data for the *current* year become available that same year. By September (Month 9) of each year, there are monthly fuel data for half the current year. This may be sufficient information on which to base a nowcast.

We illustrate the potential timeliness improvement in a timeline like the one below, to indicate at what points in the year EEs and NCs are possible:



We use timelines such as these in our assessment of the feasibility of producing EEs and NCs and present them in Annex C of this report.

Method 3: Calculate energy demand from economic activity and then apply emissions coefficients to the energy-demand figures

It is often the case that economic data are more up to date than energy data or, for nowcasting purposes; forecasts for economic indicators may be more readily available than for energy consumption. In such a situation, it may be useful to move one step further back in the chain of logic, to consider the way in which economic activity drives energy demand, which in turn drives GHG emissions. The timeliness of this method with respect to the production of EEs and NCs is the best of the methods assessed thus far, because forecasts are available up to and including the current year (the NC).

By this method, we aim to relate energy demand to household expenditure/income and industrial output (which requires energy as an input to production). Once we have produced estimates of energy demand, as in Method 2, we can apply emissions coefficients to estimate (energy-related) GHG emissions. Moreover, we may be able to link economic activity to non-energy emissions (from, for example, industrial processes).

The accuracy of this method compared to trend extrapolation rests on the strength of the relationship between economic activity and energy demand/non-energy GHG emissions. As we note above, the relationship between energy demand and emissions is fairly stable. However, there are reasons to think the relationship between economic activity and energy demand/non-energy GHG emissions is less stable because it is likely influenced by a wider array of factors such as investment (in energy-consuming technologies) as well as energy prices (which may encourage substitution). Such a method is suitable to estimate the approximate level of emissions (which is easily monitored and communicated) but not suitable as an indicator of energy/emissions intensity (because that is assumed as part of the method). An indicator produced this way is unlikely to be suitable for analysis.

We would expect a more detailed treatment of energy demand (i.e. a more model-based approach) that incorporates the aforementioned factors to be more accurate (but more costly) than a less detailed (but lower cost), more assumptions-led approach.

Overall, a more model-based version of this method, with a relatively more complete treatment of the relationship between economic activity and energy demand would be a ‘High’ value added method. A method that makes more use of assumptions will tend to be ‘Low’ in value added terms because it will have a more rudimentary treatment of substitution between energy types and of trends in energy efficiency. These are key policy questions.

The cost of this method is ‘Medium’ to ‘High’ because it requires some investment in modelling using a number of datasets to parameterise the model and estimate emissions, but it relies on freely available official data sets.

Method 4: Link GHG emissions directly to economic activity

The final method in our example list is an abbreviated version of Method 3. Rather than estimate energy demand from economic activity and then estimate emissions from projected energy demand, the last method we consider moves directly from economic activity to GHG emissions. This depends on the derivation and application of coefficients that link economic activity to GHG emissions. This method is of similar timeliness to the previous one: both make use of economic data and forecasts.

By using less data and fewer calculation steps, this method is clearly less costly than the previous method, because there is no need to estimate energy demand as an intermediate step. However, this is also likely to affect the accuracy and value added of the method, for a similar reason to Method 3: we reduce the complexity and cost by imposing more assumptions. As mentioned previously, more assumptions restrict the application of a particular EE and NC for policymaking, although the nature of the assumptions will determine whether the method yields a policy-relevant indicator.

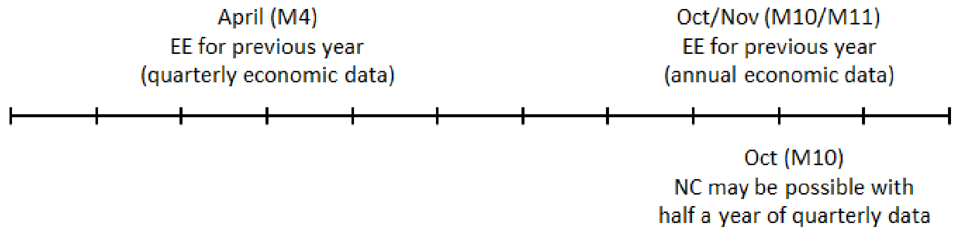
The value added of this method is likely to be 'Low', for similar reasons to a more assumptions-led approach to Method 3. Such assumptions on the relationship between economic activity and GHG emissions are likely to be poor substitutes for indicators of policy relevance (energy efficiency/substitution). This method has little use for analysis, and is likely to be poor for monitoring.

The cost of this method is Medium-to-Low, depending on the level of disaggregation used. A simple MS-level aggregate for economic activity (e.g. GDP) and total emissions will be Low cost, whereas a breakdown by economic sector would tend to be more Medium cost.

In the case of Methods 3 and 4, the key predictor variable is national accounts data from Eurostat, to track economic activity. Quarterly data are available at T+4 months, so a complete year of economic data can be formed in Month 4 of the following year. In the case of annual national accounts data, the next full release is after 10 or 11 months i.e. T+10/T+11 months. This is the earliest time we can produce an EE using the annual data.

As with the monthly energy statistics for Method 2, quarterly economic data for the *current* year become available that same year. Thus, half a year of economic data have been released by Month 10 of each year, which may be enough information on which to base an NC.

As with the monthly energy statistics method, we illustrate the timeliness of the various predictor data using a timeline, as shown below:



A comparison of the estimation methods

The summary information presented earlier in Table 2-5 allows us to apply our assessment methodology to the four methods. For analysis, only Methods 1 and 2 offer the prospect of sufficient accuracy to be fit for purpose. Method 1 offers high accuracy, but little gain in terms of timeliness and so its value added is limited and its cost is very high, so it is unattractive. Method 2 offers medium accuracy with some gain in timeliness (compared with the EEA EEs): its value added depends on how important the gain of six months is perceived to be. Since its cost is low, it could be attractive. Methods 3 and 4 offer no gain in timeliness and no improvement in accuracy compared with Method 2, and so their value added is no higher, while their cost is higher. Hence, the assessment gives the result that Method 2 could be attractive, while the other methods are not.

2.4 Applying the assessment to the remaining indicators

In this section we present the results of applying the assessment procedure to possible EE/NC methods for the list of indicators that remain after the first pass assessment. The following table summarises the results. Separate sheets giving the details for each indicator are presented in Annex C.

Table 2-6: Summary of value added and cost assessment

INDICATOR INFORMATION			CANDIDATE EE/NC METHODS	VALUE ADDED ASSESSMENT		VALUE ADDED/COST ASSESSMENT	
Indicator number	External reference number	Indicator name	Method	# years gained	Likely accuracy	Value added	Cost
RE002	A6-2	Artificial land or built-up area	Method 1 (EEs and NCs): Update the indicator with more timely spatial data from national sources.	Up to 3	Unknown	Low/Medium	High (prohibitively so)
			Method 2 (EEs only): Update the indicator with more timely physical data.	Up to 2	Low/ Medium	Low/Medium	Low
RE004	A6-4	Water exploitation index	Method 1 (EEs only): Update with information from national sources.	1 at most	Medium/High	Medium/High	Low
RE005	A6-5a	Water footprint (national level)	Method 1 (EEs and NCs): Apply historical ratios to more timely economic data and use more up-to-date physical data, where available.	Up to 6 (because indicator is not regularly reported)	Low/ Medium	Medium	Medium
RE005	A6-5c	Water footprint (product level)	Method 1 (EEs only): Apply historical ratios to more timely economic data and use more up-to-date physical data, where available.	Up to 5 (because indicator is not regularly reported)	Low/ Medium	Medium	Medium
RE007	A6-7	GHG emissions	Method 1 (EEs and NCs): Apply emissions coefficients to energy consumption data.	1-2	Medium	Medium/High	Low
			Method 2 (EEs and NCs): Calculate energy demand from economic activity and then apply emissions coefficients.	1-2	Low/Medium	Low/Medium	Low
			Method 3 (EEs and NCs): Link GHG emissions directly to economic activity.	1-2	Low/Medium	Low/Medium	Low
RE008	A6-8	Carbon footprint	Method 1 (EEs only): Apply coefficients from a previous year to more recent product consumption data.	Up to 4	Medium	High	Low/Medium

INDICATOR INFORMATION			CANDIDATE EE/NC METHODS	VALUE ADDED ASSESSMENT		VALUE ADDED/COST ASSESSMENT	
Indicator number	External reference number	Indicator name	Method	# years gained	Likely accuracy	Value added	Cost
RE016	A6-16	Output or share of green products in total output	Method 1 (EEs only): Construct indicator using Structural Business Statistics (SBS) data.	1-2	Unknown	Low/Medium	Low
RE020	A6-20	Total waste generation	Method 1 (EEs only): Link to economic statistics on waste.	3	Unknown	Medium	Low
			Method 2 (EEs only): Update with information from individual MSs.	0	High	NA	NA
RE021	A6-21	Overall recycling rate	Method 1: Use national recycling data to generate more up-to-date indicator estimates.	Up to 3	Low/ Medium	Medium	Medium
RE022	A6-22	Landfill rate	Method 1: Use national landfill data to generate more up-to-date estimates.	Up to 3	Low/ Medium	Medium	Medium
RE032	A6-32	Average annual land take on the basis of the EEA Core Set Indicator 14 land take	Method 1 (EEs and NCs): Update the indicator using the most recent LUCAS data and supplement with more timely spatial data from national sources.	Up to 6 (because indicator is not regularly reported)	Unknown	Low/Medium	High (prohibitively so)
			Method 2 (EEs only): Update the indicator with more timely physical data.	Up to 5 (because indicator is not regularly reported)	Low/ Medium	Low/Medium	Low
RE038	A6-38	Development in consumption of different meat and dairy products per capita per year based on ETC/SCP Indicator 13.2 for the EEA	Method 1 (EEs and NCs): Reconstruct annual indicator from underlying monthly data.	Up to 3	Medium/High	High/Very high	Medium

INDICATOR INFORMATION			CANDIDATE EE/NC METHODS	VALUE ADDED ASSESSMENT		VALUE ADDED/COST ASSESSMENT	
Indicator number	**External reference number**	**Indicator name**	**Method**	**# years gained**	**Likely accuracy**	**Value added**	**Cost**
RE042	A6-42	CO_2 emissions in the transport sector	Method 1 (EEs and NCs): Apply emissions coefficients to travel data.	1-2	High	High/Very high	Low
			Method 2 (no improvement in timeliness): Apply emissions coefficients to travel data.	0	Low/ Medium	NA	NA
RE044	A6-44	Average CO_2 emissions per km for new passenger cars	Method 1 (EEs only): Update indicator using individual MSs' data releases.	0-1	High	Medium/High	Low/Medium
RE045	A6-45	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD)	Method 1 (EEs and NCs): Apply emissions coefficients to travel data.	1-2	High	High/Very high	Low
			Method 2 (no improvement in timeliness): Apply emissions coefficients to travel data.	0	Low/ Medium	NA	NA
RE064	Add16	Turnover from environmental goods and services sector per GDP	Method 1 (EEs only): Construct indicator using Structural Business Statistics (SBS) data.	1-2	Unknown	Low/Medium	Low

3 Prioritising Indicators

In this chapter we develop a method and criteria to assess all remaining indicators for which suitability for early estimates (EE) and/or nowcasting (NC) has been reassessed in this study (list in Table 2.6) to rank, score, group or list them in order of how they should be prioritised for EE and/or NC. The focus is on selecting criteria that would best capture the relative importance of selected resources for EE and NC. If needed, the method could take into account changed preferences over time, i.e. priority ranking could be adjusted via changed scores on selected criteria. It also provides for a simple visual output while keeping the needed amount of detail and sophistication.

3.1 Foundations in previous chapter

Chapter 1 – REI factsheets: the indicators selected for factsheets were selected on the basis of their inclusion in the RERM and its annexes. Implicit within this is an assumption that the areas of highest policy importance and need for indicators were identified and highlighted in the RERM.

Additional indicators were also selected based on consultant and client judgement.

Important quality and status descriptors for the factsheets were:
- Policy relevance – links;
- Scale – geographical;
- Type – e.g. production, lifecycle, DPSIR, European Environment Agency;
- Current status – development, implemented?
- Quality of statistics – as understood by timeliness, frequency, length of time-series and data availability.

Chapter 2 – Assessing EE and NC potential of the REI: the primary questions asked in the first assessment of the feasibility of the REI for EE and NC were:
- Data availability - is it conceivable that there is a source available for EE/NC other than the one used to construct the indicator?
- Development status - has the indicator already been sufficiently developed or already published (so that an assessment of the accuracy of an EE/NC method could be made)?

In addition to this an assessment of data quality is undertaken which assesses indicators by the following factors:
- Relevance;
- Accuracy;
- Timeliness and punctuality;
- Comparability and coherence;
- Accessibility and clarity.

As discussed in Chapter 2 the *relevance* component measures whether an indicator may be of use to a policymaker as well as whether it is available at the appropriate time for the intended purpose, i.e. timeliness. Underlying this is an assessment of the level of relevance of each REI (from very high to low), which is important to distinguish between similar REIs in terms of the level of cost and value added. Assessment of the level of relevance is a matter of judgement and justification, for example based on whether policy makers have already used a certain indicator for monitoring or other purposes.

3.2 Overview of the method & criteria for prioritising indicators

There are a variety of potential approaches to this task, however, it is important to balance sophistication and consideration of all the issues with simplicity of undertaking this task and understanding the results.

3.2.1 "Three-dimensional ranking system"

The method chosen for this task is a "three-dimensional ranking system", based on the approach used in previous work on critical raw materials.[26] This approach ranks indicators by their three most important dimensions, two of which are plotted on a graph (each dimension corresponds to one axis) and the third of which is represented by a point size characteristic.

The two dimensions are:
1. X-axis – cost and;
2. Y-axis - value added of EE/NC.

The size dimension is:
3. Policy relevance.

This therefore takes the outputs of the NC/EE assessment presented in Chapter 2 (and Annex C) and then adds a policy relevance dimension to rank them.

Ranking

All three criteria have a score assigned from 0-10 for each of their categories (with 10 corresponding to the best score). This enables ranking of each assessed indicator along these three dimensions and deriving a final score. Moreover, since for some assessed indicators more than one NC/EE method exists, all methods for a given indicator are ranked, and the 'best' method in terms of the final score is chosen in this study to determine the final ranking of this indicator. Most of the time, the differences in scores between the methods are large, and hence the selection of 'best' method becomes obvious. For example, this is the case if one method has prohibitively high costs that applying NC/EE methods becomes impossible.

Visual presentation

As mentioned above, the two dimensions, cost and value added plot the corresponding indicator on a graph, while the third dimension, policy relevance, is shown in terms of a bubble size, i.e. the larger the bubble representing the indicator, the higher policy relevance, and *vice versa*.

3.2.2 Criteria applied

Cost

As described in the previous chapter, this is a measure of the ease in terms of implementation of an EE/NC method, i.e. the work required to develop and subsequently maintain an EE/NC (e.g. in terms of man days needed, and availability and accessibility of data). The scoring will follow the approach used for EEs and NCs, and assign a score 0-10 for each category of cost. A small modification in scoring, i.e. an inverse scale, is required for presentation purposes (to have an x-axis going from low to high cost rather than high to low cost). The cost of indicator scoring system is defined as follows:

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[26] EC DG ENTR (2010) Critical raw materials for the EU.

Table 3-1: Cost of indicator scoring system

Cost	Definition	Score ranking 0-10	Score graph (inverse)
Very High	The data processing requirements are extensive, data very costly and or require significant additional collection.	0	10
High/Very high		1.25	8.25
High	The data processing requirements are heavy and the data must be purchased, or require additional collection.	2.5	7.5
Medium/High		3.75	6.25
Medium	EE/NC requires substantial effort using available data, or EE/NC easy to do but data must be purchased.	5	5
Low/Medium		6.25	3.75
Low	EE/NC is easy to do, freely available data and relatively straightforward further processing.	7.5	2.5
None/Low		8.75	1.25
None		10	0

Value added

In general, Chapter 2 has been a screening exercise of the potential for EE/NC based on what is currently available. This is separate from implementation of an EE/NC method for an indicator, in which case actual data are used for testing the EE/NC method. The reason for this is that in some cases, it is possible to evaluate performance over extrapolation based on the logic of the EE/NC method. However, in others it may not be so either because the method needs to be tested to find out if it is an improvement or because the indicator has historically followed a trend anyway (so it would be difficult to “prove” on historical data the relative effectiveness of the method). The rules for evaluating the two components of the value added are discussed in Chapter 2. Implementation of NC/EE methods on MFA indicators forms part of Chapter 4 of this report. The scoring (0-10) used for prioritising indicators on the value added dimension is the following:

Table 3-2: Value added scoring system

Value Added	Definition	Score ranking 0-10
Very High	2-3 years added to the series and high accuracy.	10
High/Very high		8.75
High	1 year added and high accuracy or 2-3 years added and medium accuracy.	7.5
Medium/High		6.25
Medium	2-3 years added and medium accuracy 2-3 years added and unknown accuracy or 3 years added and low accuracy.	5
Low/Medium		3.75
Low	1 year added and medium accuracy or 1 year added and unknown accuracy.	2.5
None/Low		1.25
None		0

Policy relevance

Policy relevance (PR) is scored based on existing “3-layer” indicator definitions in RERM (Lead, Dashboard and Thematic) and Supplementary category is added to account for the additional indicators assessed in this study (Add1-16) but not derived directly from the Annex 6 of RERM. This is complemented by qualitative judgement as follows:

Table 3-3: Policy relevance scoring system

Policy Relevance	Indicator Type	Score ranking 0-10
Very High	Lead	10
High	Dashboard	7.5
Medium	Thematic	5
Low	Supplementary	2.5

This scoring system can be easily adapted according to the needs and political priorities of the European Commission. A spreadsheet has been supplied to DG ENV for this purpose.

Based on the first pass of EE/NC feasibility and assessment in this study there are six complementary indicators (potential for dashboard), followed by nine thematic indicators and one supplementary, in total 16 indicators.

The Lead indicator, Resource Productivity (A6-1 RE001) as well as RMC (A6-13 RE013), RP of minerals and metals (A6-29 RE029) and TMC (Add3 RE051) are not prioritised for EE/NC in this chapter since EE/NC methods will be directly applied to them in Chapter 4. Nevertheless, Resource Productivity indicator is included in the ranking of remaining 16 indicators for the purpose of comparing its score with other prioritised indicators.

3.3 Results

Applying this method and criteria, the following results were obtained (for more detail see figure 3.1 and table 3.1):

- **Four indicators ranked first in the priority list to be EEed or NCed**, scoring 21.25 points out of 30, these are:
  - Water Exploitation Index (%);
  - GHG emissions (Method 1);
  - Carbon footprint;
  - CO_2 emissions in the transport sector ($MtCO_2$) (Method 1).

The first three scored high on policy relevance dimension (all belong to the dashboard), they had medium/high – high value added and low to low/medium cost. The last of the four indicators belongs to the thematic indicators for transport (scoring medium on policy relevance), but had high/very high added value and low cost. This result is not very surprising given three out of four indicators are related to CO_2 emissions, whose statistics are well documented and highly politically relevant, hence the priority to be EEed or NCed:

- The Lead indicator, Resource Productivity would rank only the 8th on the priority list for EE/NC, if this method and criteria would be applied (score 17.5 points out of 30).

This result is a bit surprising since one would expect a higher score for this lead indicator. This relatively low score is mainly due to the high cost of producing and maintaining timely data for this indicator, as well as its medium value added compared to current timeliness and accuracy of this indicator. The fact that EE/NC methods are being applied to this indicator within this study shows the importance of political relevance. Rank 8 is shared with two indicators on water footprint, total waste generation and average CO_2 emissions per km for new passenger cars:

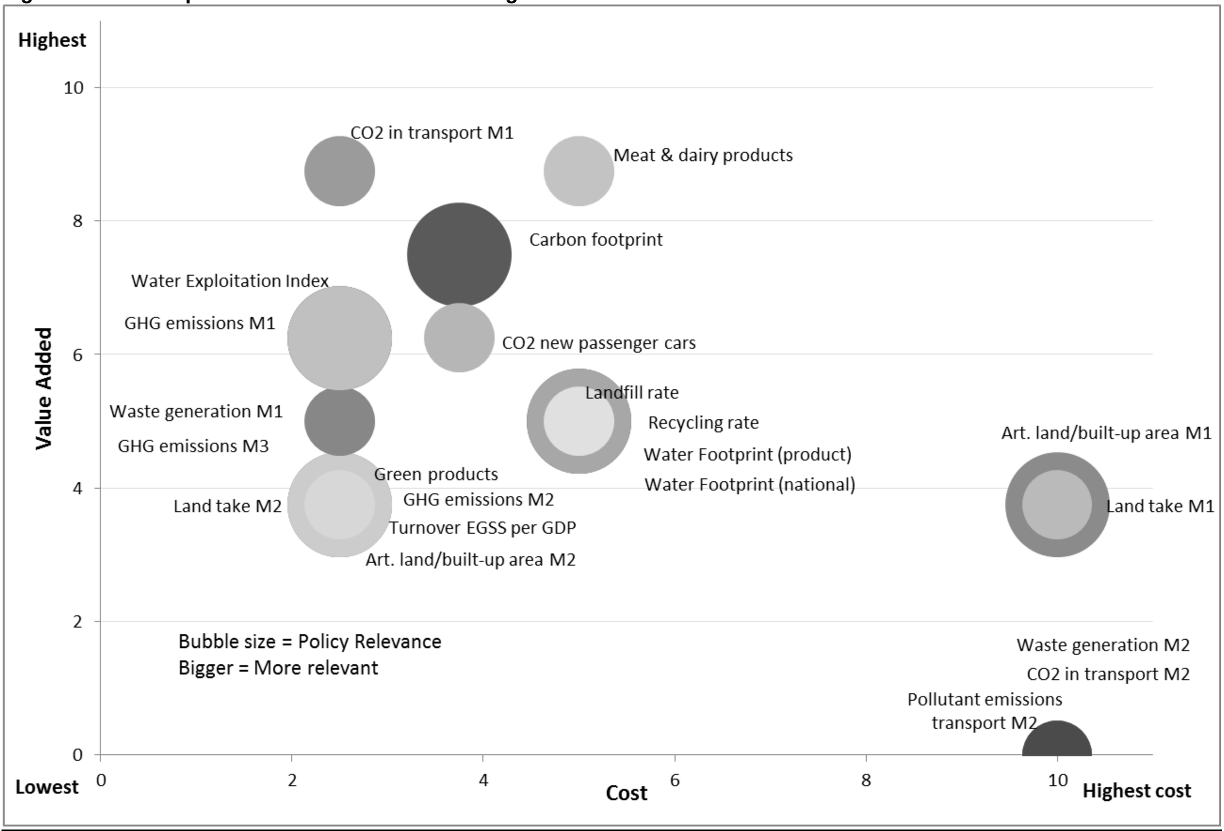
- Artificial land or built-up area would score the 6th on the priority list due to its high policy relevance, low/medium value added and low cost of method 2;

- Rank 6 is shared with the indicator measuring the development in consumption of different meat and dairy products, which has medium policy relevance and cost but high/very high value added;
- Waste indicators related to overall recycling rate and landfill rate are the second last on the priority list to be EEed or NCed due to their medium scores for all three dimensions;
- The last indicator according to this method and criteria to be EEed or NCed is the additional indicator to the RERM on the turnover from environmental goods and services sector per GDP mainly due to its low policy relevance and low/medium value added compared to current timeliness of this indicator.

In three cases, total waste generation (method 2), CO_2 emissions in the transport sector (method 2) and pollutant emissions from the transport sector (method 2), the value added and cost entries are marked NA. This is because the method originally thought of does not help to bring that indicator up to date. This shows the cases where proposed predictor was not any more timely, in order to note what ended up as a dead end.

Figure 3.1 presents visually the rankings of all indicators. The size of the bubble indicates policy relevance, the bigger size, the more relevant indicator is. The grey scales are random.

Figure 3-1: Visual presentation of indicator ranking



Source: Cambridge Econometrics assessment and Ecorys own calculations.
Note: High score on cost axis in the graph signifies high cost assigned to an EE/NC method for an indicator. This is different from the score on cost assigned for the purpose of ranking indicators. For ranking indicators, high score on cost dimension implied low cost of an EE/NC method, thus the inverse.

Table 3-4 gives an overview of the assessment and scores for each of the assessed indicators and EE/NC methods in this study. It also provides the total score per indicator, indicates the best EE/NC method (if applicable) and ranks all indicators.

Table 3-4: Overview of indicator ranking

No.	Indicator	Policy relevance (bubble size)	Score 0-10	Value added	Score 0-10	Cost	Score 0-10	Cost graph	Total Score	Rank	Best method	Indicator Rank
A6-1 RE001	Resource Productivity	Very High	10	Medium	5	High	2,5	7,5	17,5	10	17,5	8
A6-2 RE002 M1	Artificial land or built-up area (km^2) - Method 1	High	7,5	Low/Medium	3,75	Very High	0	10	11,25	20		
A6-2 RE002 M2	Artificial land or built-up area (km^2) - Method 2	High	7,5	Low/Medium	3,75	Low	7,5	2,5	18,75	6	18,75	6
A6-4 RE004	Water Exploitation Index (%)	High	7,5	Medium/high	6,25	Low	7,5	2,5	21,25	1	21,25	1
A6-5a RE005	Water footprint (national level)	High	7,5	Medium	5	Medium	5	5	17,5	10	17,5	8
A6-5c RE005	Water footprint (product level)	High	7,5	Medium	5	Medium	5	5	17,5	10	17,5	8
A6-7 RE007 - M1	GHG emissions - Method 1	High	7,5	Medium/high	6,25	Low	7,5	2,5	21,25	1	21,25	1
A6-7 RE007 - M2	GHG emissions - Method 2	High	7,5	Low/Medium	3,75	Low	7,5	2,5	18,75	6		
A6-7 RE007 - M3	GHG emissions - Method 3a (model based)	High	7,5	Low/Medium	3,75	Low	7,5	2,5	18,75	6		
A6-8 RE008	Carbon footprint	High	7,5	High	7,5	Low/Medium	6,25	3,75	21,25	1	21,25	1
A6-16 RE016	Output or share of green products in total output (turnover in current prices) - Method 1	Medium	5	Low/Medium	3,75	Low	7,5	2,5	16,25	15	16,25	13
A6-20 RE020 M1	Total Waste Generation - Method 1	Medium	5	Medium	5	Low	7,5	2,5	17,5	10	17,5	8
A6-20 RE020 M2	Total Waste Generation - Method 2	Medium	5	NA	0	NA	0	10	5	22		
A6-21 RE021	Overall recycling rate	Medium	5	Medium	5	Medium	5	5	15	17	15	15
A6-22 RE022	Landfill rate	Medium	5	Medium	5	Medium	5	5	15	17	15	15
A6-32 RE032 M1	Average annual land take on the basis of the EEA Core Set Indicator 14 land take - Method 1	Medium	5	Low/Medium	3,75	Very High	0	10	8,75	21		
A6-32 RE032 M2	Average annual land take on the basis of the EEA Core Set Indicator 14 land take - Method 2	Medium	5	Low/Medium	3,75	Low	7,5	2,5	16,25	15	16,25	13
A6-38 RE038	Development in consumption of different meat and dairy products per capita per year based on ETC/SCP Indicator 13.2 for the EEA	Medium	5	High/Very high	8,75	Medium	5	5	18,75	6	18,75	6
A6-42 RE042 M1	CO_2 emissions in the transport sector ($MtCO_2$) - Method 1	Medium	5	High/Very high	8,75	Low	7,5	2,5	21,25	1	21,25	1
A6-42 RE042 M2	CO_2 emissions in the transport sector ($MtCO_2$) - Method 2	Medium	5	NA	0	NA	0	10	5	22		
A6-44 RE044	Average CO2 emissions per km for new passenger cars	Medium	5	Medium/High	6,25	Low/Medium	6,25	3,75	17,5	10	17,5	8
A6-45 RE045 M1	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD) - Method 1	Medium	5	High/Very high	8,75	Low/Medium	6,25	3,75	20	5	20	5
A6-45 RE045 M2	Pollutant emissions (NOx, VOC, PM) from the transport sector (available from EEA / Reporting under NECD) - Method 2	Medium	5	NA	0	NA	0	10	5	22		
Add16 RE064	Turnover from environmental goods and services sector per GDP	Low	2,5	Low/Medium	3,75	Low	7,5	2,5	13,75	19	13,75	17

4 Nowcasting of Material Flow Indicators: Method

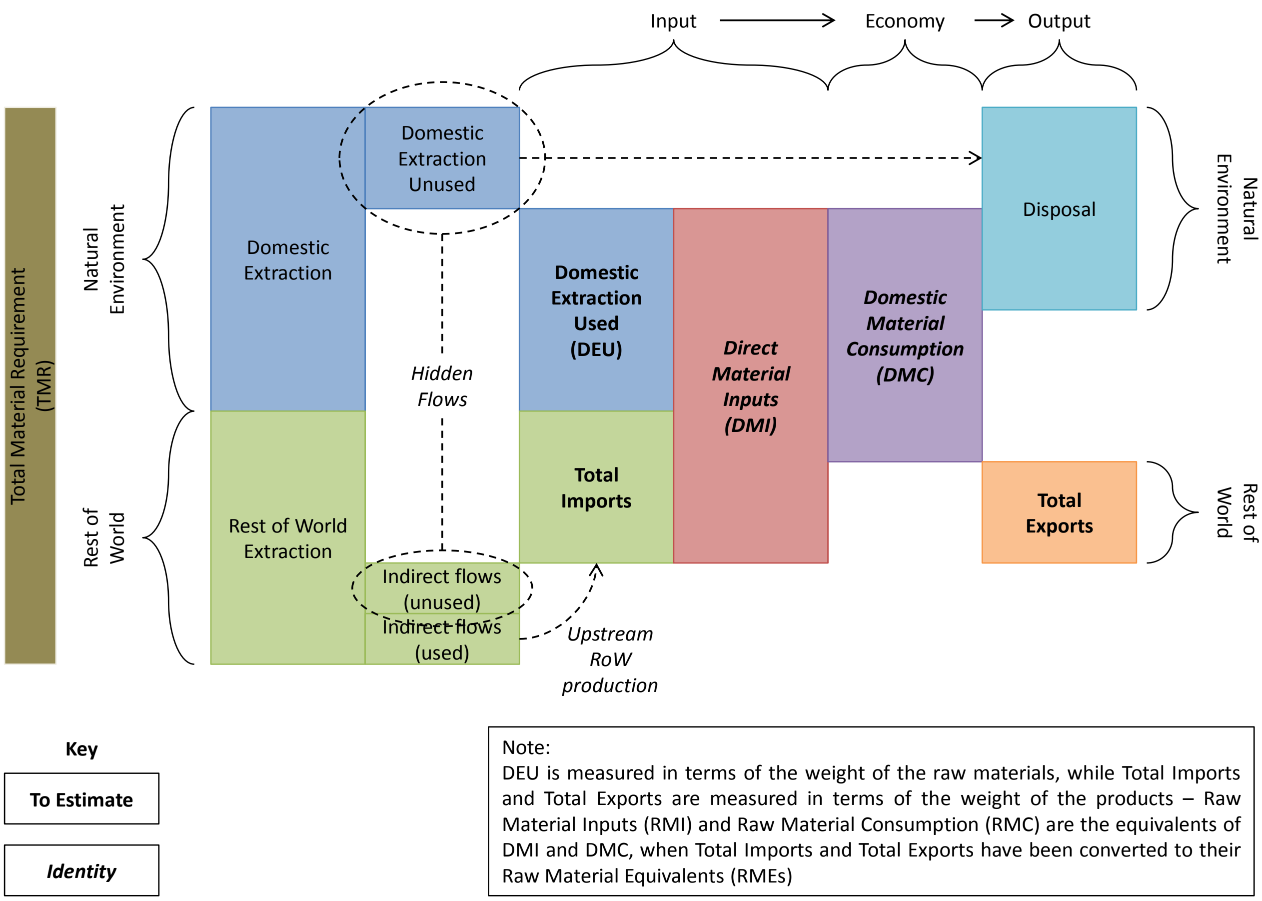
In this chapter, we present the method we have adopted for producing EEs and NCs for material flow indicators, together with the results of applying the method to generate EEs/NCs for the indicators.

4.1 The accounting structure and the indicators for which estimates are required

4.1.1 The accounting structure

Figure 4-1 shows the accounting structure used to measure various flows of materials in and out of an economy.

Figure 4-1: Representation of material flows in the domestic economy



Domestic Extraction refers to the quantity of material removed from the natural environment by the domestic economy and consists of used and unused domestic extraction. The part that is used is the domestic material flow into the economy, *Domestic Extraction Used* (DEU):

Domestic Extraction = DEU + Unused Domestic Extraction

Similarly, materials extracted by the rest of the world may be divided into used and unused. The part that is used and flows into the domestic economy is called *Total Imports*. The portion of rest-of-world extraction that does not flow into the domestic economy makes up so-called *Indirect Flows*:

Rest of World Extraction = Total Imports + Indirect Flows

These indirect flows may either be from unused overseas extraction (the rest-of-world analogue of Unused Domestic Extraction), or because the materials are used upstream for the production of goods that flow into the domestic economy. The Eurostat database also identifies *Extra-EU27 Imports* as a series.

The sum of Domestic Extraction and Rest of World Extraction (i.e. used and unused material extraction both domestically and abroad) give the Total Material Requirement (TMR):

TMR = Domestic Extraction + Rest of World Extraction

Because Indirect Flows include upstream material consumption in overseas production, as defined, the Total Imports flows into the domestic economy are not necessarily materials in their rawest form; the imported products will be a mix of:

- raw products;
- semi-manufactured products;
- finished products.

Thus, the definition of Total Imports does not cover the materials embodied in the production of the imported goods, only the material content of the products that actually enter the domestic economy i.e. the weight of the products. The raw material equivalents (RMEs) of the imported goods would represent the Indirect Flows associated with imports, in addition to the material content of the products. Eurostat is currently developing conversion factors to convert the relevant imported products into RME.

Together, DEU and Total Imports constitute *Direct Material Inputs* (DMI), the material flows into the domestic economy, for production and consumption:

DMI = DEU + Total Imports

In the terminology of EW-MFA, unused domestic extraction and unused Indirect Flows make up so-called *hidden flows*:

Hidden Flows = Unused Domestic Extraction + unused Indirect Flows

The materials that flow into the economy, DMI, may remain in the domestic economy (for, ultimately, domestic consumption) or may be exported (as products, typically). DMI is thus broken down into Domestic Material Consumption (DMC) and Total Exports. Equivalently, DMC is:

DMC = DMI – Total Exports

As with Imports, Eurostat also collects data on *Extra-EU27 Exports*. As with Total Imports, Total Exports are not expressed in RME. The process for converting to RME is the same as for Total Imports.

We may also define DMC as:

DMC = DEU + (Total Imports – Total Exports)

where the terms in brackets, the difference between Total Imports and Total Exports, give the Physical Trade Balance (PTB), which may be in either surplus or deficit.

Because DEU is, by definition, a measure of raw material extraction, but Total Imports and Total Exports are simply measures of the weight of the products, there are some concerns that DMC may be a misleading measure of resource consumption. For example, if an economy switches from domestic ore extraction (raw material) to imports (likely to have been processed, at least in part, and thus of lower weight), DMC may fall, indicating an increase in resource efficiency, even if the production process that makes use of the processed ore is unchanged in the domestic economy. DMC may understate the resources associated with traded products.

Raw Material Consumption (RMC) is likely to give a more balanced view of resource use, because it uses the RMEs of Total Imports and Total Exports:

RMC = DEU + Total Imports (RME) – Total Exports (RME)

The RME of DMI, Raw Material Inputs (RMI) is similar:

RMI = DEU + Total Imports (RME)

4.1.2 The indicators for which estimates are required

The nowcasting system is to provide estimates for:

- Domestic Material Consumption (DMC);
- Domestic Extraction Used (DEU);
- Imports;
- Exports.

ensuring that the following identity holds (which also determines Direct Material Inputs (DMI)):

DEU + imports = DMC + exports = DMI

The system will also provide estimates for the raw material equivalents (RME) of imports and exports and, given these indicators, we will also have estimates for:

Raw Material Inputs (RMI) = DMI + RME of imports

and

Raw Material Consumption (RMC) = RMI – RME of exports

Finally, the system is also to estimate:

Total Material Requirement (TMR) = DMI + hidden flows in domestic and RoW extraction

Given an estimate for GDP (which is outside the scope of this work), it is possible to calculate an estimate for the derived productivity indicator GDP/DMC.

4.2 Characteristics of the Eurostat EW-MFA dataset

4.2.1 Timeliness of data

Eurostat collects MFA data from the individual Member States through the EW-MFA questionnaire. Eurostat issued the most recent questionnaire in May 2011[27], to collect data principally for the period 1990-2009, although the data are most complete from 2000 onwards. MSs were also invited to submit data for 2010, if available. To date, Eurostat has issued EW-MFA questionnaires at two-year intervals and published the data in the spring of the following year.

The EW-MFA are largely a compilation of existing European and national statistics. The key sources for domestic extraction are statistics on:

- agricultural, forestry and fishery production;
- mining;
- energy balances.

Foreign trade statistics are the main source of import and export data, although some countries make use of their national accounts data.

4.2.2 Coverage by material type

At its broadest, the EW-MFA distinguish four main categories of material for domestic extraction, each with its own further subdivisions:

- Biomass (classification code MF1);
- Metal ores (gross ores) (MF2);
- Non-metallic minerals (MF3);
- Fossil energy materials/carriers (MF4).

For imports and exports, each of the above has a subcategory ('Products mainly from …') for cases where it is not straightforward to allocate a product to a particular material subcategory. Additionally, there are two top-level categories that relate to imports and exports only:

- Other products (MF5) (for goods that cannot easily be classified to a particular material);
- Waste for final treatment and disposal (MF6).

At present, Eurostat only publishes Total Imports and Total Exports in terms of product weight, not as RMEs.

4.3 Predicting DEU and DMC by linking to production and economic indicators

4.3.1 Motivation

The method set out in Agilis (2011)[28] for producing EEs for MFA series is bottom-up and data-intensive, in that it tries, as far as possible to replicate the procedure followed by Eurostat to produce the published MFA series. For some of the components of MFA (), the method scores relatively poorly in terms of costliness (because of the time required to gather and process the detailed data sets) and timeliness (because it only provides information up to the last year for which the detailed data sets are available): estimates are available only at T+2 years.

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27 See the CIRCA Eurostat library: http://circa.europa.eu/Public/irc/dsis/pip/library?l=/material_accounts/questionnaire_2011&vm=detailed&sb=Title.

28 Agilis (2011), 'Methodology for the now-casting of Material Flow Accounts'.

An alternative approach is to link DEU to *production indicators that are relevant to the extraction of materials*, and DMC to *economic indicators that are relevant to the use of materials*. The economic indicators are typically available only at a relatively highly aggregated level (1-digit or, at most, 2-digit NACE); also, to the extent that forecasts for these indicators are to be used for nowcasting, the cost/feasibility of obtaining forecasts for all Member States also points to the use of broad aggregates.

Since data on trade in goods are relatively up to date, EEs for exports and imports can be based directly on the trade data. Our modelling strategy for any given material and country is, therefore, either:

- to use a production indicator to predict DEU;
- to use an economic indicator to predict DMC.

and then to use estimates for imports and exports to derive the remaining variable (DEU or DMC) from the identify that links them. For example, if we use a production indicator to predict DEU, we derive DMC using the rule:

DMC = DEU + (Total Imports – Total Exports)

4.3.2 Matching of MFA variables and components to predictors

The choice of disaggregation of MFA components (materials)

The overriding purpose of the EE and NC exercise is to produce estimates of the MFA variables for each Member State and the EU27 total. A subsidiary aim is to break these down into broad groups of materials (at 1-digit level for the MF classification). However, in some cases we choose to disaggregate a little further by material, because an available predictor is most plausibly related to a more specific category than the 1-digit MF classification.

About 41% of DMC in 2009 of the six largest Member States was accounted for by building materials: sand & gravel (32%) and limestone & gypsum (9%). A further 15% was accounted for by oil and gas products (‘Liquid and gaseous energy materials/carriers’). A further 32% was accounted for by crop residues (22%: 12% and 10% respectively for fodder and non-fodder) and coal and other solid energy carriers (10%). These materials therefore together accounted for 88% of the total. In a small number of countries, other items are also important: wood, iron and non-ferrous metal ores, other groups of building materials (marble, granite, sandstone etc., and ‘other non-metallic minerals’). When these are included, the coverage of MFAs for the six largest Member States rises to almost 100%, and the coverage is 93% or more in every Member State.

We therefore focus our attention on economic indicators relevant for predicting consumption and production of:

- non-metallic minerals (mainly building materials);
- oil & gas and coal;
- crops and crop residues;
- metal ores;
- wood.

The choice of predictor variables

Table 4-1 shows the predictors that have been used to link to these groups within the MFAs. The choice of predictors balances the need for an indicator that is closely related to the material of interest, with the need for an indicator for which data are likely to be available in a reasonably timely manner (including forecasts/ nowcasts). All of the predictors shown in the table are available less than a year after the end of the calendar year to which they refer (that is, their timeliness is better than T+12), and in some cases there are monthly data which can inform a nowcast for the current year.

In order to predict DMC we use an indicator of the scale of activity in a relevant user industry. Clearly this is more likely to be effective when there is a single industry that is a dominant user of the material. For example, the construction sector is the dominant user of non-metallic minerals and so we expect changes in the use of these materials to reflect changes in the scale of activity in the construction sector. The question then arises as to which indicator to use to measure the scale of activity in the user industry. In some Member States and sectors there is a measure of 'production' (the weight or value of the output of the sector); in most Member States and sectors there is a measure of 'real'[29] Gross Value Added. Formally, GVA is a measure of the value added by an industry, and so (for example) GVA of the construction sector is the difference between the value of the sector's production (what is built) and the value of the inputs it purchases (including building materials). Consequently GVA does not directly measure the purchase of materials. However, in practice in the short term (which is what the EE/NC method is seeking to cover), the ratio of *inflation-adjusted* GVA to the *inflation-adjusted* value of purchases of materials does not change much[30], and so we regard this measure of GVA as a good candidate as a predictor for DMC. The most likely source of prediction error is not whether we choose to use 'production' or GVA as the predictor, but rather the degree of precision that we use in defining the user industry. For example, within the construction industry, some activities are more intensive users of sand and gravel (for example, road construction) than others (say, refurbishment of housing). If different parts of the industry are growing at different rates, a broad measure of construction activity will not reflect these differences. However, the potential advantage of using a more precise measure of the user industry has to be weighed against the disadvantage of the lack of availability of suitable, timely data in the maximum number of Member States.

Table 4-1 shows the proportion of DMC[31] in 2009 in the six largest countries that is accounted for by each group. The table also shows the standard deviation of the annual growth rate of DMC (in the six largest countries) for each group. Our interest is in predicting total DMC (summed across materials) and, in particular, detecting any change in trend. The component groups that make the largest contribution to annual changes in DMC are therefore those which account for a large proportion of the total and those which could themselves be subject to a marked change in trend. In practice, since it relates to future possibilities, the latter is a matter of judgment. In the table we show the standard deviation of the annual growth rate in each case, which is a measure of the historical volatility of the annual changes. This does not give us direct information about the potential for a marked change in trend in the future, but it does indicate cases where it may be difficult to identify such a change in trend until sometime after any such change occurs.

29 That is, adjusted to remove the effects of inflation. The conventional method used in the System of National Accounts to represent this kind of inflation-adjusted indicator is the 'chained volume measure'.

30 In contrast, the ratio of *current-price* GVA to the *current-price* value of purchases of inputs can vary greatly, because changes in the price of output are typically reflected in large changes in the operating surplus component of GVA: in the short term, changes in market conditions lead to large swings in profits.

31 We focus here on DMC because this is the indicator used to form the headline resource productivity indicator GDP/DMC.

Table 4-1: Predictors for EE/NCs for MFA indicators

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
MF11-12	Crops and crop residues	22.0	7.6	Agriculture value added (cvm[32])	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), Sector A01	T+3 (March)	Eurostat Agricultural Production Data (Harvested production:1000s tonnes)	Crops Production Database (apro_cpp_crop). Crop codes: C1040, C1360, C1390, C1370, C1300, C1410, C1500 Fruits and Vegetables Database (apro_cpp_fruveg). Crop codes: C2230, C2450, C1610, C1660, C1750, C1761, C1766, C1780, C1790, C1799, C1800, C1885, C1910, C1920, C2992, C1771, C1777, C2090, C2095, C2170, C2250, C2260, C2270, C2300,	T+4 (April)

[32] 'Chained volume measure': a measure which adjusts for the effects of price changes and which therefore should correspond to the physical use of materials.

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
								C2410, C2993	
MF13	Wood	2.4	6.4	Forestry value added (cvm)	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), Sector A02.	T+3 (March)	Forestry production data	Eurostat database: for_remov. All species of tree, roundwood, under bark, thousands of cubic metres.	T+11 (November)
MF21-22	Metal ores	2.3	14.0	Basic metals value added (cvm)	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), sector C24.	T+3 (March)	Production volume ('000 tonnes) for selected detailed product codes	PRODCOM Codes: 07101000, 07291100, 07291200, 07291300, 07291400, 07291500, 07291900.	T+7 (July)
MF3	Non metallic minerals	47.2	5.0	Construction value added (cvm) or Construction production	Eurostat national accounts database (NACE Rev 2: nama_nace64_k), sector F.	T+3 (March)	Production volume ('000 tonnes) for selected detailed product codes	PRODCOM Codes: 08111133, 08111136, 08121250, 08111233, 08111236, 08111290, 08121290, 08113010, 08911100, 08113030, 08114000, 08931000, 08112050, 08112030, 08121190, 08122140, 08122160, 08122210, 08122230, 08122250, 08121210. 08121230.	T+7 (July)
MF41	Coal and other solid energy	10.1	3.4	Gross inland consumption of	Eurostat database: tsdcc320. Total solid	T+11 (November)	Eurostat Energy Statistics – Solid	Eurostat database: nrg_101a. Primary	T+11 (November)

MFA identifier	Description	DMC in 2009 in Germany, Spain, France, Italy, Poland and UK		Proposed predictor of DMC			Proposed predictor of DEU		
		Proportion of total DMC	Standard deviation of annual growth rate 2001-2009	Description	Reference	Timeliness	Description	Reference	TImeliness
	materials/carrier s			solid fuels ('000 tonnes of oil equivalent).	fuels.		Fuels	production of all solid fuels (product code: 2000) in 1000s tonnes.	
MF42	Liquid and gaseous energy materials/carrier s	15.4	2.5	Gross inland consumption of petroleum products ('000 tonnes of oil equivalent) plus Gross Inland Consumption of Natural Gas ('000 tonnes of oil equivalent).	Eurostat database: tsdcc320. Total petroleum products plus total natural gas.	T+11 (November)	Eurostat Energy Statistics – Liquid and Gaseous Fuels ('000 tonnes).	Eurostat Energy databases, (nrg_102a, nrg_103a). Primary production (B_100100) of total petroleum products (3000) and total gas (4000). Gas converted from TJ (GCV) to 1000 tonnes using conversion factor = 1/50.	T+11 (November)

4.3.3 *Estimation results*

Where data permit, we have estimated (for each Member State and each material) a simple equation using ordinary least squares estimation to predict DEU or DMC using the appropriate predictor as the explanatory variable. There are too few observations (typically about ten annual data points) to support a more sophisticated approach (which would use more explanatory variables or a more sophisticated econometric method).

The meaning of 'goodness of fit'

An indication of the extent to which an equation succeeds in predicting the actual values over the historical period is given by a measure of goodness of fit (R^2). A value of 1.0 for R^2 would indicate that the predictions from the equation exactly match the observed values; a value of 0.0 would indicate that the predictions are no better than using a prediction rule that the value in any year is simply the same as the average across all the years).

To illustrate what 'goodness of fit' means in practice, we present here some illustrative examples.

The first example shows an equation that predicts DMC of non-metallic minerals in Germany using construction sector real GVA as a predictor. It can be seen that the trend is well captured, but there is the occasional year when a short-term movement is not captured (notably 2006). The equation predicts a modest upturn in DMC in 2010. The R^2 for this equation is 0.94.

Figure 4-2: Actual and fitted results for predicting DMC for non-metallic minerals in Germany

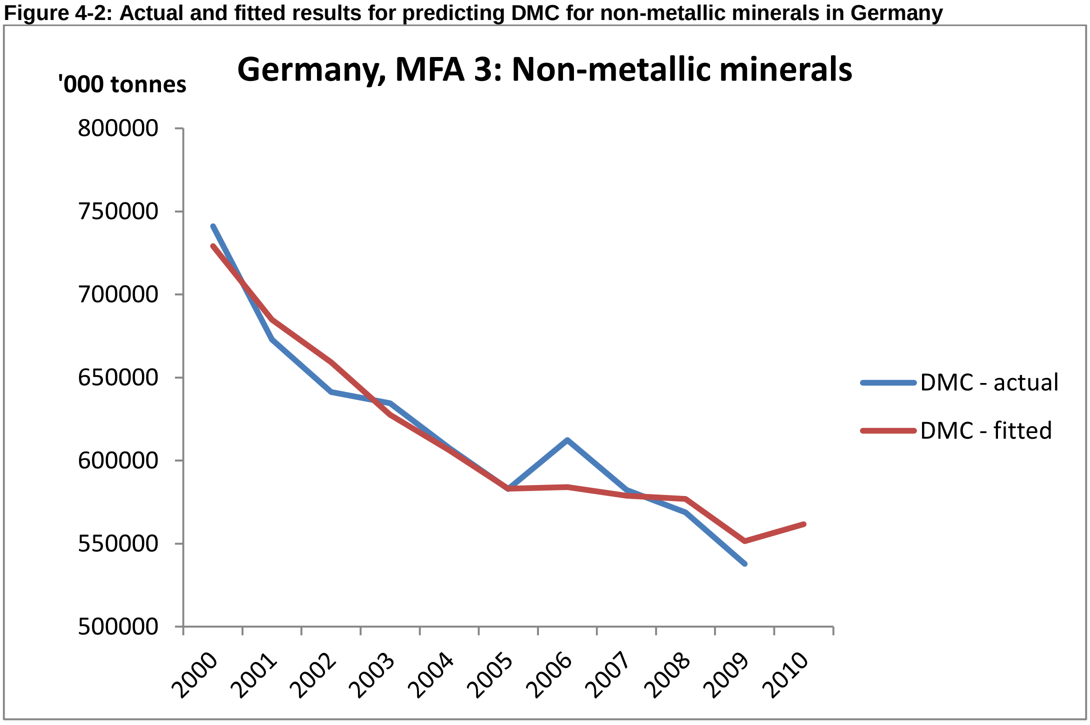


Figure 4-3 shows a data series with a sharp break in trend when the construction boom in Spain came to an end. In this case, the preferred equation predicts DEU using data on the production of relevant mineral categories. The R^2 for this equation is 0.90.

Figure 4-3: Actual and fitted results for predicting DEU for non-metallic minerals in Spain

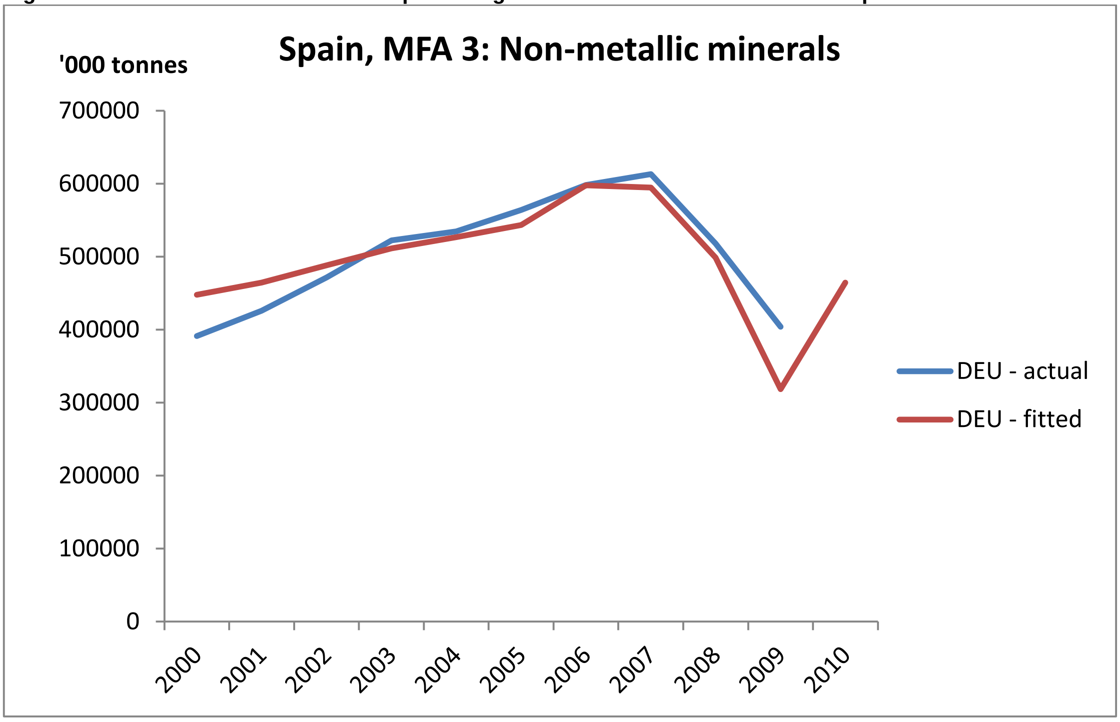


Figure 4-4 shows an agricultural series (where weather conditions can produce substantial year-to-year volatility). In this case, the GVA of the agriculture sector has been used to predict DMC and the fit is surprisingly good (the R^2 for this equation is 0.86).

Figure 4-4: Actual and fitted results for predicting DMC for non-fodder crops in France

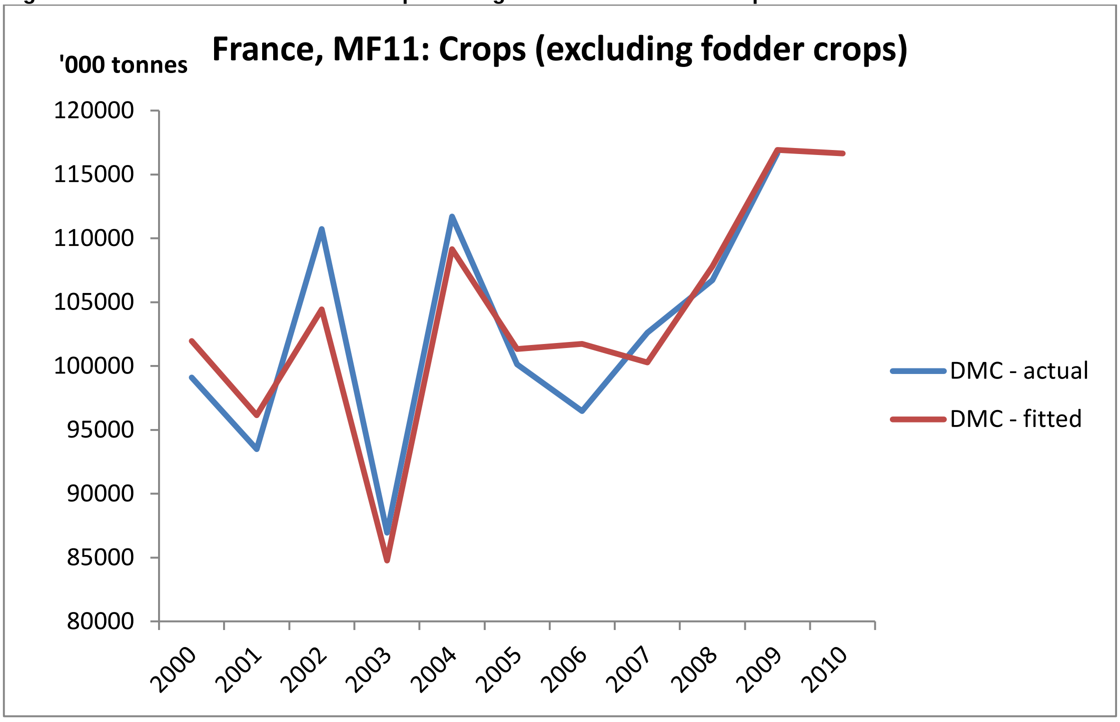
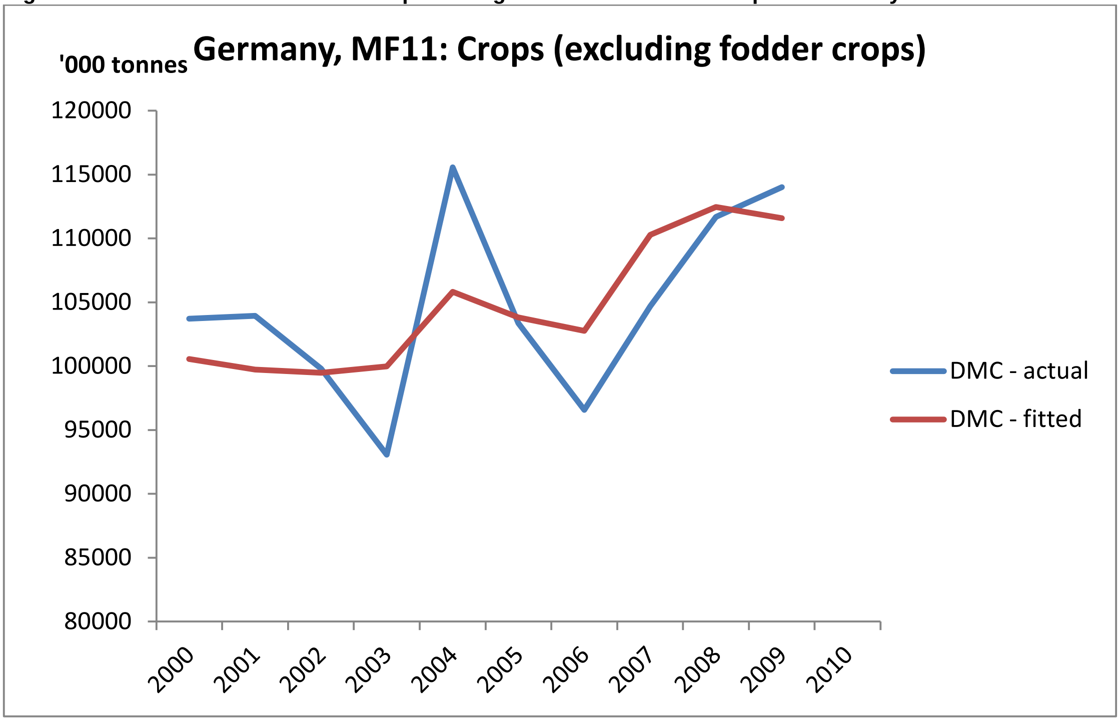


Figure 4-5 shows that the same method is much less successful for predicting DMC in Germany. The volatile peaks and troughs are only reflected with much smaller amplitude in the GVA data used as a predictor. We do not know whether this is due to differences in the nature of agriculture in Germany compared to France, or to differences in the way that DMC is estimated by the national statistical offices in the two countries. Although the volatility of the actual series is not captured in the fitted series, the broad trend is captured. The R^2 for this equation is 0.49.

Figure 4-5: Actual and fitted results for predicting DMC for non-fodder crops in Germany



Overview of estimation results

Figure 4-6 to Figure 4-12 below summarise the estimation results for each material for which equations for DMC and DEU were estimated. In each case the figure shows, firstly, the scale of DMC and DEU in 2009 (to indicate the relative importance of the Member States) and, secondly, the goodness of fit statistic (R2) for the preferred equation. The colour of the circle in the goodness of fit scale indicates whether the preferred equation was for DMC (red) or DEU (blue).

Table 4-2 presents overall conclusions organised by each material, in order of the importance of each material to overall DMC.

Table 4-2: Summary comments on performance of equations for DMC/DEU by material and country

MFA identifier	Comments	Priorities for improvement
MF3: Non-metallic minerals	Reasonable: for 17 of the MS the R2 is higher than 0.5.	Equations for France, Italy and the UK.
MF41: Coal and other solid energy materials/carriers	Among the best of the equation sets. Generally, as we would hope, the DEU method is chosen for the countries that are the key producers. For 23 of the MS the R2 is higher than 0.5. For three countries, the DMC equation is poor, but the quantities involved are small.	
MF42: Liquid and gaseous energy materials/carriers	Reasonable results. Generally, as we would hope, the DEU method is chosen for the countries that are the key producers. For 19 of the MS the R2 is higher than 0.5. The poor results for DEU in the Netherlands merit further investigation.	Equation for DEU in the Netherlands.
MF11: Crops (excluding fodder crops)	The fit is generally very high (the R2 is higher than 0.5 for 25 MS). The poor results for DEU in the Netherlands merit further investigation.	Equation for DEU in the Netherlands.
MF12: Crop residues (used), fodder crops and grazed biomass	Not generally good. The results show that the relationship between the published MFA data for DEU and the predictor (all crop production) is not strong.	Further examination of how the NSOs construct estimates for this group.
MF2: Metal ores (gross ores)	For the top 3 producers, an acceptable equation for DEU was found. For other countries, the predictor for DMC was not generally satisfactory.	Not a high priority as it is a relatively small contributor to overall DMC and DEU. Weak equations for some countries (Finland, Germany, UK, Spain and France) could be investigated.
MF13: Wood	Generally good (the R2 is higher than 0.5 for 24 countries). MFA identifier Comments Priorities for improvement	

Figure 4-6: Estimation results for MF11

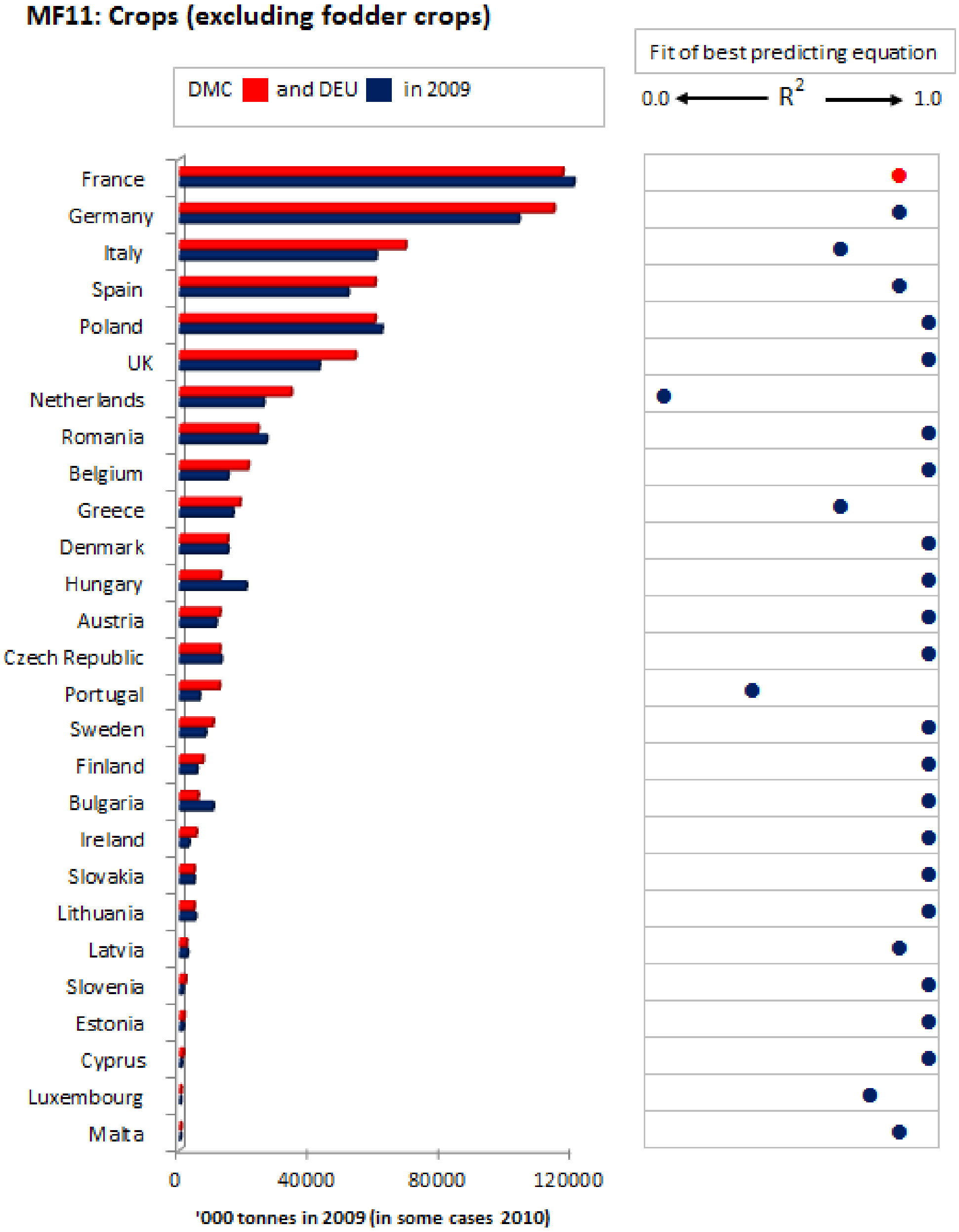


Figure 4-7: Estimation results for MF12

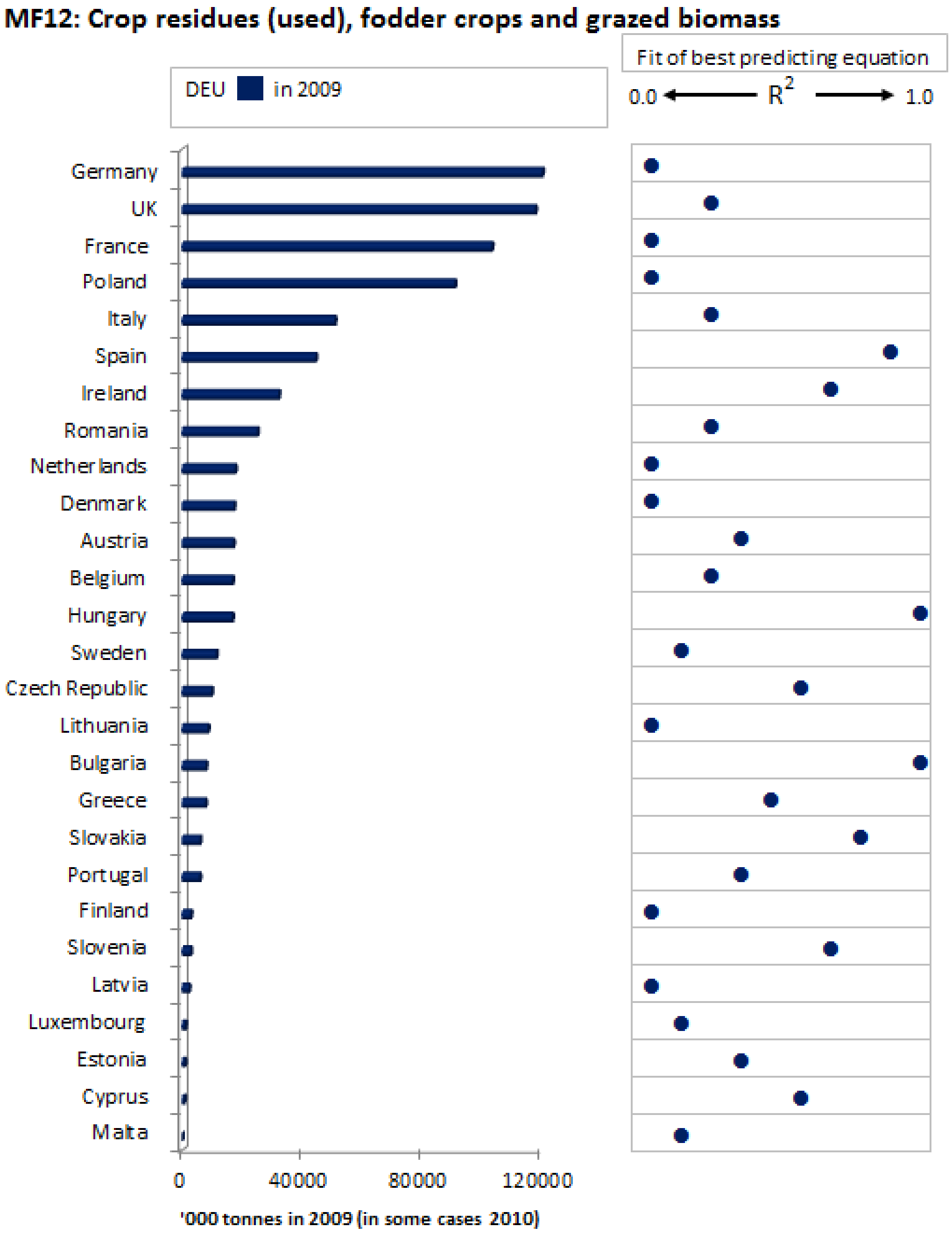


Figure 4-8: Estimation results for MF13

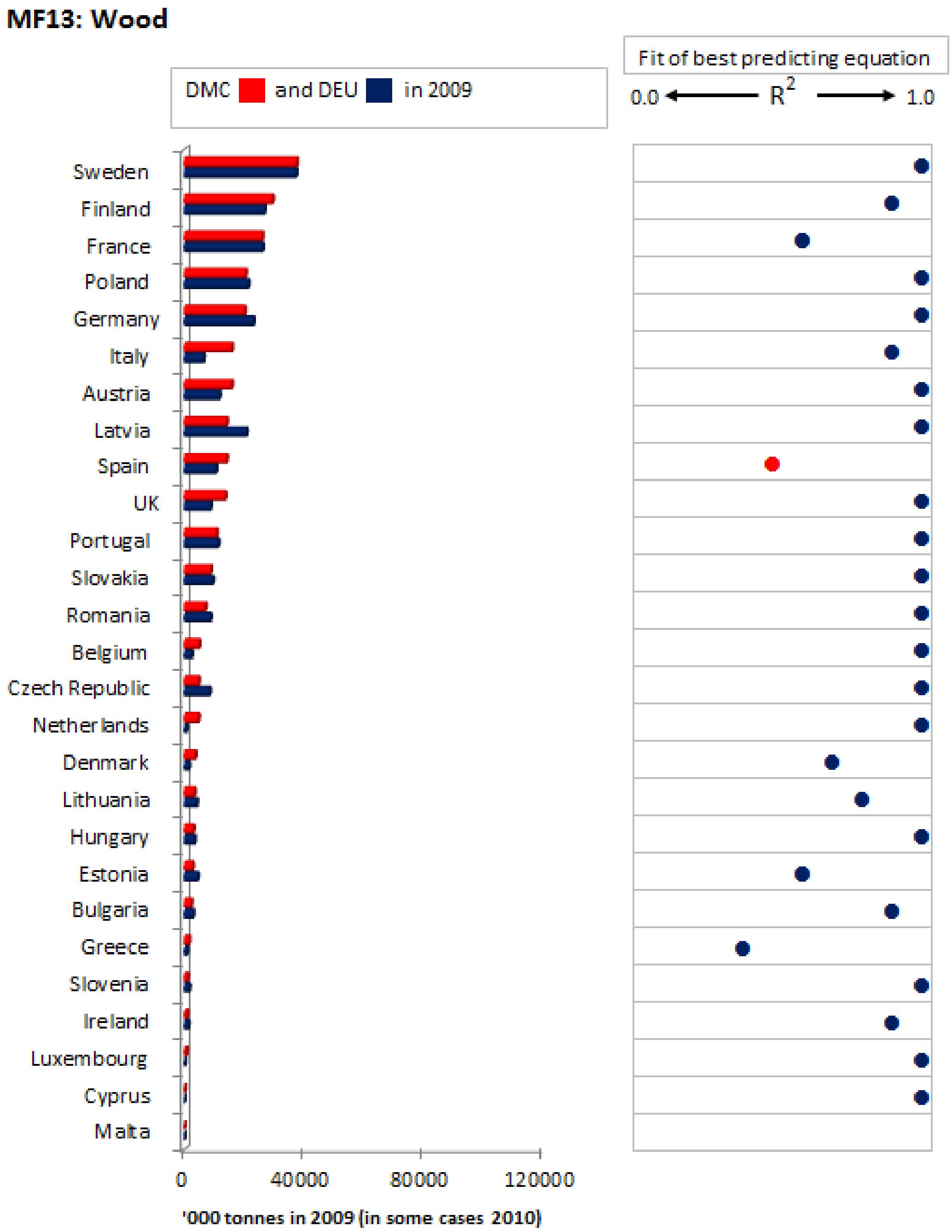


Figure 4-9: Estimation results for MF2

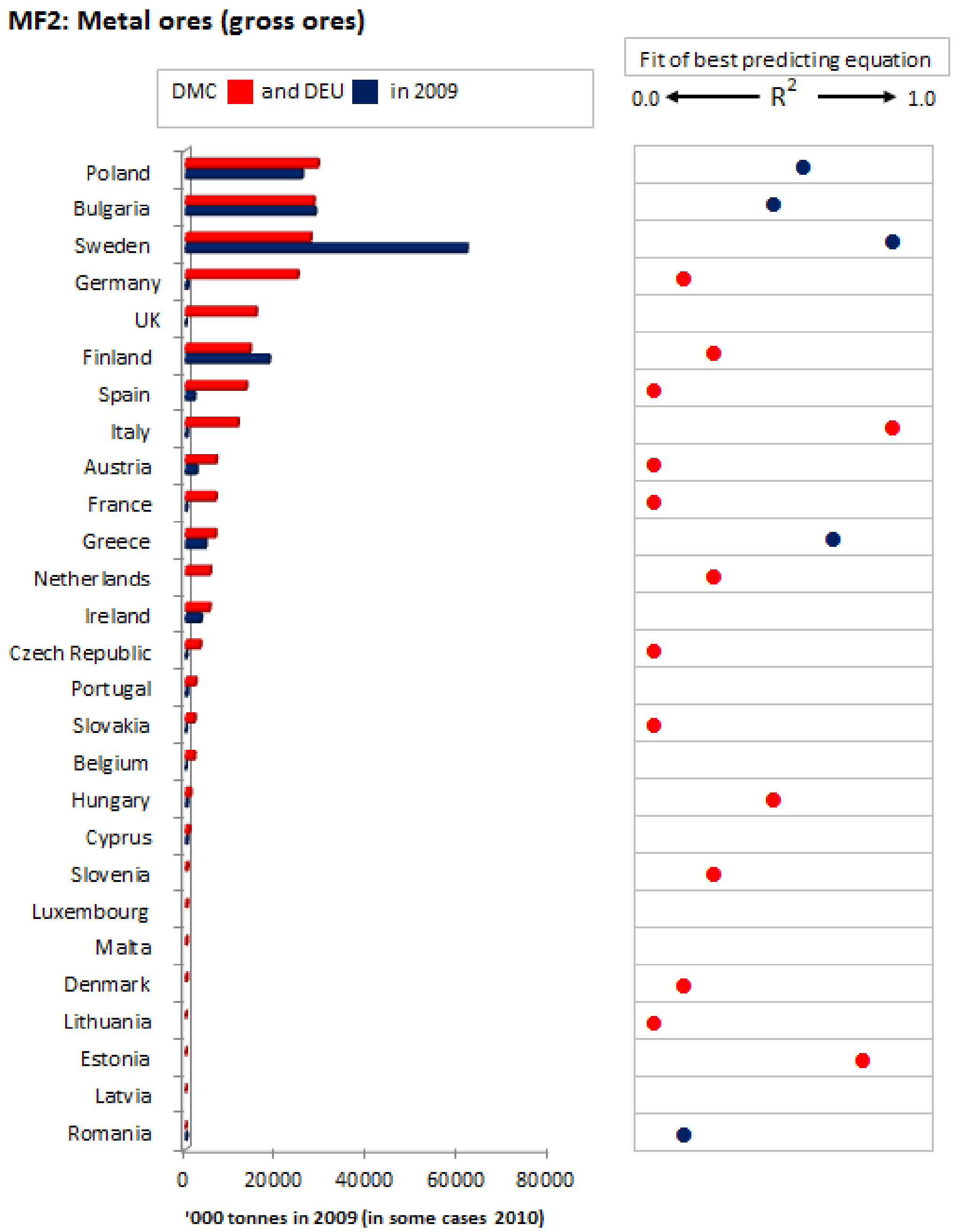


Figure 4-10: Estimation results for MF3

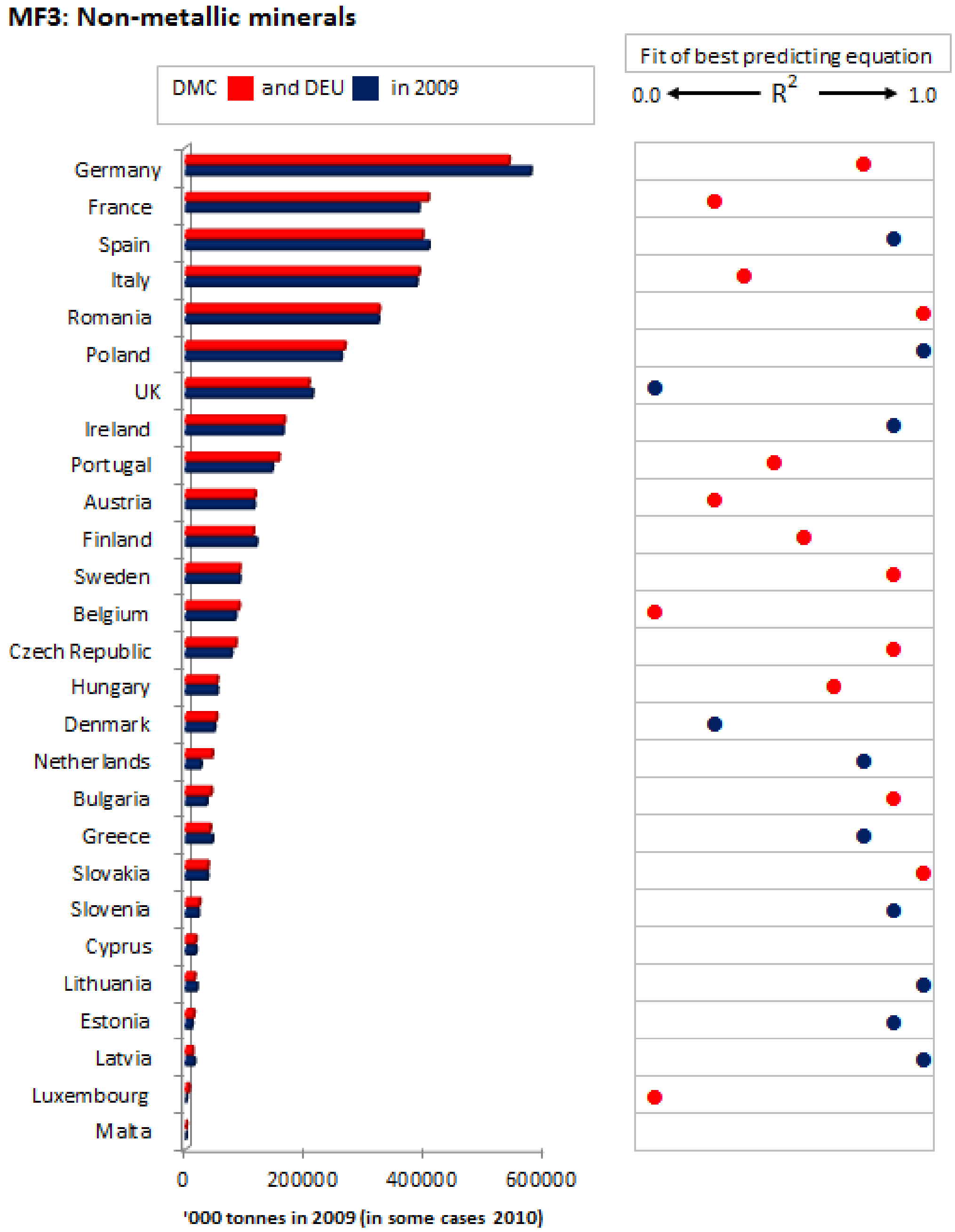


Figure 4-11: Estimation results for MF41

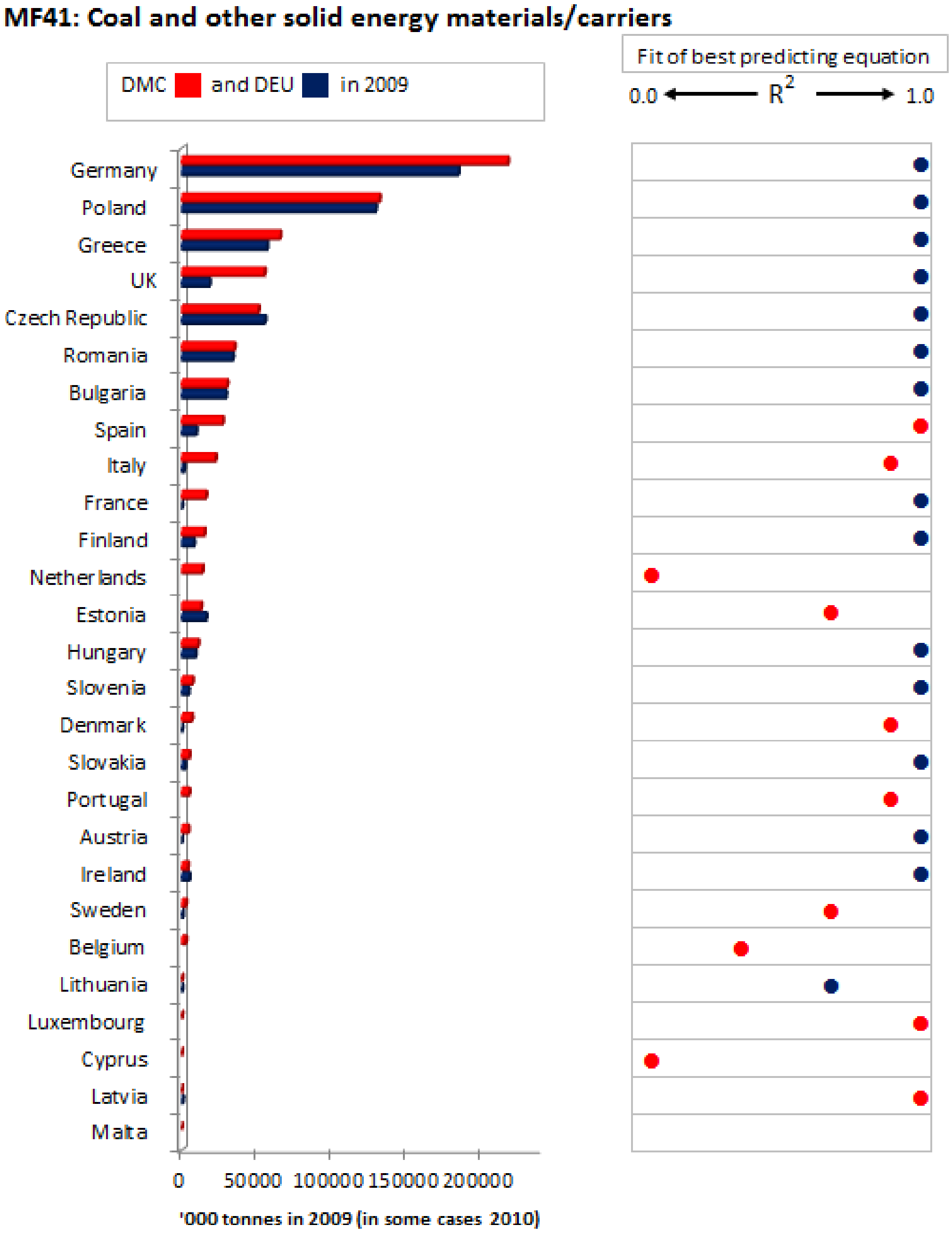
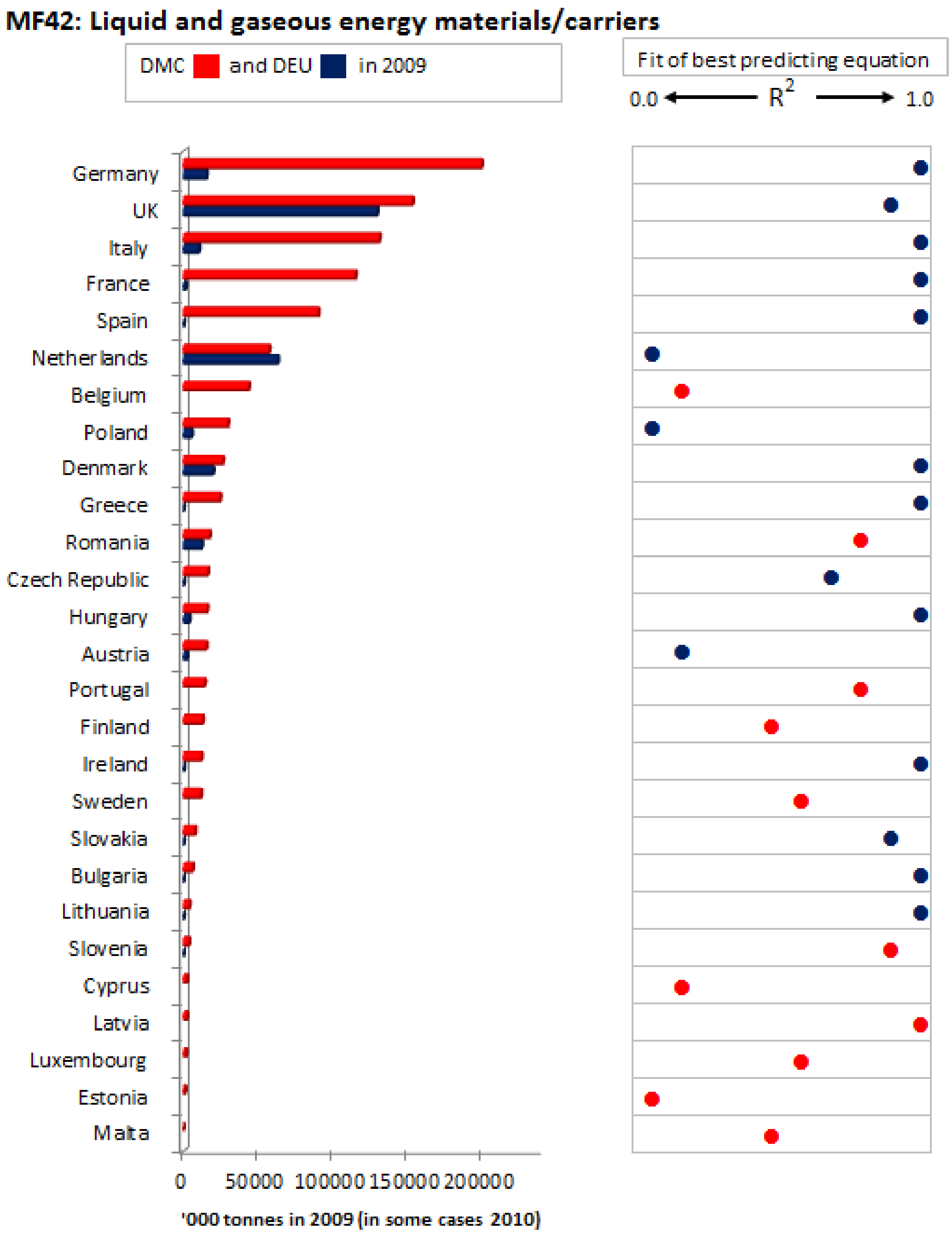


Figure 4-12: Estimation results for MF42



4.3.4 *From estimated model to Early Estimates and Nowcasts*

For each Member State and each key material, the estimation results provide an equation that can be used to forecast DMC or DEU using a predictor for which more timely data are available than for the published MFA estimates. However, the predicted results of the equations do not match the historical values exactly and so, in particular, there is a discrepancy (or 'residual') in the last year of MFA history. Because of this residual, if we were simply to include the equation's prediction as the forecast for the next year, the implied growth rate between the last year of history and the first year of the forecast would not match the growth rate of the equation's predictions and, by implication, the growth implied by the predictor variable. This is a standard problem in forecasting and there are two ways of addressing it:

- accept the equation estimate as the best available estimate for the forecast year, effectively treating the residual in the last year of history as a random error which we do not expect to persist;
- apply the growth rate from the equation results to the level in the last available historical year, effectively treating the residual in the last year of history as a persistent change affecting values in all subsequent years.

Although there are, in principle, statistical methods[33] to inform a judgement as to which of these is best supported by the evidence, there are insufficient observations for such methods to be effective. We adopt the second procedure on the grounds that users will find it more intuitively appealing (otherwise, for example, if the equation over predicted DMC in the last year of history, the next year could see a *fall* in the predictor variable for DMC while the forecast might show an *increase* in DMC from the last historical period).

Equations were estimated for DMC and DEU for most of the MFA materials, but not all. We did not produce equations for MF14, MF15, MF16, MF43, MF5 and MF6. In these cases, which account for a very small proportion of total DMC and total DEU, the forecast method is simply to assume that the value is unchanged from the last year of history. Because their contribution to total DMC or DEU is so small, it was not considered worthwhile attempting any more sophisticated method.

For each MFA material, having obtained a forecast for DMC or DEU (depending on which equation was selected, we derive the other indicator using the identity:

DMC = DEU + (Total Imports – Total Exports)

together with the forecast for imports and exports derived by the method described in the next section.

4.4 Exports and Imports

The method used to produce exports and imports early estimates attempts to reproduce as closely as possible the Eurostat method used to produce the published MFAs[34] by making use of the Comext trade data, which are very timely (the data for a given month are published at T+2 months).

We collect the export and import data by weight for the relevant codes of the Combined Nomenclature (CN) and then aggregate to MFA categories following the definitions set out in Annex 3 of the 2011 EW-MFA Questionnaire[35] which provides the required mapping.

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33 Tests for stationarity of residuals.

34 http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/Economy-wide%20material%20flow%20accounts%20compilation%20guide%20%20-.pdf.

For the individual Member States, we gathered data for imports and exports to cover all origins/destinations. We then aggregated across Member States in order to get a EU27 total.

For each MFA category, we compared the resulting estimates with those published in the Eurostat MFAs and discovered that there were discrepancies between the two. To construct EEs were therefore applied the growth rates for the estimates constructed from the Comext data to the levels in the last year of history available from the Eurostat MFAs.

As an example of the methodology, in producing an early estimate for 2011, the growth rate in the Comext data between 2010 and 2011 has been applied to the 2010 historical data from the Exports and Imports MFA series. In order to produce nowcasts for 2012, the growth rate from 2010-2011 has been used again. In principle, towards the end of 2012, an estimate could be formed from the monthly Comext data.

4.5 RMI, RMC and TMR

4.5.1 RMI and RMC

Recall the definitions of RMI and RMC:

RMC = DEU + Total Imports (RME) – Total Exports (RME)

RMI = DEU + Total Imports (RME)

When we apply these definitions to calculate RMI and RMC, we have used the historical data for DEU and the early estimates for subsequent years derived by the procedures described above. The process used to predict raw material equivalent (RME) imports and exports relies on the method documented in Eurostat's historical hybrid input-output tables (IOTs)[36]. In those tables, materials are measured in one of three units: tonnes (for non-energy raw material commodities), tonnes of oil equivalent (for energy inputs) and euros (for downstream products). In gathering the latest data we obtain trade data for the indicators that are measured in in tonnes and euros from Comext. (using, in this case, the CPA 2002 product classification which is used in the hybrid IOTs). In the case of the indicators that are measured in tonnes of oil equivalent, we gather the trade data from Eurostat's Energy Statistics (we use the annual Energy Statistics to the latest available year, currently 2010, and the monthly energy statistics for the more recent period through 2011). All data are collected for the Member States, distinguishing extra-EU and intra-EU trade.

We then apply the coefficients from the hybrid IOTs which convert the trade data to raw material equivalents. The hybrid IOTs have only been calculated for EU27 as a whole and relate to extra-EU trade. When calculating estimates at Member State level we apply the hybrid IOTs' extra-EU import coefficients to a Member State's extra-EU imports, but we apply the hybrid IOTs' extra-EU *export* coefficients to a Member State's intra-EU imports: the motivation is that each country's intra-EU imports represent an export from other Member States and so the raw material composition of EU exports is the best guide we have to convert the intra-EU imports to raw material equivalents.

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[35] http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/EW-MFA_Questionnaire_2012_(Version_31_July_2012).xls.

[36] http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/Project_Estimates_for_Raw_Material_Consumption_(RMC)_and.pdf.

Note that not all RME sectors in the hybrid IOT are used in our estimation procedure. RME sectors 41-95 were not included as these are services; data are not available in Comext for trade in services and so if our system required service trade data the estimates would be much less timely, while the evidence from the hybrid IOTs is that the raw material equivalents of service trade contribute a small proportion of total RME. Some other RME sectors were also excluded because their raw material equivalent made up a small proportion of overall RME. In addition, some RME sectors were excluded because all the coefficients relating to their sector in the hybrid IOT were equal to zero. All the excluded RME sectors are summarised in Table 4-3 below.

Table 4-3: RME Sectors excluded from the Early Estimates method for raw material equivalents

RME Sector	Reason for Exclusion
10.10.12 – Coal, agglomerated.	Very small RME.
10.2.b – Lignite, agglomerated.	Very small RME.
11.10.3 - Liquefaction and regasification services of natural gas for transportation.	All coefficients equal to zero.
11.10.4 – Bituminous or oil shale and tar sands.	Very small RME.
11.2 – Services incidental to oil and gas extraction, excluding surveying.	All coefficients equal to zero.
12 – Uranium and thorium ores.	Very small RME in the case of imports. All coefficients equal to zero in the case of exports.
23.3 – Nuclear fuel.	All coefficients equal to zero.
40.2 - Manufactured gas and distribution services of gaseous fuels through mains.	All coefficients equal to zero.
40.3 - Steam and hot water supply services.	All coefficients equal to zero.
41-95 - Services	Insignificant RME and trade data not available in Comext.

When we apply this method to EU27 trade data, the resulting estimates do not match the hybrid IOT results exactly, and so we calculate the ratio of the actual (hybrid IOT) values to our estimates and then apply these factors to our estimates at Member State level (for which there are no data in the hybrid IOTs).

Finally, we calculate RMC and RMI from DEU and the raw-material equivalent trade estimates using the identities noted at the beginning of this section.

4.5.2 TMR

Recall the definition of TMR:

TMR = DMI + hidden flows in domestic and RoW extraction

This can also be written as:

TMR = DEU + UDE + Imports + Imports (Hidden Flows)

DEU and imports

Domestic extraction used (DEU) and imports are calculated as described earlier.

UDE

To calculate domestic extraction unused (UDE), we apply to DEU a coefficient that represents the ratio of domestic extraction unused to domestic extraction used.

For each MFA category, we derive this coefficient from data presented at http://materialflows.net/[38]. The last year for which data are published is 2008 and so we use the 2008 ratios for all years thereafter. We apply the ratios to historical or early estimated DEU to obtain an estimate for UDE.

Imports (Hidden Flows)

To estimate the hidden flows associated with imports we rely on coefficients that represent the ratio of hidden flows to imports kindly supplied by the Wuppertal Institute. We aggregate imports classified on the 8 digit CN code to 6-digit HS6 categories.

For a small number of precious commodities, we follow the Wuppertal procedure and estimate the tonnes of precious metal content in the Comext tonnes of traded weight by comparing the value/ quantity relationships in the Comext data with the average annual prices for the precious commodities.

For the HS6 category Electrical Energy, data for electricity imports and exports in terawatt hours were extracted from the Eurostat Energy Statistics rather than Comext.

Finally, we applied the biotic, abiotic and erosion coefficients to the processed imports data and sum across HS6 product categories to obtain an estimate of imports hidden flows across all MFA categories. Given that there is no straightforward mapping from HS6 product categories to MFA categories, our estimates of TMR are not disaggregated by MFA categories but presented simply as a total.

4.6 Nowcasting and Early Estimates Results for DMC for EU27 and by Member State

The modelling system produces results for all the MFA indicators for each Member State and for each of the main materials distinguished in the MFA. To present an overall assessment of the effectiveness of the method, we focus here on the indicator DMC and we aggregate across materials.

For EU27 (which is calculated as the sum across Member States) and for each Member State, Figure 4-14 to Figure 4-18 below present comparisons between the model results and the historical data since 2000, together with the model-based Early Estimates for 2010.[39]

The chart for EU27 in Figure 4-14 shows that the model-based DMC captures the trend in the historical data quite well both up to and after the 2008 peak. However, the full extent of the peak in 2008 and the fall in 2009 are not completely captured. Had this model been available to give an early estimate of the 2009 outturn, it would have correctly predicted a sharp fall in 2009 (reflecting the recession), but would have understated the extent of that fall. The 2010 Early Estimate predicts

37 http://materialflows.net/ is a database on global resource extraction, set up and administrated by SERI (Sustainable Europe Research Institute) in cooperation with the independent researcher Monika Dittrich and the Wuppertal Institute for Climate, Environment, Energy.

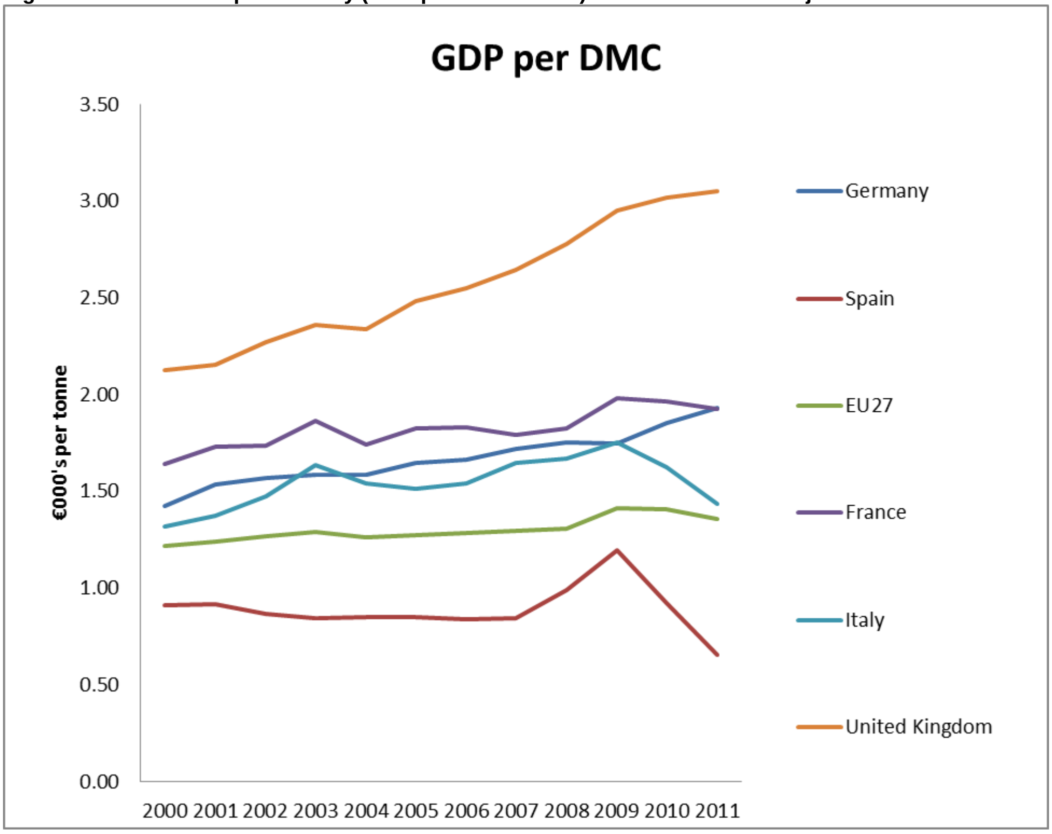
38 http://materialflows.net/ is a database on global resource extraction, set up and administrated by SERI (Sustainable Europe Research Institute) in cooperation with the independent researcher Monika Dittrich and the Wuppertal Institute for Climate, Environment, Energy.

39 These charts were obtained from the accompanying Excel file *Nowcasts of MFA Indicators.xlsm.* The comparison between the model results and the historical data is found on sheet *DMC Comparison*.

that the fall in DMC did not continue. When we examine the detailed results by material[40] we can identify the main reasons why DMC is estimated to have stopped falling in 2010: a return to modest growth in consumption of non-metallic minerals and a sharp increase in consumption of gas. When taken together with the known outturn for GDP growth, the Early Estimate would support advice to policy-makers that the sharp fall in 2009 was driven mainly by the recession rather than a sharp increase in resource productivity[41].

Figure 4-13 shows that resource productivity is estimated to have been flat or slightly declining after 2009 in the EU27 as a whole (although it is estimated to have continued to rise in Germany and the UK).

Figure 4-13: Resource productivity (GDP per unit of DMC) in the EU27 and 5 Major EU Economies



The charts in Figure 4-14 to Figure 4-18 show that the model performs quite well in predicting DMC for most Member States, but there are some exceptions. The least satisfactory cases from the point of view of overall fit are Malta and Ireland. However, from the point of view of contribution to the EU27 total, the failure to capture the 2009 declines in Italy, the UK and, to a lesser extent, France are probably a higher priority for improvement. Examination of the detailed results shows that in all cases this was because the model failed to capture the sharp decline in consumption of non-metallic minerals, and so we recommend that further analysis be undertaken to improve its performance in this area.

There are a small number of particular cases where the analysis suggests deficiencies in the predictor data. The model result for Denmark in 2007 shows a sharp, temporary fall; further investigation has shown that the predictor indicator from PRODCOM for the production of non-metallic minerals has a zero value for that year. The model result for Sweden is persistently below

40 See sheet *DMC Final* in the accompanying Excel file *Nowcasts of MFA Indicators.xlsm*.

41 See sheet *GDP per DMC* in *Nowcasts of MFA Indicators.xlsm.*

the historical value from 2003 onwards; the predictor indicator from PRODCOM for production of metal ores is zero from 2003 even though the MFA DEU data has values for metal ores.

Figure 4-14: Comparison of model-based results with historical data for DMC, Part 1

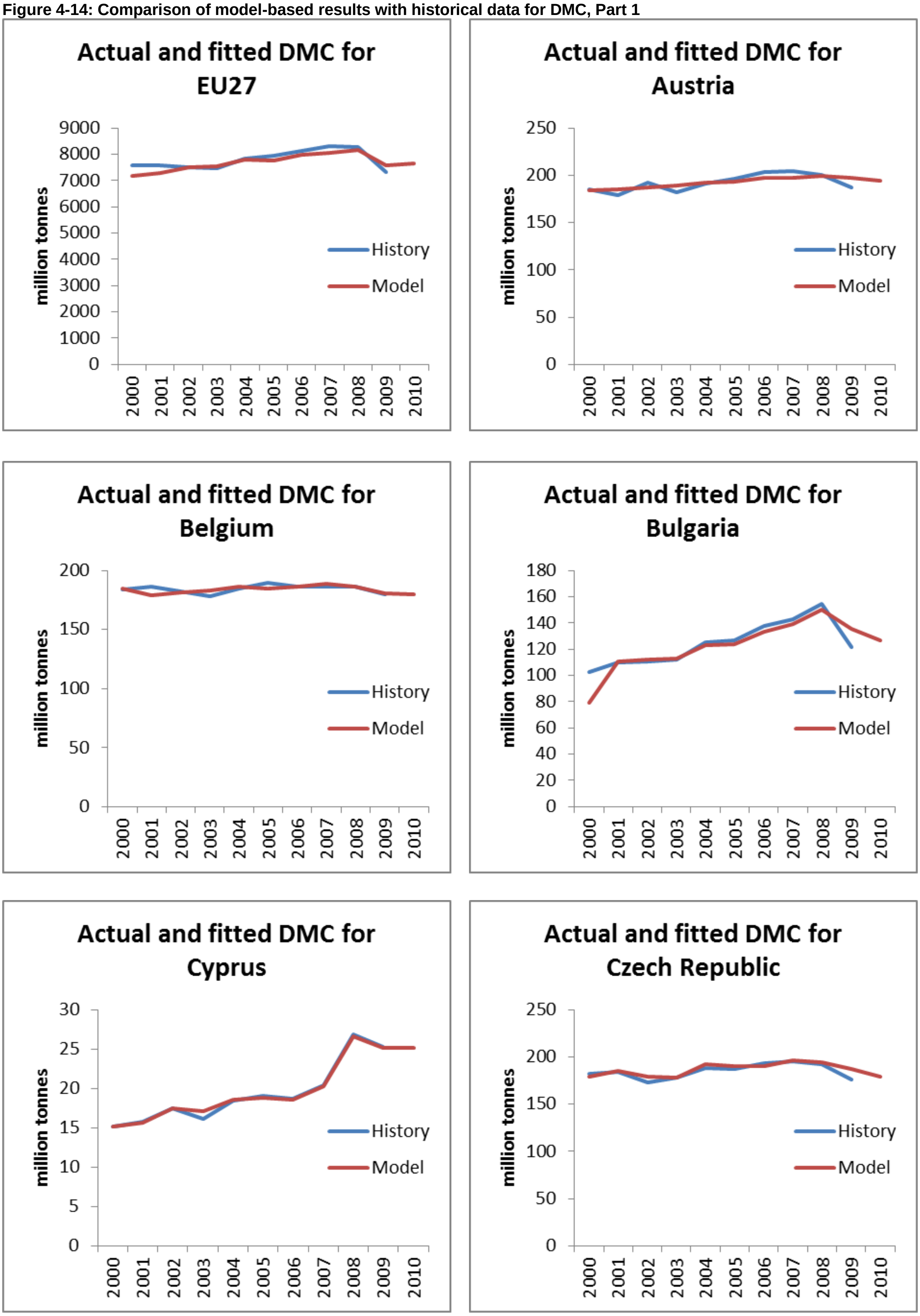


Figure 4-15: Comparison of model-based results with historical data for DMC, Part 2

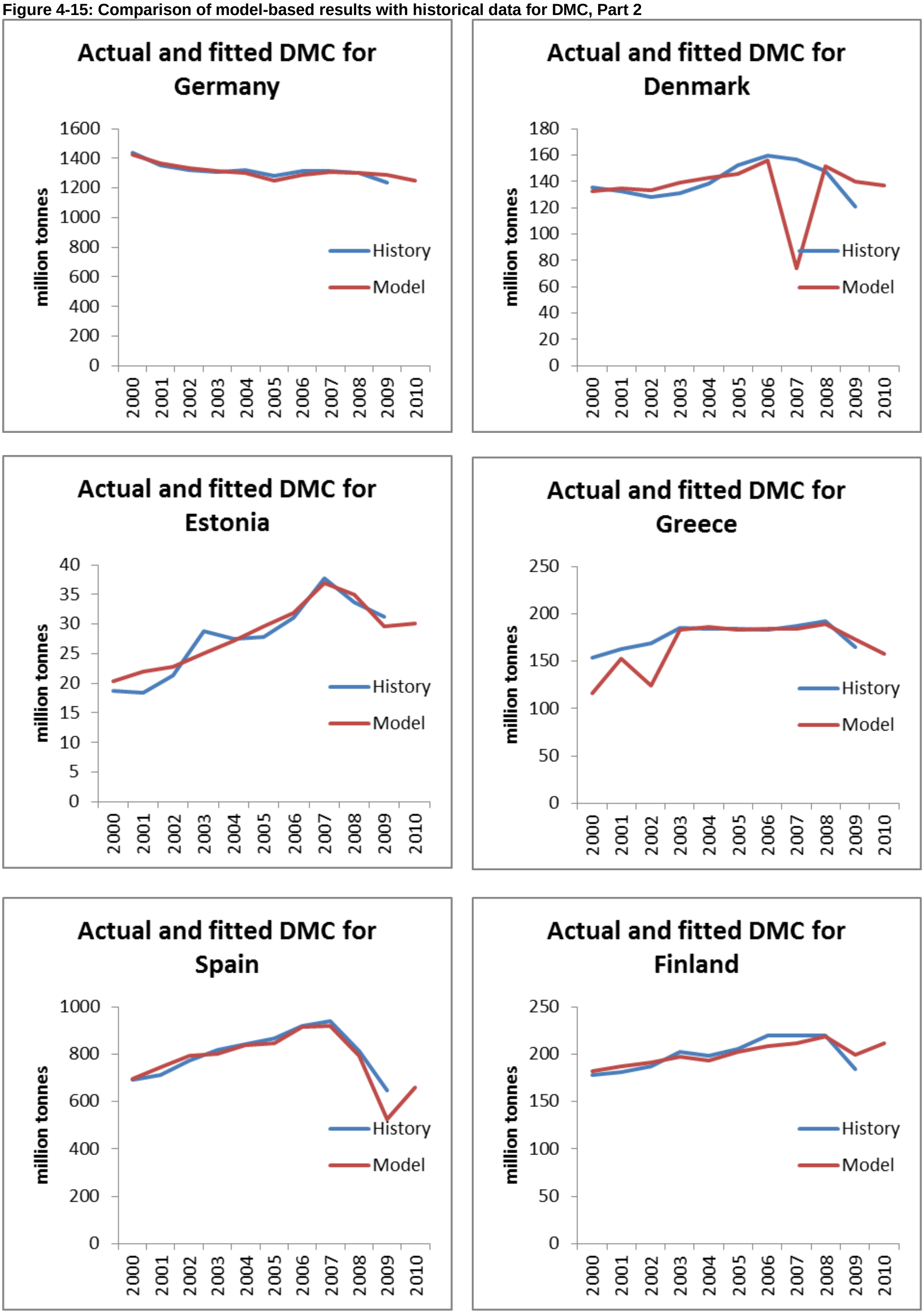


Figure 4-16: Comparison of model-based results with historical data for DMC, Part 3

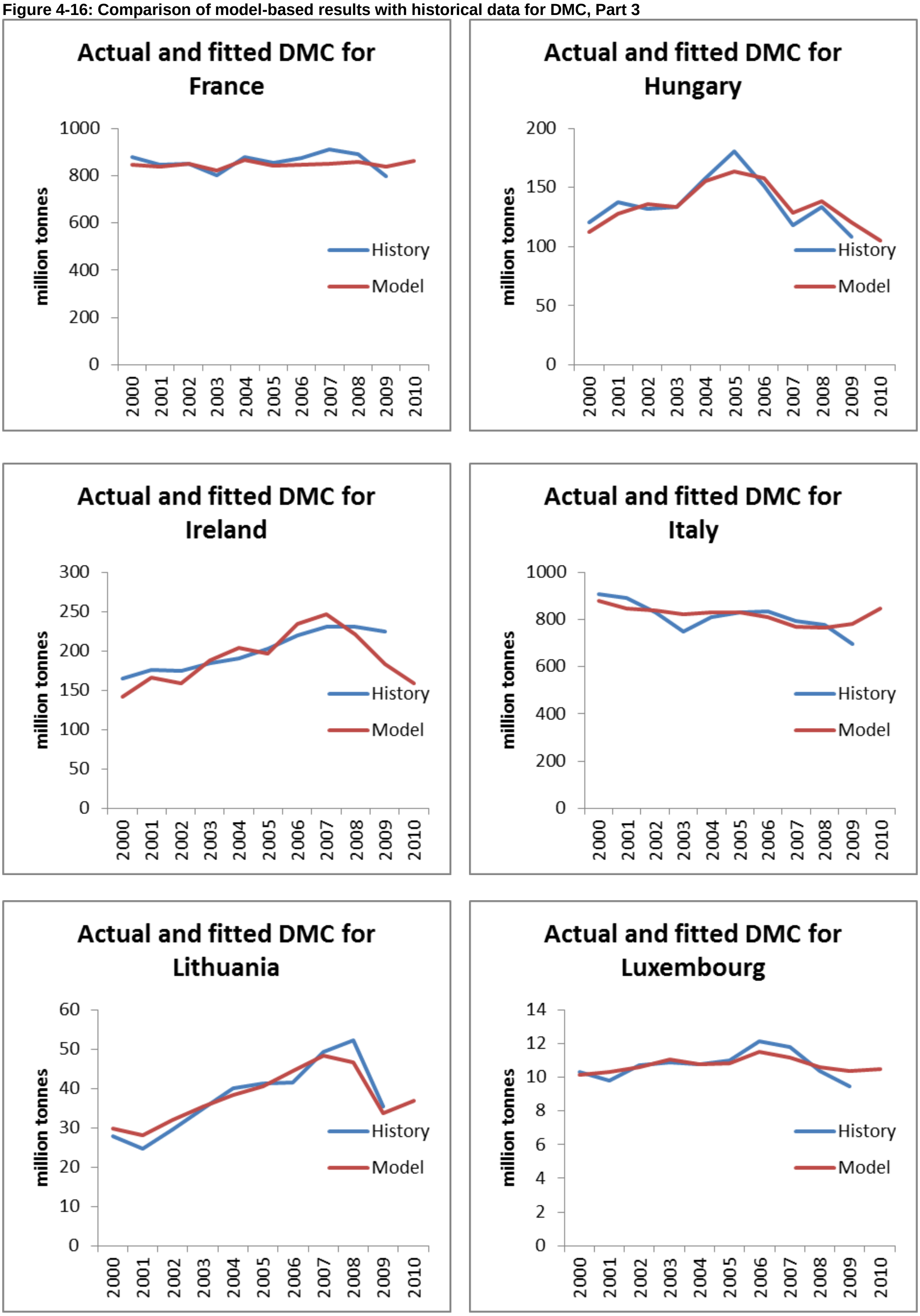
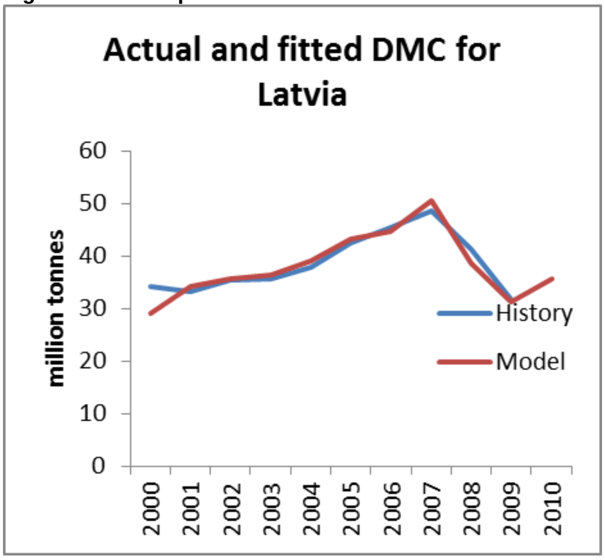
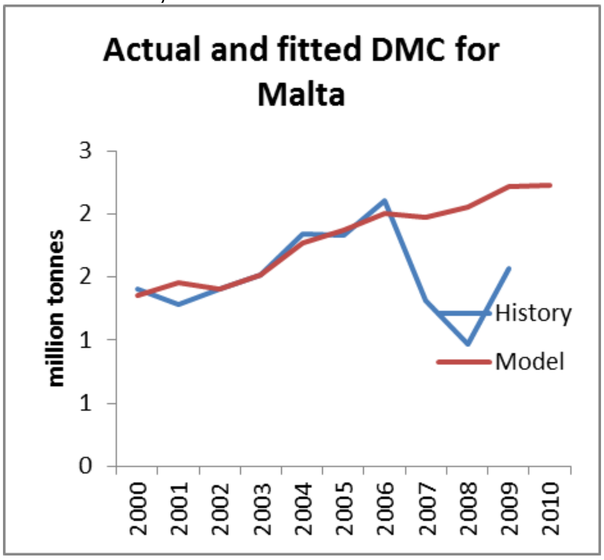
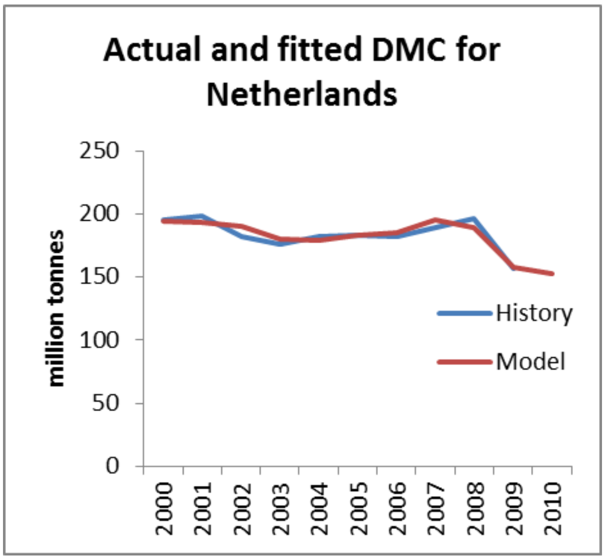
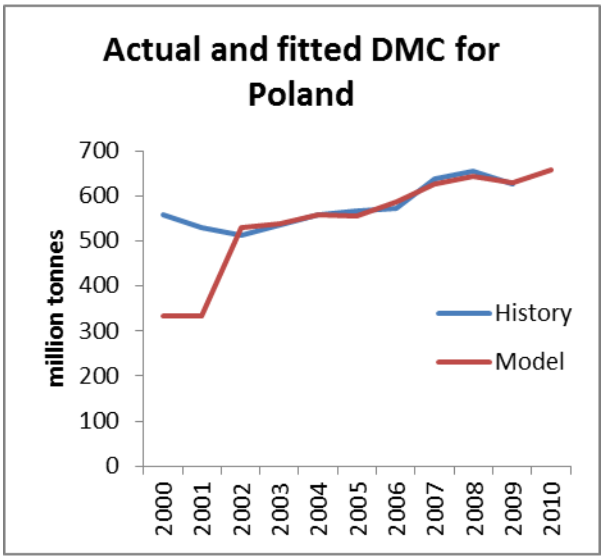


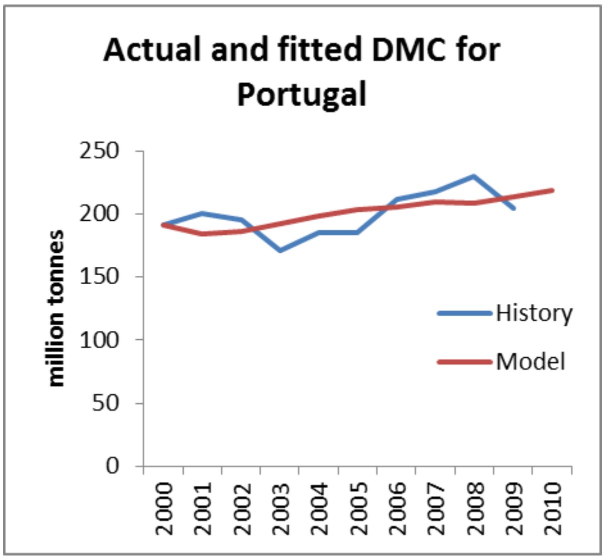
Figure 4-17: Comparison of model-based results with historical data for DMC, Part 4











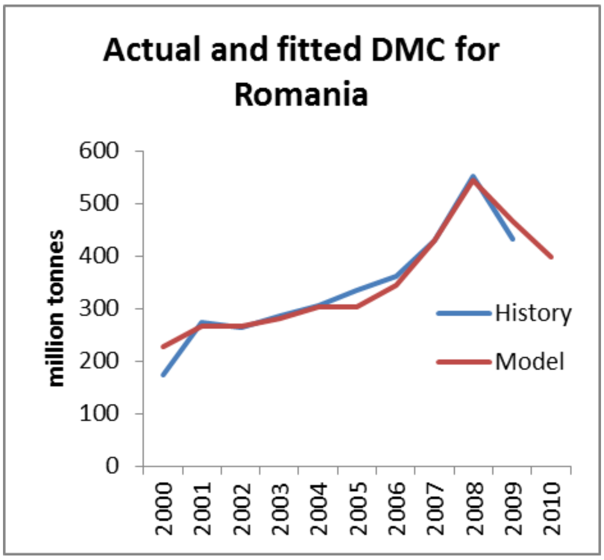
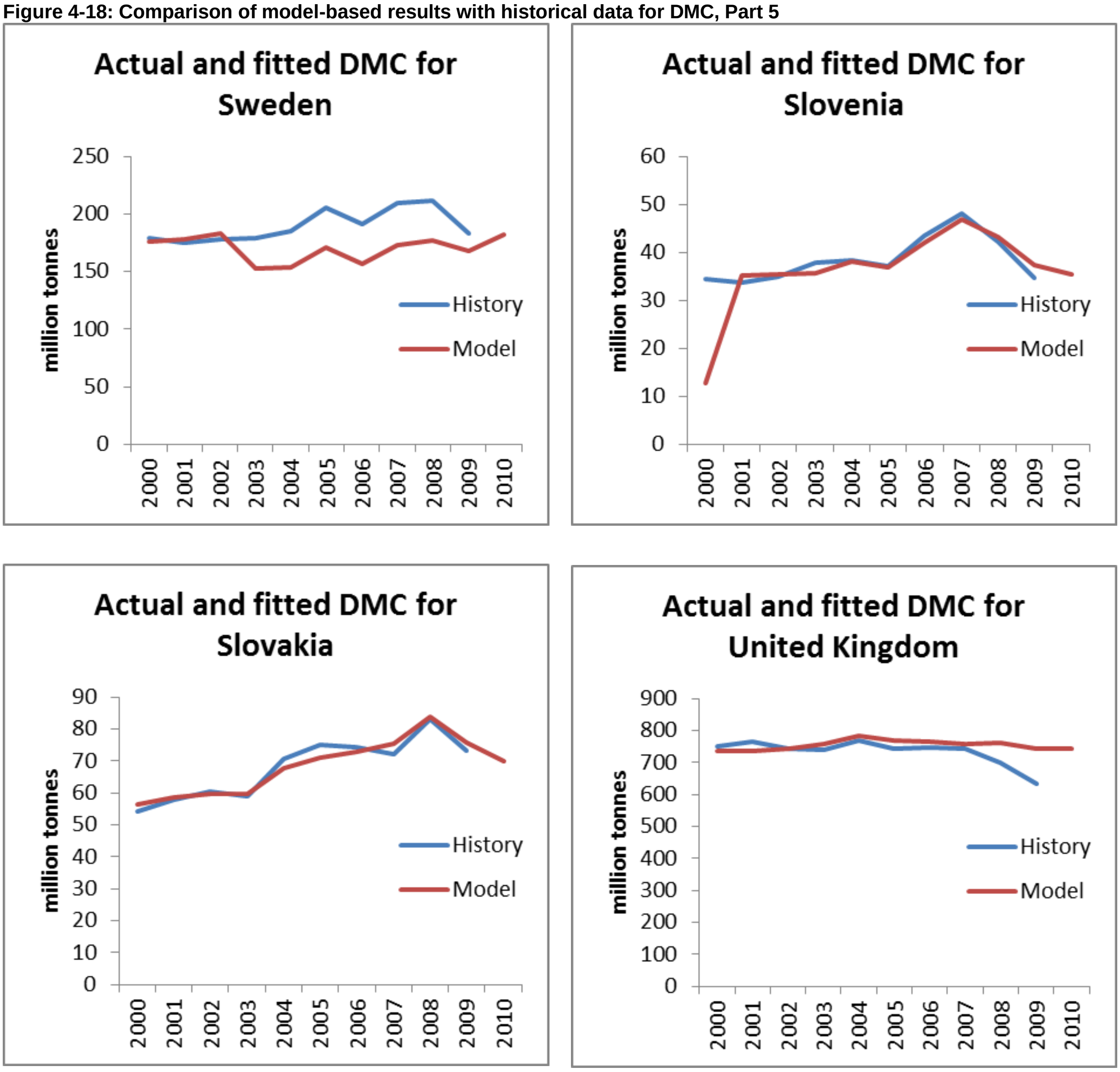


Figure 4-18: Comparison of model-based results with historical data for DMC, Part 5



5 Indicators, targets and sustainability thresholds

This chapter of the report is based on the methodology outlined below for assessing the suitability and feasibility of target setting for individual indicators in the context of scientific environmental thresholds, good management practice and existing environmental policy targets.

5.1 Background, objectives and aims

5.1.1 Background

The Roadmap to a Resource Efficient Europe (COM(2011) 571 final) is accompanied by the Commission staff working paper (SEC(2011) 1067 final) Analysis associated with the Roadmap to a Resource Efficient Europe Part II, which includes eight annexes outlining the scientific background in support of the Roadmap. In Annex 6, a set of indicators is presented which are either already – at least partially – available or under development. Their relevance and need is discussed in parallel with their scope and limitations in the staff working paper.

This set of indicators has been examined and added to by the consortium to ensure coverage of all aspects in the RERM. The final list of mapped indicators was delivered in Task 1 of this project.

The Resource Efficiency Road Map and many stakeholders call for target setting. Target setting that takes into account the relevant political, economic, social and environmental factors is essential so that the measures can be put to practical policy use to encourage greater resource efficiency.

Furthermore, the Communication from the Commission to the Council and the European Parliament - GDP and beyond: measuring progress in a changing world (COM/2009/0433) also recognises the need to measure environmental sustainability and calls for actions that can be taken in the short to medium term. The overall aim of the Beyond GDP Initiative is to develop more inclusive indicators that provide a more reliable knowledge base for better public debate and policy-making. The Sustainable Development Scoreboard to be developed under this initiative sets respect for the limits of the planet's natural resources as a key objective to. The Communication called for cooperation between research and official statistics in order to identify – and regularly update – such threshold values for key pollutants and renewable resources in order to inform policy debate and support target setting and policy assessment.

5.1.2 Objectives of Task 4

Task 4 aims at assessing the suitability and feasibility of setting targets for each of the indicators in the pool of indicators gathered under Task 1, based on environmental sustainability thresholds stemming from science and/or good management practices of the resources in question. While not directly related to early estimates and nowcasting, this is a crucial step for policymakers.

5.1.3 About the methodology

The first section of the report outlines the methodology used in assessing the suitability and feasibility of the indicators identified in Task 1 of this project to be used for target setting. First, it presents an overview of the elements that are deemed relevant to such an assessment of suitability for target setting: the methodology outlined here includes eight elements that combine to determine an indicator's suitability for target setting in the context of the RERM and addressing the points raised by the Beyond GDP Initiative.

This report then outlines the format and logical flow that the assessment will take, including how the eight individual elements will be combined into an integrated assessment for each indicator, and the eventual presentation of results is also outlined. All of the identified indicators are subject to assessment, the first assessment steps are designed to carry out a first screening of indicators and identify those that do not meet initial criteria for target setting. These indicators will not be subject to further assessment.

In section 5.4, the rationale and methodology used for assessment of each of the eight elements is outlined. Each assigned score within this element will be further elaborated with qualitative information justifying the score applied for each indicator.

Finally, section 5.5.1 provides a summary of key findings relevant to this project on environmental thresholds and a synthesis of the results and main findings of our assessment.

5.2 Overview of elements relevant to the assessment

5.2.1 Introduction

The suitability and feasibility of an indicator for target setting in the context of environmental thresholds and existing environmental policies should take a number of different elements into account.

Some of these elements are concerned with the indicator's relationship to external environmental thresholds or environmental policy i.e. whether a relevant environmental threshold exists, whether the scientific foundation of the threshold is reliable and robust and/or whether a broad consensus has been reached over the existence of the threshold or alternatively over good management practices for an environmental resource. The strength of the connection between the variable being measured by the indicator and the 'end' phenomenon for which a sustainability threshold has been calculated or agreed is also a relevant element in determining whether it is meaningful to define a target for the indicator.

Other elements are more internal to the indicator and the phenomenon being measured by the indicator. These 'internal' elements include the robustness and reliability of the indicator itself (an indicator based on an immature methodology or on unreliable data may not be suitable for target setting) and the practicability of developing policy which can work towards achieving a target set for the indicator.

Eight different assessment elements have been identified and are described in more detail below.

5.2.2 Overview of assessment elements

The following elements have been identified for use in the assessment:

1. **The existence of one or more environmental sustainability thresholds or good management practices** which are relevant to the specific indicator. An example of an environmental sustainability threshold would be a two degree tipping point in relation to an indicator on greenhouse gas emissions or maximum sustainable yields of biomass extraction or fish populations. Examples of good management practice might include established

management practices for water catchments or forestry which aren't necessarily related to any actual thresholds beyond which the extraction of water or timber would no longer be sustainable. Similarly to element 1, the relevance to a given indicator in the indicator pool might be direct or indirect;

2. **Existence of an EU policy target which has relevance to the indicator**. These targets may have been adopted within other parts of the EU Acquis. The relevance of this policy target to the indicator can be direct or indirect i.e. the indicator may be measuring a development which is a contributing sub-factor important in meeting the target. In some cases the existing EU policy target may be related to an environmental threshold as described below, in others it will not. In either case, the existence of such targets will give a clear signal on the applicability of related targets for the given indicator;
3. **The scientific maturity of the threshold**. This will vary considerably. The science of quantifying sustainable fish population levels and sustainable catches is fairly mature, whereas quantifying critical levels of biodiversity, mineral resource scarcity or acceptable levels of some toxins to water courses is less so. Consensus on a particular value of a threshold may be an indicator of its maturity;
4. **How well is the spatial scale of the environmental issue matched to EU level target setting.** If the threshold relevant to the indicator in question is locally determined then the EU or individual Member State (MS) contribution to meeting that threshold is relatively uncomplicated. I.e. if it is a water quality threshold of standing water bodies then each MS can determine targets for levels of pollution emissions to water which will meet these thresholds. However, the other extreme of the threshold is global, e.g. the 2 degree tipping point for climate or scarcity of critical metals then the determination of each region or country's 'fair' contribution level to overall global targets is far from simple and subject to political negotiations;
5. The relationship of the subject of the indicator to the relevant EU policy target, environmental threshold or good management practice. As noted under elements 1 and 2 above the relationship of the phenomenon being measured by the indicator to the phenomenon subject to the EU policy target or environmental threshold can be direct or indirect. An example of the latter would be an indicator level of recycling that could be linked to scarcity of certain raw materials or another one measuring average CO_2 emissions per km for new cars which could be indirectly linked to GHG emissions targets. The level of separation can be determined in part via the DPSIR framework. The more separated the indicator variable is from the variable which is subject to a policy target or environmental threshold, the greater the uncertainty in the links between them and the more difficult it would be to decide on an appropriate target for the indicator. This does not mean that that a target could not be set but that considerable analysis would be needed prior to setting a target which would aid in achieving the existing target;
6. **The practicability of meeting a target set for this indicator.** A further consideration in suitability for indicator setting might be the extent to which policy can be developed which could achieve the target. It may be simpler to design policy which can achieve targets for a given Driver or Pressure within the DPSIR framework than designing policy to achieve targets for an Impact or State based indicator since in many cases a complex set of drivers and in some cases pressures contribute to a given Impact;
7. **The quality of the indicator.** This is a characteristic internal to the indicator itself. If the methodology behind the indicator is not mature, or the indicator is built on unreliable data, this will reduce the degree to which countries would be confident in committing to a target based on that indicator;
8. **Potential conflicts with targets in other indicators.** The subjects of many indicators may be closely interlinked which may make target setting more complex. In many, perhaps most cases, targets set for various RE indicators will be complimentary. However, in certain cases they will be conflicting. For example, a target for reducing dependence on fossil fuels may have a negative impact on targets for reducing the demand on land if it would lead to an increase in the

demand for biofuels, or similarly reduction of fossil fuels might be conflicted by the increase in recycling rates for critical metals. Any such potential conflicts with possible targets set for other indicators in the pool of RE indicators should be identified. Such potential conflicts would then need to be considered carefully when deciding on targets.

5.3 Assessment flow and format

5.3.1 Overall assessment process

This section provides an overview of the overall assessment, the order in which the various elements are considered for a given indicator, and how the results are presented in an integrated assessment of the suitability and feasibility of target setting for that indicator. Section 5.4 describes in detail the methodology used for assessing and reporting on individual assessment elements.

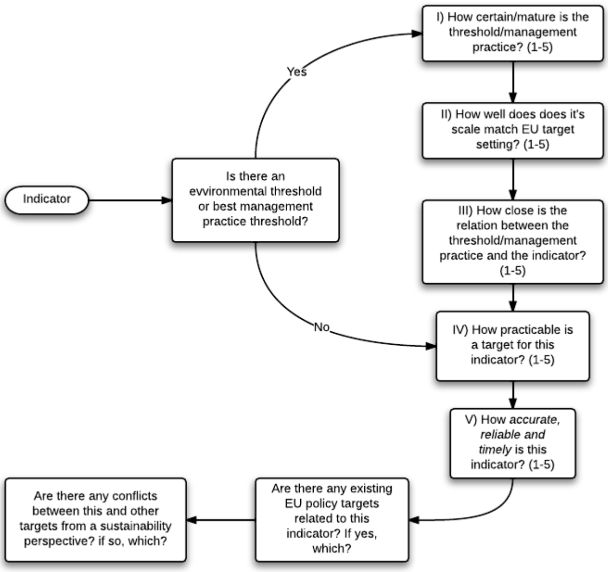
Figure 5-1 below presents the assessment process. The first element to be considered is whether or not there is a relevant threshold (s) arising from science or good management practice(s). Where multiple thresholds or management practices are identified, the one most relevant is used.

Where a relevant threshold or good management practice is identified, then degree to which this threshold is well established – whether there is broad scientific or political consensus with respect to the threshold or management practice – is then qualitatively assessed (see 5.4.3), resulting in a score between 1 and 5. The suitability of the scale of the threshold for policy target setting at the EU level (see 5.4.4) and the closeness of the relationship between the indicator and the threshold (see 5.4.5) are then similarly qualitatively assessed on a 1-5 scale.

All indicators – regardless of the presence or absence of threshold or best practice – are then assessed for practicability of target setting (see 5.4.6) and overall indicator quality (see 5.4.7). Again, these are qualitative assessments resulting in a score 1-5.

All indicators are also assessed for the presence of any existing related EU policy targets (see 5.4.2), as well as for potential conflicts with other indicators and targets (see 5.4.8).

Figure 5-1: Overview of assessment process for each indicator



5.3.2 Presentation of assessment results

The end result of carrying out the assessments on the full pool of indicators gathered during Task 1 of this project will be one group of indicators for which it is not considered that target setting in the context of environmental thresholds or existing EU policy targets is relevant, and a second set for which a qualitative assessment has been carried out which can advise on the suitability for target setting for the indicators in that set.

The development of a weighting system for each individual assessment elements 2-6 (or I to V in the above diagram) was considered in order to provide an overall suitability/feasibility score which would then allow a ranking of individual indicators for target setting. However, after some consideration it was decided that weighting of the various elements and the resulting single score would be too arbitrary. Rather the scores and qualitative assessments for the individual elements will be presented in an integrated assessment to allow the European Commission to make an informed decision on target setting.

The results will be presented in table format providing a short description of the targets, thresholds and potential conflicts and a score between 1 and 5 for each of the assessment criteria I-V.

A template assessment sheet is provided in Figure 5-2 below and Figure 5-3 is an illustration of a final indicator template that uses a more visual, easy-to understand format.

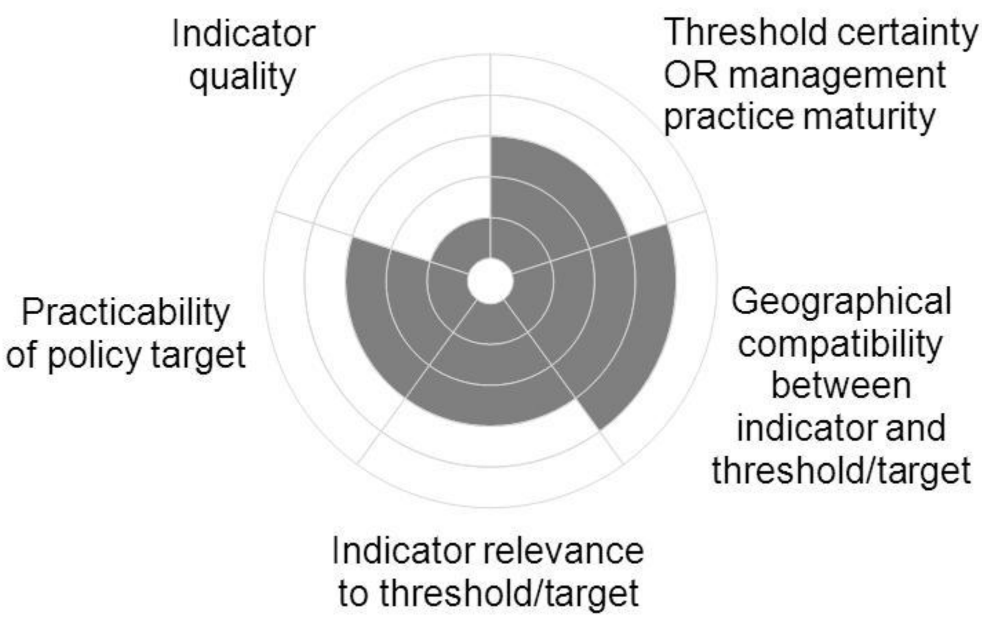
Figure 5-2: The Indicator Assessment Template

INDICATOR ASSESSMENT

	Assessment element	*Scoring*	*Description*
1.	Existence of relevant environmental threshold or good management practice?	*☐ Yes*	*Short description of threshold or good management practice.* *If there is more than one threshold identified, select most relevant (and list the others) and then fill in Elements 2 to 4 and proceed to Element 5*
		☐ No	*Continue to element 5.*
2.	I) How certain/mature is the threshold/management practice?	*… (1-5)*	*Scoring justification* *(ONLY FILLED WHEN THRESHOLD IDENTIFIED)*
3.	II) How well is the scale of the environmental phenomena/resource matched to EU target setting?	*... (1-5)*	*Scoring justification* *(ONLY FILLED WHEN THRESHOLD IDENTIFIED)*
4.	III) How closely is the indicator subject related to the policy/threshold subject?	*... (1-5)*	*Scoring justification* *(ONLY FILLED WHEN THRESHOLD IDENTIFIED)*
5.	IV) How practicable would a target be for this indicator?	*... (1-5)*	*Scoring justification (ALL INDICATORS)*
6.	V) How accurate, reliable and timely is the indicator?	*... (1-5)*	*Scoring justification (ALL INDICATORS)*
7.	Existence of relevant EU environmental target?	*☐ Yes*	*List any relevant policy targets, providing relevant policy documents.* *Continue with element 6*
		☐ No	*Continue with element 6*
8.	Are there conflicts with targets for other indicators?	*☐ Yes*	List conflicting indicators
		☐ No	N/A

Figure 5-3: Example of the Indicator assessment results

No. *RE059 Add11*	***Recycling rates of metals***
Environmental threshold / good management practice?	*scarcity estimates of different metals*
Relevant EU target?	*Recycling targets related to* ▪ *Waste Framework Directive (2008/98/EC)* ▪ *ELV directive(Directive 2000/53/EC)* ▪ *WEEE directive (Directive 2002/96/EC)*
Conflicts with targets for other indicators?	*Increased efficiency may lead to increased direct energy use and GHG emissions from recycling processes.*



Typology (DPSIR)	*Driver*
Perspective	*Territorial production*
Scale	*EU-27, economic sector(s), product (group)*

5.4 Assessment Methodology for individual elements

5.4.1 Existence of relevant environmental threshold or good management practice

Screening methodology and interpretation of 'relevant'

This initial screening assessment is concerned with the existence and relevance of environmental thresholds or good management practices which are of *relevance* (see below) to the phenomenon measured by the given indicator.

The assessment will not evaluate the quality or robustness of the environmental threshold(s) or good management practice(s), but will only provide a 'yes' or 'no' answer to whether environmental thresholds or management practices exist which are relevant to the specific indicator.

The environmental sustainability threshold is here defined as a quantifiable limit for which, if exceeded, adverse effects on and irreversible impacts to the environment or human health are expected to occur. The defined limits should be set on a scientific basis (see Section 5.5.1 for more details on findings). The information on existence of environmental thresholds has also been assessed in the factsheets from task 1 for each indicator.

The relevance will again be determined by how the indicator and the environmental threshold or good management practices are linked. If the connection between the environmental threshold or good management practices and the indicator are straightforward or if a logical and reliable connection exist and the indicator is a significant contributor to the variable covered by the thresholds or good management practices, it is considered to be a relevant link.

The following set of questions is used to define whether an environmental threshold or good management practice exists for an indicator:

- Are there any existing environmental thresholds concerning the environmental issue or sector to which the indicator is related?
- Are there any existing good management practices concerning the environmental issue or sector to which the indicator is related?
- Are there other relevant thresholds to take into account e.g. human health concerns?
- Are the link between the indicator and the threshold or management practice relevant according to the above definition of 'relevant'?
- Is the environmental threshold or management practice relevant according to the environmental issue or sector it is related to?

From the above methodology, it can be assessed whether a relevant environmental threshold or good management practice exists, and a ***'yes'*** or ***'no'*** can be provided for each indicator. It should be noted that the thresholds and good management practices should not be confused with policy targets, which are addressed in the previous section.

In cases where more than one threshold is identified, the assessment is carried out on the most relevant threshold, with other relevant thresholds indicated on the template as additional information.

5.4.2 Existence of relevant EU policy target

Screening methodology and interpretation of 'relevant'

The assessment of existing relevant EU policy targets defines whether a future target related to indicator has already been set. Thus, the assessment does not include evaluation of existing EU policy targets and will only provide a 'yes' or 'no' answer according to whether a relevant target for the indicator already exists. Neither will it evaluate to what extent an existing target is related to an environmental threshold.

The linkage between the indicator and the policy target can be both direct and indirect. An example of a direct link could be the indicator measuring PM_{10} concentrations in air and the target defining the maximum PM_{10} concentration of $50µg/m^3$ (daily average value) in air or a target defining fishing quotas against maximum sustainable yields. An example of an indirect link could be the indicator measuring landfill rates and the target of reducing the biodegradable municipal waste going on landfills.

The indirect targets can be more or less relevant to the indicator depending on how large uncertainties are related to the underlying processes linking the variable being measured by the indicator to the variable subject to the existing policy target. Here the policy target will be considered as 'relevant' to the indicator being assessed where; the connection between the indicator and the policy target is straightforward and the indicator is a significant contributor to the variable covered by the policy target.

The following three questions serve to determine if a target exists for an indicator:
1. Is the indicator directly or indirectly linked to a target?
2. Is the indirect link relevant according to the above definition of 'relevant'?
3. Is the target included in an EU policy or a broadly accepted policy set on an international level and adopted by the EU?

If all questions can be answered with a '***yes***' the indicator has an existing relevant EU policy target. If any questions can be answered with '***no***' the indicator has no existing relevant EU policy target.

In the context of this project for the EC, and in the context of the RERM, only global and EU wide targets are considered relevant: i.e. the existence of national targets is not addressed. Also, note that a policy target should not be confused with an existing policy link, which is a more general context in which the indicator could be relevant. An example of this could be the indicator 'RE019 A6-19 Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list'. This indicator is linked to the EU policy REACH, but is not subject to any direct EU policy target.

Moreover, the assessment only considers targets within environmental policy. Economic targets are seen as outside the scope of this assessment.

Information gathering method and source identification
Information on both policy link and relevant EU policy targets can be obtained from the factsheets from task 1, since these issues are assessed and collected in the factsheets. The relevant policy targets found in the factsheets are obtained from the indicator locations e.g. EEA, ESTAT, private organisations and international organisations, where links to the relevant policies can be found. However the information from the factsheets needs to be crosschecked, since as previously mentioned, not all policy links directly include the indicator. The information from the factsheets will be supplemented by further desk research, screening websites, including the EC and other international organisations like the UN, OECD etc.

5.4.3 *Is the threshold or management practice well established?*

Assessment methodology and scoring

Following the identification, under stage 2 of the assessment, of an environmental threshold or good management practice which is relevant to the indicator under review, an assessment is made of the degree to which the relevant threshold/good practice is well established and accepted. It should be noted that the assessment is applied to the environmental threshold or good management practice, rather than to the specific RE indicator to which the threshold/management practice has some relevance.

To carry out this assessment the source on which they are founded, needs to be evaluated. A qualitative approach has been used. Based on the qualitative assessment a weighting can be conducted, grading each indicator with 1, 3 or 5 points according the certainty/maturity.

Good management practices are not necessarily scientifically based, and thus the maturity depends on how broadly accepted the practice is and to what extent a consensus is established. For environmental thresholds and evaluation of how reliable the scientific estimate of the threshold is and to what extent a consensus is established, is important. Thus environmental thresholds and the good management practices cannot be evaluated under the exact same criteria and different approaches will be used.

The methodology used to assess the maturity of the quantification of the environmental threshold or good management practices are:

Environmental thresholds certainty:

- How reliable or how broadly accepted is the method for quantifying the threshold?
- Is the source for the environmental threshold considered reliable and robust within the scientific community?
- Is the environmental threshold cited by several or single sources?

Good management practices maturity:

- Are the management practices established and used at an EU level?
- Are the management practices broadly accepted in the sector to which it is related or at a political level?
- Is there a consensus about the management approach?
- Do the management practices have a sustainability or precautionary principles foundation?

The grading of the maturity of the quantification of the environmental thresholds or good management practices is assessed in accordance to following definition of maturity level:

Table 5-1: Definition of maturity level

Points	Certainty of environmental thresholds	Maturity of good management practices
1	Environmental threshold where the scientific foundation is criticised and only accepted by few.	Newly established management practice not yet implementer in policies or in sectors. Not broadly accepted.
3	Environmental threshold accepted by few but based on robust scientific methods or ideas.	Management practice only implemented by few institutions, but relatively broadly accepted.
5	Environmental threshold broadly accepted by scientific and political institutions and based on scientific robust methods or ideas.	Management practice already implemented in a policy or broadly accepted in the sector where it is used.

Information gathering method and source identification

Some information for assessing the maturity can be obtained from a search of scientific papers, such as different sources for the same environmental threshold or good management practice. The robustness assessment will also be based on a qualitative evaluation of the available sources found during the screening process under stage 2 of the assessment.

5.4.4 How well is the scale of the environmental phenomena/resource matched to EU target setting?

As with the stage 3 of the assessment, it should be noted that the stage 4 assessment is also applied to the environmental threshold or good management practice, rather than to the specific RE indicator to which the threshold/management practice has some relevance.

If the environmental threshold or good management practice relevant to the indicator in question is locally determined then the EU or individual Member State (MS) contribution to meeting that threshold is relatively uncomplicated. For example, water quality thresholds of standing water bodies can be used to determine local targets for releases of water born pollutants.

However, at the other extreme of the threshold is globally defined, e.g. the two degree tipping point for climate or global resource scarcity, then the determination of each region or country's 'fair' contribution level to overall global targets is far from simple and is subject to political negotiations.

The scale to which a threshold is determined is to a large extent dependent on the scale of the environmental compartment and sub-units and the level of exchanges between those sub-units. For example, a water catchment area is a well-defined and isolated system for which thresholds such as maximum abstraction rates could be defined. Other systems are less sharply defined due to exchanges between them. For example, waters in the North Sea mix with those of the Atlantic Ocean, English Channel, and Baltic Sea etc. Nevertheless, mixing may be slow enough in comparison to, for example, chemical breakdown times to allow emission thresholds to be defined for the North Sea for some chemical pollutants. For long-lived pollutants in an environment with relatively high mixing, a threshold is relevant for the whole global compartment – i.e. GHG emissions or emissions of ozone depleting substances in the atmosphere or global scarcity of certain material resources. In compartments with low mixing such as soils, thresholds will be much more locally defined.

An added complication is that in some cases a threshold/good management practice may have been defined at the global scale only, but which covers a phenomenon with low exchange between sub-units and therefore could equally well have been defined at a local scale. An example would be the global maximum sustainable extinction rates loosely estimated by Rockström et al (2009) at 10 extinctions per million species per year in order to protect ecological resilience of ecosystems. The disappearance of a species in Europe won't have a direct effect on the ecological resilience of the Amazon rainforest, therefore acceptable extinction rates can be independently defined for each ecosystem. Moreover, acceptable extinction rates in the Amazon may be more rapid than acceptable extinction rates in less energetic eco-systems at higher latitudes. Therefore, it may be inappropriate to use these globally determined thresholds to advice on European targets.

In order to be consistent with assessments in other elements a 1-5 scoring is used. The scoring is applied using the following guidance:

Table 5-2: Scoring guidance

Score	Characteristic of threshold
1	The environmental threshold is defined globally and cannot be defined locally (i.e. relatively rapid mixing in the compartment) and no agreement has been made on regional contributions.
2	The environmental threshold/good management practice is defined globally, but can be defined locally (i.e. limited mixing) although this has not been done in the EU.
3	The environmental threshold/good management practice is defined globally and cannot be defined locally (i.e. relatively rapid mixing in the compartment) but there is some consensus on regional contributions *or* The environmental threshold/good management practice is defined globally, but can be defined locally (i.e. limited mixing) and this has been done in a number of EU countries.
4	The environmental threshold/good management practice is defined globally, but can be defined locally (i.e. limited mixing) and this has been done in most EU countries *or* The environmental threshold/good management practice has been defined at global scale but is reasonably applicable at all scales.
5	The environmental threshold/good management practice has been defined at European, national and/or local scale *or* The environmental threshold/good management practice has been defined at global scale but is applicable at all scales *or* The environmental threshold/good management practice is defined globally and cannot be defined locally (i.e. relatively rapid mixing in the compartment) but there is full consensus on regional contributions.

The score for each indicator will be accompanied by a written justification.

5.4.5 How closely is the indicator subject related to the threshold/policy subject?

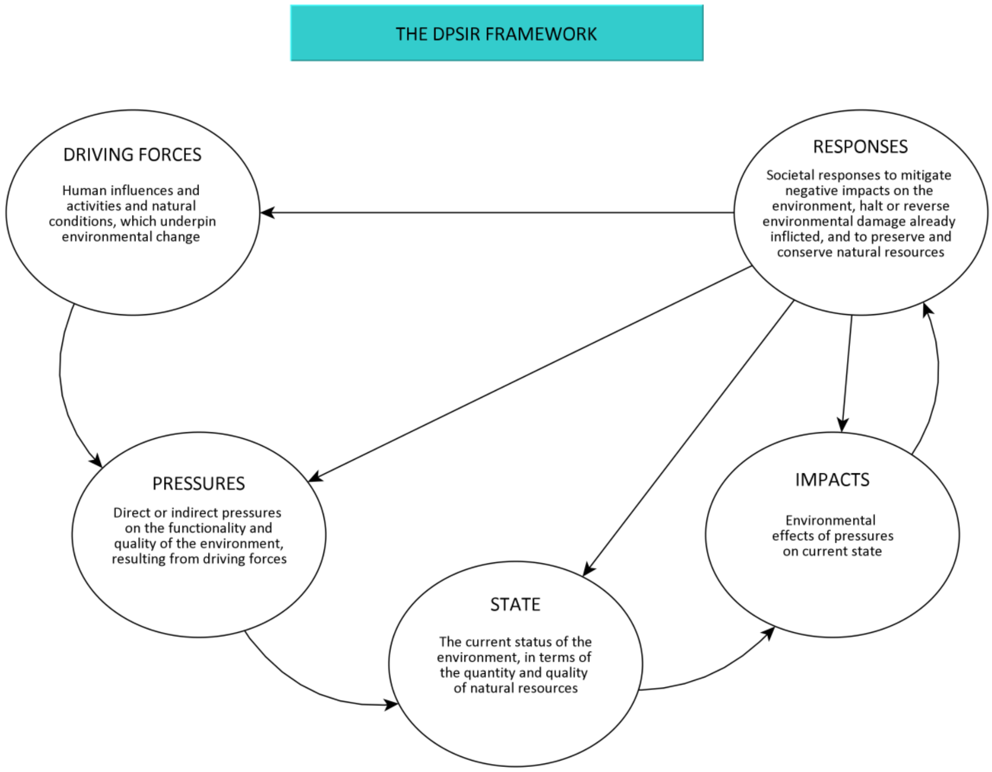
The relationship of the variable being measured by the indicator to the variable subject to the EU policy target/environmental threshold /good management practice can be direct or indirect.

An example of a direct relationship would be an indicator measuring the yearly European fish catch for key species compared to the sustainable catch threshold for those species. In these cases the threshold could be indicated directly on a graphic representation of an indicator. An example of a rather indirect relationship would be an indicator measuring average CO_2 emissions per km for new cars and GHG emissions targets for the EU.

The more separated the indicator variable is from the variable which is subject to a policy target or environmental threshold, the greater the uncertainty in the links between them and the more difficult it would be to decide on an appropriate target for the indicator. This does not mean that that a target could not be set but that considerable analysis would be needed prior to setting a target which would contribute appropriately to operating within the environmental threshold.

The level of separation can be determined in part via the DPSIR framework shown in Figure 10. If the threshold target is set for a Pressure and the threshold/policy target/good management practice is set for a State or Impact then the separation may be reasonably high, due to uncertainties in *exposure-dose-response* pathways. Even more so if the threshold is set for a Response, since the uncertainty in the effects of a response on relevant actors' activities must be added to the pressure to state/impact uncertainty. Response-to-pressure uncertainties will be higher for economic instruments than for more direct regulatory responses such as substance bans or limits.

Figure 5-4: The DPSIR Framework



A further consideration is the significance of the contribution of the variable being measured by the indicator compared to other sources of that variable. This is most easily illustrated with respect to pressures: private cars are a significant contributor to total GHGs in Europe. Therefore, it would be reasonable and productive to set a target for total GHG emissions from private cars in order to meet the 2050 80-95% overall GHG reduction target. It would, however, not seem so imperative to set a target for total GHG emissions from passenger ferries that have a negligible contribution to GHG emissions.

In order to be consistent with assessments in other elements a 1-5 scoring is used. The scoring is applied using the following guidance:

Table 5-3: Scoring guidance

Score	Characteristic of threshold
1	The indicator covers an element of the DPSIR which is two stages separated from the element covered by the relevant environmental threshold/policy target/good management practice. The connection is diffuse and is only a weak contributor to the variable covered by the environmental threshold/policy target/good management practice.
2	The indicator covers an element of the DPSIR which is two stages separated from the element covered by the relevant environmental threshold/policy target/good management practice. The connection is fairly diffuse and has a low contribution to the variable covered by the environmental threshold/policy target/good management practice.
3	The indicator covers an element of the DPSIR which is one stage separated from the element covered by the relevant environmental threshold/policy target/good management practice. The connection is reasonably straightforward and is a medium level contributor to the variable covered by the environmental threshold/policy target/good management practice.
4	The indicator covers the same element of the DPSIR framework as covered by the relevant environmental threshold/policy target/good management practice. The variable is a significant contributor to the variable subject to the relevant environmental threshold/policy target/good management practice *or* The indicator covers an element of the DPSIR which is one stage separated from the element covered by the relevant environmental threshold/policy target/good management practice. The connection is reasonably strong and straightforward and is an important contributor to the variable covered by the environmental threshold/policy target/good management practice.
5	The indicator covers precisely the same variable as covered by the relevant environmental threshold/policy target/good management practice.

The score for each indicator will be accompanied by a written justification.

5.4.6 *How practicable would a target be for this indicator?*

A further consideration in determining the suitability for an indicator to be used for target setting is the extent to which policy can be developed which could help achieve the target. This is, of course, a complex matter and is, to a large extent, reliant on the political weight a particular subject is accorded, but it is also reliant on the amenability of the measured phenomenon to policy interventions.

Taking the DPSIR indicator framework as a reference point, it may be simpler to design policy which can achieve targets for a given Driver or Pressure within the framework than designing policy to achieve targets for an Impact or State based indicator, since in many cases a complex set of drivers and in some cases pressures contribute to a given Impact. (Note, however, that this assessment stage does not explicitly use DPSIR to gauge suitability).

Similarly, targets defined within sectors or affecting a limited range of actors could potentially be easier to support with policy than economy wide targets.

The following table illustrates how the practicability of the indicator for target setting will be assessed.

Table 5-4: Practical use of threshold

Score	Practical use of threshold
1	*Phenomenon which the threshold occurs in* cannot be influenced by policy
2	*Phenomenon which the threshold occurs in* can be influenced but there are many competing drivers.
3	*Phenomenon which the threshold occurs in* can be influenced by policy, but easier to influence policy targets for related indicators
4	*Phenomenon which the threshold occurs in* can be influenced by policy
5	*Phenomenon which the threshold occurs in* can be directly influenced by policy

Note: all scores are justified and elaborated on in the individual indicator assessments.

5.4.7 Indicator quality

It is essential that any indicator used for target setting, and consequently as the basis and justification for the implementation of further policy tools, be accurate, reliable and timely. If the methodology behind the indicator is not mature, or the indicator is built on unreliable data, this will reduce the degree to which politicians would be confident in committing to a target based on that indicator. If it is not timely then there will be long delays between implementation of a policy aimed at achieving a target, and identifying whether the policy has had the desired effect. This would also reduce its attractiveness to politicians for target setting.

This aspect of the assessment of suitability of the selected indicators for target setting is primarily concerned with practical data issues and internal characteristics of the indicator itself. Elements of the assessment criteria are inspired by the RACER indicator assessment methodology, first developed by the Commission in its Impacts Assessment Guidelines 2005, and further developed in the DG Environment project *"Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use"*[42] and the SERI project "*Environmental Impact of Trade (EIPOT)"*[43].

Assessment methodology and scoring

The reliability, robustness and timeliness of an indicator pertain to various aspects of the data and indicator in question:

At the indicator-level:

- Quality/maturity of the indicator methodology:
  - The maturity of the indicator itself is a useful gauge of its reliability, as is the organisational level at which it is currently produced and used;
  - *Criteria: Approach is credible and reliable regarding underlying theory and the full methodology published in academic (peer reviewed) journals and related technical reports or is already employed by EU Institutions.*

At the data-level:

- Quality/maturity of the collection method:
  - The data collection, verification and delivery process is critical to the reliability of an indicator. Measuring the effectiveness of this process is only possible in mature indicators;
  - *Criteria: that data is available from national or international institutions and/or uses official government statistics and/or unofficial data of good quality from trustworthy sources.*
- Geographic availability of the data:
  - Indicators suitable for target setting at the EU level should cover the whole EU-27 and preferably also the ascension countries;

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42 http://old.seri.at/documentupload/pdf/best_et_al_2008_impacts_from_resource_use.pdf.
43 http://www.sei.se/eipot/EIPOT_Final_Report_07Aug09.pdf.

- *Criteria: that data is available for all EU27 Member States.*
- Timeliness of the data:
  - Less critical to the reliability of an indicator, but the timeliness of and indicator also dictates the policy response time: it is easier to tailor policy toward a target if there is up to date information about progress toward that target;
  - *Criteria: that data is available with at most 24 months lead time.*

A deficiency in any of the above criteria will result in an indicator that is ill-suited to target setting at the EU (and subsequently National) level. However, to align with the other criteria for assessing indicator suitability, the following 5-point scale is used to apply a score for indicator reliability.

Score	Indicator quality
1	Two or more criteria are unfulfilled (detail)
2	One criteria remains unfulfilled (detail)
3	All criteria are fulfilled, but some unsatisfactorily (detail)
4	All criteria are fulfilled, but one unsatisfactorily (detail)
5	All criteria are fulfilled satisfactorily

Information gathering methodology

Information for this aspect of the assessment will primarily be gathered from the factsheets, as these provide detailed information on the data availability for each indicator, as well as information about the methodology behind the indicator. Indicator supporting documents also provide information about scope and methodological reliability. These also often provide information about the reliability and robustness of the data upon which the indicator is built.

5.4.8 Are there conflicts with targets for other indicators?

The subjects of many of the indicators in the pool of RE indicators may be closely interlinked which may make indicator setting more complex. Links can be positive or negative. A positive or complementary link would be where pushing indicator A in the wished for direction would contribute to pushing indicator B in the wished for direction and/or vice versa. A negative or conflicting link would be where pushing indicator A in the wished for direction would potentially push indicator B in the unwished for direction.

This presupposes that for each indicator the wished for direction is quite clear. This may not always be the case. However, it should be noted that any indicator without a wished for direction is unlikely to have passed through the original screening process.

It can be expected that targets set for many RE indicators will be complimentary. However, in certain cases they will be conflicting. For example, a target for reducing dependence on fossil fuels may have a negative impact on targets for reducing the demands on land if it would lead to an increase in the demand for biofuels.

For this assessment a scoring system is not seen as appropriate. Rather the assessment should be more of a screening process where any potential conflicts between the ‘wished-for-direction’ for indicator A and any other indicator in the pool will be highlighted and briefly described. Such potential conflicts would then need to be considered carefully when deciding on any targets for the conflicting indicators. Those indicators without any identified conflicts will be simply given a ‘no conflicts identified’ note.

Any conflicts with other *key* EU environmental policy targets will also be identified where possible. However, identifying potential conflicts with economic policy targets are seen as beyond the scope of this project.

5.5 Literature review, assessment results and main findings

5.5.1 Literature review on thresholds

Unsustainable patterns in the use of environmental resources have already been addressed by some researchers, before the scientific discussion reached its current level of intensity. For example, Daly[44] suggested the following three operational rules defining the condition of ecological (thermodynamic) sustainability:

- Renewable resources such as fish, soil, and groundwater must be used no faster than the rate at which they regenerate;
- Non-renewable resources such as minerals and fossil fuels must be used no faster than renewable substitutes for them can be put into place;
- Pollution and wastes must be emitted no faster than natural systems can absorb them, recycle them, or render them harmless.

In order to complete the information on environmental thresholds and good management practices data has been collected from sources such as scientific journals (Nature, Ecology and Society, Responsabilité & Environment, Sustainability etc.), reports from relevant research institutes (IPCC, SERI, BIO Intelligence etc.) and the knowledge of experts within the consortium on management practices.

To create an overview, a table (See Table 5-5) was created dividing the different environmental thresholds and good management practices into environmental aspects and sectors.

However it should be noted, that no human health thresholds or good management practices (including those from policies) are included in the factsheets, and thus the information from the factsheets is only partly applicable for information collection and has to be crosschecked for each indicator. The last column lists indicators which the identified threshold has a relevance to. However, it does not necessarily mean that the threshold has also been assigned to an indicator via this assessment. Some indicators are very complex /composite/aggregated by nature and are therefore less/not suited to monitoring a single threshold even if that has a relevance to it.

Rockström et al, 2009[45] identified nine planetary boundaries, which have recently been much discussed and quoted. These are as follows:

- climate change;
- stratospheric ozone;
- land use change;
- freshwater use;
- biological diversity;
- ocean acidification;
- nitrogen and phosphorus inputs to the biosphere and oceans;
- aerosol loading;
- chemical pollution.

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[44] Daly, H. E. 1990. "Toward some operational principles of sustainable development." Ecological Economics 2: 1–6.

[45] Rockström et al, 2009. Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society 14(2): 32. and Rockström et al, 2009. A safe operating space for humanity. Nature, Vol 461|24 September 2009.

Drawing upon current state-of-the-art scientific understanding, they proposed quantifications for seven of them. According to the research findings, it is concluded that planetary boundaries have been trespassed in at least three of these (climate change, biological diversity and nitrogen input to the biosphere).

However, the intention of the task team in this project was to collect additional information and evidence from which any thresholds or limits can be extracted in order to support the formulation of relevant policy targets.

In this regard, the task team went beyond the planetary boundaries identified by Rockström and his colleagues in the collection of relevant information.

For example, there are very few concrete thresholds suggested on material resource use. Based on an MFA approach, Bringezu, 2011[46] has discussed the current level of resource use against target values for long-term development. According to Bringezu, in order to outline how this may develop in the future in order to obtain sustainable conditions, the following aspects should be considered:

- The net addition to stock (NAS), measuring the amount of buildings and infrastructures added each year to the existing stock, must be reduced to zero;
- Domestic biomass harvested from agriculture and forestry may probably be kept constant or increased by up to 25% under conditions of sustainable cultivation, in particular by mobilising unused potential from forestry. Imported biomass should be reduced with regard to a balanced global land use;
- The use of abiotic resources (naturally non-renewable) should be significantly reduced in order to mitigate the domestic and foreign environmental pressure of resource extraction and waste disposal, and to contribute to a more equitable pattern of global resource consumption;
- Erosion of agriculture fields within the EU should be reduced by a factor of 10 in order to approach the level of soil regeneration;
- Fossil fuel use for combustion needs to be phased out.

Further to thresholds, arising from scientific evidence, examples for local limits were also taken into account based on practical experiences for example in water management, forestry or agriculture. Good management practices providing any tangible limits or a clear ‘rules of thumb’ that can be used similarly to thresholds have also been considered to complement those arising from scientific evidence.

For this exercise broadly accepted practices, where a consensus about the approach is established have been identified. These practices do not necessarily have a defined limit, but could also relate to the precautionary principle, since they are applied based on a pragmatic approach to securing sustainable use of resources.

Examples of good management practices are forest management, conversion of land and the factor 4 material consumption approach.

The following table summarises the most important scientific and good management environmental sustainability thresholds identified from the literature and their relevance to indicators in this study.

[46] Bringezu, 2011. Key Elements for Economy-wide Sustainable Resource Management. Responsabilité & Environnement N° 61 Jan. 2011.

Table 5-5: Most important environmental thresholds identified

Thresholds	Type	Value(s)	Unit	Scale	Reference(s)	Relevant indicators*[47]
Climate change						
Atmospheric carbon dioxide concentration	Scientific (proposed boundary)	350	ppm CO_2 by volume	Global average	Rockström et al (2009)[48] A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	Indicators related to GHG emissions RE007 A6-7; RE008 A6-8 RE040 A6-40; RE041 A6-41 RE042 A6-42; RE043 A6-43 RE044 A6-44
World total biocapacity (carbon)	Scientific	1.41	Gha/cap (2005 reference year)	Global average	Wiedmann T. and Barrett J., (2010) A Review of the Ecological Footprint Indicator – Perceptions and Methods, *Sustainabillity* 2010, 2, pp. 1645-1693, ISSN 2071-1050.	RE008 A6-8 Carbon footprint
Average global temperature change	Policy-based and scenario based	2 equals 445-490	°C CO_2e ppm	Global average	Intergovernmental Panel on Climate Change, "Summary for Policymakers of the Synthesis Report of the IPCC Fourth Assessment Report," November 2007. EC, (2002) Kyoto protocol, *European Commission*: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32002D0358:EN:NOT.	Indicators related to GHG emissions RE007 A6-7; RE008 A6-8 RE040 A6-40; RE041 A6-41 RE042 A6-42; RE043 A6-43 RE044 A6-44
Cumulative atmospheric green house gas emissions	Scientific (quantifying the 2°C policy based target in long term perspective)	590 (medium probability) 170 (high probability)	Petagrams of carbon (PgC)	Global average	Zickfeld k., Eby M., Matthews D. and Weaver A.J., (2009) Setting cumulative emissions targets to reduce the risk of dangerous climate change, *Proceeding of the National Academy of Sciences of the United States of America (PNAS),* September 2009, vol. 106 no. 38, 16129 - 16134.	Indicators related to GHG emissions RE007 A6-7; RE008 A6-8 RE040 A6-40; RE041 A6-41 RE042 A6-42; RE043 A6-43 RE044 A6-44
Air						
Air quality; Particulate	Health or policy-based	See list in footnote[49]		Local average	WHO, (2006) WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide,	RE030 A6-30 Concentrations of Particulate Matter (PM10) in ambient

[47] * The last column lists indicators to which the identified threshold has a relevance to. However, it does not necessarily mean that the threshold has also been assigned to indicator on its assessment. Some indicators are very complex /composite/aggregated by nature and therefore are less/not suited to monitor a single threshold even if that has a relevance to it.

[48] Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Ill, Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder, P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. A., (2009) A safe operating space for humanity, Nature, September 2009, vol 461, No 24.

Thresholds	Type	Value(s)	Unit	Scale	Reference(s)	Relevant indicators*[47]
concentration in the atmosphere (PM, SO_2, NO_2, Lead, Ozone, PAH, CO, Benzene, As, Cd and Ni)					Global update 2005, summary of risk assessment, *World Health Organisation*: http://whqlibdoc.who.int/hq/2006/WHO_SDE_PHE_OEH_06.02_eng.pdf EC, (2012) Air Quality Standards, *European Commission*: http://ec.europa.eu/environment/air/quality/standards.htm.	air RE031 A6-31 Percentage of urban population in areas with PM10 concentrations exceeding daily limit values RE045 A6-45 Pollutant emissions (NOx, VOC, PM) from the transport sector
Stratospheric ozone depletion; Concentration of Ozone	Scientific (proposed boundary)	276	Dobson unit	Global average	Rockström et al (2009) A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	Composite/Complex impact indicators RE045 A6-45 Pollutant emissions (NOx, VOC, PM) from the transport sector RE050 Add2 Substitution of dangerous chemicals
Water						
Good water quality; good ecological status Water	Management (WFD)			Locally	EC, (2000) Water Frame Directive, *European Commission*; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2000:327:0001:0072:EN:PDF.	RE004 A6-4 Water exploitation index (WEI, %)
Water quantity; Consumption of freshwater by humans	Scientific + management	20	% (WEI)		Ecologic Institute and SERI (2010) Establishing Environmental Sustainability Thresholds and Indicators. Final report to the European Commission's DG Environment, November 2010.	RE004 A6-4 Water exploitation index (WEI, %)
Water quantity; global fresh	Scientific (proposed boundary)	4000	Km^3/year	Global average	Rockström et al (2009) A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	RE005 A6-5a Water footprint NATIONAL LEVEL A6-5b Water footprint

[49] **WHO:** PM10: 20 µg/m^3 annual mean; PM2.5: 10 µg/m^3 annual mean; O_3: 100 µg/m^3 8-hour mean; NO_2: 40 µg/m^3 annual mean; SO_2: 20 µg/m^3 24-hour mean.
EC: PM10: 40 µg/m^3 annual mean;PM2.5: 25 µg/m^3 annual mean; O_3: 120 µg/m^3 8-hour mean;NO_2: 40 µg/m^3 annual mean;SO_2: 125 µg/m^3 24-hour mean; Lead: 0.5 µg/m^3 annual mean;CO: 10mg/m^3 8-hour mean; Benzene: 5 µg/m^3 annual mean; Arsenic: 6ng/m^3 annual average; Cadmium: 5ng/m^3 annual average; Nickel: 20ng/m^3 annual average; Polycyclic Aromatic Hydrocarbons: 1ng/m^3 annual average.

Thresholds	Type	Value(s)	Unit	Scale	Reference(s)	Relevant indicators*[47]
water consumption by humans						COMPANY LEVEL A6-5c Water footprint PRODUCT LEVEL RE006 A6-6 Embodied water
Ocean acidification						
Global mean saturation state of argonite in surface sea water	Scientific (proposed boundary)	2.75	Mean saturation state	Global average	Rockström et al (2009) A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	
Fish stocks						
Maximum sustainable yield	Management and policy based			Local	Ecologic Institute and SERI (2010) Establishing Environmental Sustainability Thresholds and Indicators. Final report to the European Commission's DG Environment, November 2010.	RE036 A6-36 Share of fish and shellfish populations within safe biological limits
Land use/land use change						
Percentage of global land cover converted to cropland	Management + policy measure + scientific	15	% converted land cover	Global average	Rockström et al (2009) A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	RE011 A6-11 Landscape Ecosystem Potential
World biocapacity (build-up land)	Scientific	0.07	Gha/cap	Global average	Wiedmann T. and Barrett J., (2010) A Review of the Ecological Footprint Indicator – Perceptions and Methods, *Sustainabillity* 2010, 2, pp. 1645-1693, ISSN 2071-1050.	RE002 A6-2 Artificial land or built-up area
Sustainable amount of protected forest land	Scientific	10%	% strict protection of forest habitat types	European	BirdLife International, (2005) Priorities for developing the proposed EU forest action plan, European Forrest Task Force, October 2005; http://ec.europa.eu/agriculture/fore/action_plan/birdlife.pdf.	RE009 A6-9 Natural ecological capital (under development) RE011 A6-11 Landscape Ecosystem Potential (under development) RE012 A6-12 Ecosystem

Thresholds	Type	Value(s)	Unit	Scale	Reference(s)	Relevant indicators*[47]
					Bücking, W., (2003) Are there threshold numbers for protected forests?, *Journal of Environmental Management*, 67, pp. 37-45; http://www.china-sds.org/kcxfzbg/addinfomanage/lwwk/data/kcx779.pdf.	Degradation (under development) RE062 Add14 eHANPP
Land use change to biofuels (indirect land use)	Scientific	5.6%	First generation biofuels as a share in the 10% EU target	European	Ecologic Institute and SERI (2010) Establishing Environmental Sustainability Thresholds and Indicators, Final report to the European Commission's DG Environment, November 2010	RE003 A6-3 Indirect land use / embodied land for agricultural and forestry products)
Soil degradation						
Soil erosion	Scientific + human judgment (compared to the country based natural rate)	1	Ton per ha per year	European average (formation rate) Look at country level	SERI, Establishing an environmental sustainability threshold on soil erosion, Factsheet on soil erosion, *Ecologic Institute and Sustainable Europe Research Institute.*	RE033 A6-33 Soil erosion on RE034 A6-34 Soil organic matter levels
Chemical pollution						
Substances of very high concern	Management (REACH)	Risk assessment		European	EC, (2006), Registration, Evaluation, Authorisation and Restriction of Chemicals, *European Commission*; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006R1907:EN:NOT.	RE019 A6-19 Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list.
Nitrogen cycle						
N2 removed from the atmosphere for human use	Scientific (proposed boundary)	35	Million tonnes/year	Global average	Rockström et al (2009) A safe operating space for humanity, *Nature*, September 2009, vol 461, No 24.	none
Phosphor cycle						
Amount of P	Scientific	11	Million	Global	Rockström et al (2009) A safe operating space for	RE060 Add12 Nutrient leaking to

Thresholds	Type	Value(s)	Unit	Scale	Reference(s)	Relevant indicators*[47]
flowing into oceans	(proposed boundary)		tonnes/year	average	humanity, *Nature*, September 2009, vol 461, No 24.	water bodies
Waste						
Zero landfill and recycling society	Management				EC, (2008) Waste Framework Directive, *European Commission*; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32008L0098:EN:NOT.	RE020 A6-20 Total waste generation RE021 A6-21 Overall recycling rate
Materials						
Total Material Consumption (abiotic)	Management + scientific	10	Tonnes/capita (2050)	Global average	Bringezu, S., (2011) Key Elements for Economy-wide Sustainable Resource Management, *Responsabilité & Environnement,* N° 61 Jan. 2011, pp- 78-87.	RE013 A6-13 Raw Material Consumption (RMC) RE020 A6-20 Total waste generation RE021 A6-21 Overall recycling rate RE054 Add6 Material dependency RE029 A6-29 Resource productivity of minerals and metals (GDP/DMC minerals+metals)
Material consumption and productivity	Management	Factor X (4-10)		European average	von Weizsäcker, E., Hargroves, K., Smith, M., Desha, C. and Stasinopoululos, P., (2009) Factor 5: Transforming the Global Economy through 80% Increase in Resource Productivity, *Earthscan*, UK and Droemer, Germany. Schmidt-Bleek, F., (2009) The Earth, Natural Resource and Human Intervention, *Haus Publishing Ltd*, London. Giljum, S., Hammer, M. and Hinterberger, F. (2004) Resource use scenarios for Europe in 2020, *SERI studies*, No. 1, Sustainable Europe Research Institute, Vienna.	RE013 A6-13 Raw Material Consumption (RMC) RE020 A6-20 Total waste generation RE021 A6-21 Overall recycling rate RE054 Add6 Material dependency RE029 A6-29 Resource productivity of minerals and metals (GDP/DMC minerals+metals)

Policy implications of environmental planetary boundaries concept

Science based evidence on the planetary boundaries that should be respected by the socio-economic system, and thus are candidates for becoming subjects of policies and target setting, have been documented by various researchers, as also illustrated by the table above.

However, the level of uncertainty is still rather high for individual thresholds, and even more uncertain is the co-causality between them in the complex Earth Systems. Often, even though one might be sure there is a threshold, it is very difficult to find[50] where it is and many systems are so complicated that it is impossible to really measure their resilience.

Researchers of planetary boundaries stress that their approach does not offer a complete roadmap for sustainable development, but they argue that it does provide an important element by identifying critical planetary boundaries[51].

Another challenge recognized by some of the key authors of Rockström et al (2009) is the fact that the boundaries are likely to change over time: scientific advances will lead to revised estimates of the individual boundaries, and the interactions between the boundaries themselves will require continuous revisions and updates.

On the other hand, it must be important to define a danger zone (policy targets) even in cases where the certainty of threshold is not known. We illustrate this with a pragmatic example of environmental taxes aimed at capturing the external costs caused by an economic activity. These taxes are often criticised for being based on a vague quantification of the externalities. However, should the tax rate be set different from the ideal (Pigovian tax rate), but not exactly quantifiable level, it still might be an effective policy measure reducing the environmental impacts (and externalities) of an economic activity.

As also recognised during the ‘Beyond GDP’ process, it is clear that while scientists are seeking to identify related physical environmental threshold values and highlight the potential long-term or irreversible consequences of crossing them, for policy-making it is important to know the "danger zones" before the actual tipping points are reached, thereby identifying alert levels.

5.5.2 Assessment results

This analysis for suitability for target setting has been carried out for all 66 indicators identified under Task 1 of this project. The following table provides an overview of the assessment results.

Based on this table, individual fact sheets are prepared for each of the indicators as illustrated.

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[50] See Massachusetts Institute of Technology - MIT News for an example: From yeast, researchers learn how populations collapse. Findings could help fishery and wildlife managers monitor their stocks before disaster strikes.

[51] See website of Stockholm Resilience Institute: Tipping towards the unknown.

Table 5-6: Most important environmental thresholds identified

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE001	A6-1	Resource Productivity (GDP/DMC)		No	3	5	5	2	4	Increased efficiency may lead to increased use of resources (i.e. land, water, minerals).
RE002	A6-2	Artificial land or built-up area (available with restrictions in time series)		No	3	5	5	5	2	
RE003	A6-3	Indirect land use / embodied land for agricultural and forestry products (to be developed)		No	5	1	4	2	2	
RE004	A6-4	Water exploitation index (WEI, %) (available with restrictions on completeness of data and regional/temporal resolution - river basin/intra-annual variations)		Yes - indirectly linked to Water framework directive targets (WDF 2000/60/EC)	5	5	4	2	2	
RE005	A6-5a	Water footprint (to be updated and improved) NATIONAL LEVEL		No	5	2	3	2	2	
RE005	A6-5b	Water footprint (to be updated and improved) COMPANY LEVEL		No	5	2	1	2	2	
RE005	A6-5c	Water footprint (to be updated and improved) PRODUCT LEVEL		No	5	2	1	2	2	

52 **Assessment criteria**

I. Threshold certainty OR maturity of management practice;
II. How well is the scale of the environmental phenomena/resource matched to EU target setting?
III. The relationship of the subject of the indicator to the relevant environmental threshold (DPSIR);
IV. How practicable would a target be for this indicator?
V. Indicator quality.

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE006	A6-6	Embodied water (to be developed)		No	5	2	1	2	2	
RE007	A6-7	GHG emissions		Yes - 20 20 20 targets + 2050 80-90% reduction (Council Decision 2002/358/EC)	5	5	4	3	5	Reduction of GHG emissions from fossil fuels may lead to increased land and water use for the production of biofuels.
RE008	A6-8	Carbon footprint (estimates available from scientific sources)		No	5	5	4	2	2	
RE009	A6-9	Natural Ecological Capital (under development)	Yes - factor 4/factor 10 - good management practice	No	1	5	3	2	1	
RE010	A6-10	Environmental impacts of resource use (under development)	yes - good management practice - putting a ceiling on urban land/cap	No	N/A	N/A	N/A	2	2	
RE011	A6-11	Landscape Ecosystem Potential (to be developed)	Yes - available global land per capita	No	3	4	3	2	3	
RE012	A6-12	Ecosystem Degradation (to be developed)	Yes - water stress	No	N/A	N/A	N/A	3	1	
RE013	A6-13	Raw Material Consumption (RMC) (to be developed)	Yes - water scarcity max abstraction of water	No	1	3	4	3	3	
RE014	A6-14	Percentage of the value, and number, of public procurement contracts that include GPP criteria.	Yes - water scarcity max uptake of water	Yes - non-binding target 50% by 2010 (COM(2008)400 final)	N/A	N/A	N/A	5	2	

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE015	A6-15	Number and value of green products purchased by households	Yes - water scarcity max uptake of water	No	N/A	N/A	N/A	3	1	
RE016	A6-16	Output or share of green products in total output	Yes - water scarcity max uptake of water	No	N/A	N/A	N/A	3	3	
RE017	A6-17	Proportion of companies using environmental footprint, by sector and size class, within priority sectors, for: measuring, managing and meeting benchmarks	Yes - 450 ppm CO_2e concentration	No	N/A	N/A	N/A	5	1	
RE018	A6-18	Number of companies, by sector and size class, benefiting from advisory assistance from Member States or regional government on improving their environmental performance.	Yes - 450 ppm CO_2e concentration	No	N/A	N/A	N/A	5	1	
RE019	A6-19	Number of known 'substances of very high concern' (SVHC) included on the REACH Candidate list.	Yes - biomass available to support ecosystem services and to maintain a self-sustaining ecosystem	Yes - REACH targets (Regulation (EC) No 1907/2006)	1	5	N/A	4	3	
RE020	A6-20	Total waste generation	Yes - thresholds in multiple environmental impacts categories	Yes - Waste Framework Directive (Directive 2008/98/EC)	N/A	N/A	N/A	2	5	

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE021	A6-21	Overall recycling rate	Yes - relative change (+ improvement and - degradation)	yes - Waste Framework Directive (Directive 2008/98/EC)/packaging directive (Directive 94/62/EC)/WEEE directive (Directive 2002/96/EC)	1	3	4	4	4	Increasing recycling may lead to increased energy use and direct GHG emissions. On the other hand emissions (from resource extraction) avoided by recycling yields in a net positive balance in most cases.
RE022	A6-22	Landfill rate	No	Yes - Landfill directive (Directive 1999/31/EC)	5	5	3	4	4	
RE023	A6-23	Proportion of secondary raw material used in the EU economy compared to primary raw material (to be developed based on existing information)	Yes - Bringezu; resource scarcity estimates	No	1	3	3	2	2	Increasing recycling may lead to increased energy use and direct GHG emissions. On the other hand emissions (from resource extraction) avoided by recycling yields in a net positive balance in most cases.
RE024	A6-24	Number and value of funding (€/year) of research and innovation projects promoting mainly resource efficiency and sustainable environmental management, allocated through European financial support programmes.	No	No	N/A	N/A	N/A	5	3	
RE025	A6-25	Annual value of all Environmentally Harmful Subsidies (EHS) provided (to be	No	Yes - non binding (Sixth Environmental Action Programme and EU Sustainable	5	5	5	5	2	

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52]					Potential conflicts with targets in other indicators
					I.	II.	III.	IV.	V.	
		developed)		Development Strategy 2006)						
RE026	A6-26	The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate	No	Yes - non binding (Sixth Environmental Action Programme and EU Sustainable Development Strategy 2006)	5	5	5	5	2	
RE027	A6-27	Environmental taxes as share of total taxes and social contributions	No	Yes - non binding (RERM)	N/A	N/A	N/A	5	5	
RE028	A6-28	Total value of environmental taxes paid	No	No	N/A	N/A	N/A	5	5	
RE029	A6-29	Resource productivity of minerals and metals (GDP/DMC minerals + metals)	Yes - complex risk potentials for individual chemicals	No	3	5	4	2	5	Increased efficiency may lead to increased use of metal resources.
RE030	A6-30	Concentrations of Particulate Matter (PM_{10}) in ambient air	No	Yes - Concentration limits (Daughter Directive 1999/30/EC)	5	5	5	3	4	
RE031	A6-31	Percentage of urban population in areas with PM_{10} concentrations exceeding daily limit values	Yes - scarcity estimates	Yes - Concentration limits (Daughter Directive 1999/30/EC)	5	5	4	2	4	Decreased percentage of pop in areas exceeding PM_{10} concentration limits could signify increase in artificial land (reduced urban density).

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE032	A6-32	Average annual land take on the basis of the EEA Core Set Indicator 14 Land take	yes - best practice zero landfill of biodegradable waste	Yes - Biodiversity targets (Decision 1600/2002/EC)	5	5	4	2	4	
RE033	A6-33	Soil erosion on the basis of the EEA indicator Soil erosion by water and the PESERA and/or RUSLE models of the JRC	Yes - scarcity estimates	No	5	5	4	2	3	
RE034	A6-34	Soil organic matter levels, e.g. on the basis of LUCAS results	No	No	5	5	4	3	3	
RE035	A6-35	Share of contaminated sites on which remediation actions have started in the previous year on the basis of the EEA Core Set Indicator 15 Progress in management of contaminated sites	good management practice - RIO+20 declaration to remove all EHS	No	N/A	N/A	N/A	4	3	
RE036	A6-36	Share of fish and shellfish populations within safe biological limits	good management practice - RIO+20 declaration to remove all EHS	Yes - aspirational target (RERM)	5	5	3	3	3	
RE037	A6-37	The number and area of Marine Protected Areas (MPAs)	No	Yes - (Marine Strategy Framework Directive and EU Strategy on Biodiversity to 2020)	5	5	4	5	4	
RE038	A6-38	Development in consumption of different meat and dairy products per capita per year based on	No	No	N/A	N/A	N/A	2	4	Decreasing meat consumption may lead to increased consumption of fish, grains and

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
		ETC/SCP Indicator 13.2 for the EEA								vegetables and pose pressure on land use.
RE039	A6-39	Share of edible food waste in households, retailers and catering.	Yes - factor 4/factor 10 - good management practice	No	N/A	N/A	N/A	2	1	
RE040	A6-40	The rate of nearly zero-energy new buildings (to be developed)	Yes - EU maximum allowed concentration - health	Yes - EPBD (Directive 2010/31/EC) -by end 2020 (private) and end 2018(public), all new buildings must be nearly zero energy buildings	5	5	2	4	1	
RE041	A6-41	Energy consumption per m^2 for space heating, per dwelling and for total housing stock alongside growth in m^2 of living space per capita based on ETC/SCP Indicator 16.1 for the EEA (to be further developed)	Yes - EU maximum allowed concentration - health	No	5	5	3	2	4	
RE042	A6-42	CO_2 emissions in the transport sector	Yes - natural capital based threshold	No	5	5	3	3	5	Reduction of GHG emissions from fossil fuels may lead to increased land and water use for the production of biofuels.
RE043	A6-43	Total energy consumption/km driven as a proxy for energy efficiency in transport	Yes - 1 tonnes/ha/year in EU average	No	5	5	3	3	4	
RE044	A6-44	Average CO_2 emissions per km for new passenger cars	Yes - Good management practice exists.	Yes - Voluntary agreement (Regulation (EC) No 443/200 (2009))	5	5	3	5	5	Reduction of GHG emissions from fossil fuels may lead to increased land and water use

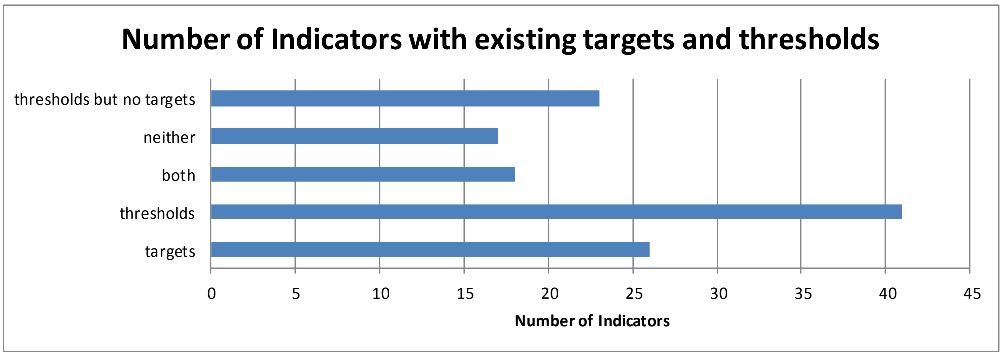
Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
										for the production of biofuels. Potential increase in hazardous waste from battery technology and increased demand for certain critical metals.
RE045	A6-45	Pollutant emissions (NO_x, VOC, PM) from the transport sector (available from EEA / Reporting under NECD)	No	yes - Concentration limits (Directive 2001/81/EC and Directive 2008/50/EC)	N/A	N/A	N/A	4	5	Development of catalytic converters increased demand for certain critical metals.
RE046	A6-46	Energy consumption by fuel type	Yes - maximum sustainable yield MSY	No	N/A	N/A	N/A	3	5	Reduction of GHG emissions from fossil fuels may lead to increased land and water use for the production of biofuels.
RE047	A6-47	Share of total budget spent on the environmental and resource efficiency measures	Yes - Marine biodiversity loss	No	N/A	N/A	N/A	5	4	
RE048	A6-48	Capitalisation of 'Core' and 'broad' Sustainable and Responsible Investments (SRI) in Europe (billion/€) based on ETC/SCP Indicator 24.1 for the EEA (to be further developed)	No	No	N/A	N/A	N/A	2	4	
RE049	Add1	Ecological footprint	No	No	3	2	5	2	4	See comments on reduction of GHG emissions and meat consumption: offsetting GHG emissions may lead to

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
										increased use of land and water.
RE050	Add2	Substitution of dangerous chemicals	Yes - 450 ppm CO_2e concentration	Yes - REACH (Regulation (EC) No 1907/2006)	N/A	N/A	N/A	4	4	
RE051	Add3	Total Material Consumption (TMC)	Yes - 450 ppm CO_2e concentration	No	1	3	3	2	1	
RE052	Add4	Environmentally weighted material consumption (EMC)	Yes - 450 ppm CO_2e concentration	No	N/A	N/A	N/A	3	1	
RE053	Add5	Energy dependency (all energy sources, incl. renewables, nuclear, electricity (with source split)) based on final energy consumption	Yes - 450 ppm CO_2e concentration	Yes - Renewables directive (Directive 2009/28/EC), Energy 2020 (COM(2010)639) and Energy roadmap 2050 (COM(2011)885/2)	N/A	N/A	N/A	4	4	Reduction of import fossil fuels may lead to increased land and water use for the production of biofuels and other renewables. Development of photovoltaic technologies increases demand for certain critical metals.
RE054	Add6	Material dependency	Yes - 450 ppm CO_2e concentration	No	N/A	N/A	N/A	2	3	Substitution of raw materials from intra-EU extraction may lead to increased land use for extraction of biotic and abiotic resources and increase direct energy use.
RE055	Add7	Eco-innovation Index	yes (multiple and complex)	No	N/A	N/A	N/A	4	3	
RE056	Add8	External costs – getting the prices right	No	yes - objective	N/A	N/A	N/A	4	1	

Indicator number		Indicator name	Relevant environmental threshold /good management practice	Relevant EU or global target	scoring criteria[52] I.	II.	III.	IV.	V.	Potential conflicts with targets in other indicators
RE057	Add9	Resource prices	No	No	N/A	N/A	N/A	4	1	
RE058	Add10	Fossil fuel EHS	No	Yes - objective	N/A	N/A	N/A	5	1	
RE059	Add11	Recycling rates of metals	Yes (available biocapacity per global citizen)	Yes - WFD targets (Directive 2008/98/EC), ELV directive () and WEEE directive (Directive 2002/96/EC)	3	4	3	3	1	Increased efficiency may lead to increased direct energy use and GHG emissions from recycling processes.
RE060	Add12	Nutrient leaking to water bodies	complex risk potentials for individual chemicals	Yes - Water Framework Directive (WFD 2000/60/EC)	5	5	4	3	3	
RE061	Add13	Life years lost due to PM 2.5	yes - scarcity estimates	Yes - Limit values (Directive 2008/50/EC and Air quality guidelines for PM published by WHO)	N/A	N/A	N/A	4	2	
RE062	Add14	eHANPP	Yes - thresholds in multiple environmental impacts categories	No	3	5	4	3	1	
RE063	Add15	Share (in area) of new and renovated buildings with energy label A	No	Yes - EPBD (Directive 2010/31/EC)	N/A	N/A	N/A	5	1	Increased material consumption and increased C&D waste.
RE064	Add16	Turnover from environmental goods and services sector per GDP	No	No	N/A	N/A	N/A	3	2	

5.5.3 *Main findings*

The following provides a summary of the result of the analysis and identifies indicators of particular relevance for target setting or further development.



The majority of the indicators specified in the RERM (and the additional indicators proposed by the project team) are related to environmental thresholds or best practices. Approximately one quarter of the assessed indicators are related to neither targets nor thresholds and a similar number had both.

More interesting in the context of this analysis is that 23 indicators *are* related to environmental thresholds or best practices, but *are not* related to a policy target.

Of the 23 indicators for which there are relevant environmental thresholds or best management practices, but no targets, eleven are assessed to be related to mature thresholds or management practices (score 5).

Of these eleven, six are related to thresholds of a scale suitable for EU policy making, of which only three also exhibit a reasonably close relation to the threshold phenomenon (score 3 or above), and are assessed to be reasonable practicable for target setting (score 3 or above):

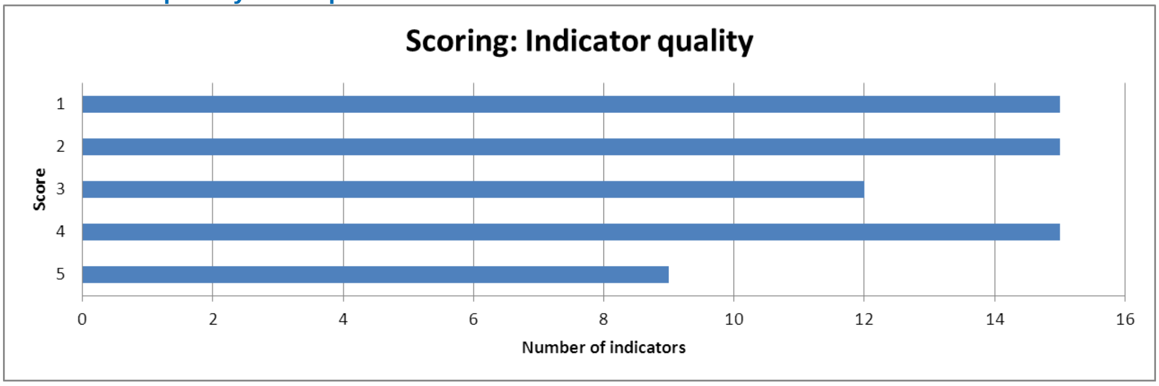
- **RE034 – A6-34** (soil organic matter levels);
- **RE042 - A6-42** (CO_2 emissions in the transport sector);
- **RE043 – A6-43** (Total energy consumption/km driven as a proxy for energy efficiency in transport).

However, the first (**RE034**) is assessed to currently be of insufficient quality for target setting. **RE042** and **RE043** are assessed to be of sufficient quality (score 4 or 5) for target setting and as such could be considered potential candidates for target setting.

Three indicators are linked to a scientifically mature threshold (score 5) (plus including 2 that have related multiple and complex thresholds, score N/A), that are also judged to be practicable for target setting (score 4 or 5) and of high quality (score 4 or 5). All five of these indicators are already related to existing targets. These are:

- **RE022 - A6-22** (Landfill rate);
- **RE037 - A6-37** (The number and area of Marine Protected Areas (MPAs));
- **RE044 - A6-44** (Average CO_2 emissions per km for new passenger cars);
- **RE045 - A6-45** (Pollutant emissions (NO_x, VOC, PM) from the transport sector (available from EEA / Reporting under NECD));
- **RE050 - Add2** (Substitution of dangerous chemicals).

Indicators for priority development



A total of 30 indicators are assessed to be of poor quality (score 1 or 2), of which 11 are associated to a **certain/mature** (score 5) environmental threshold (8 indicators) or best practice (3 indicators).

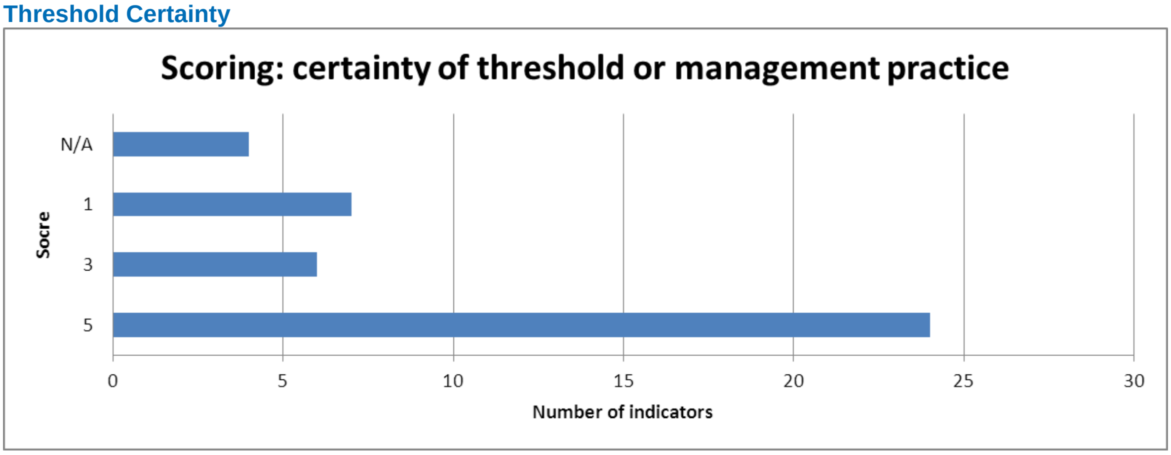
The three of these indicators assessed to be particularly practicable (score 4 or five), are related to existing targets or obligations and as such further development of these indicators and their underlying data could be considered a priority:

- **RE025 – A6-25** (Annual value of all Environmentally Harmful Subsidies (EHS) provided);
- **RE026 – A6-26 (**The value of EHS removed measured by last year's or last years' average annual spending, including tax exemptions where appropriate);
- **RE040 – A6-40** (The rate of nearly zero-energy new buildings).

In addition, indicator **RE002 – A6-2** (Artificial land or built-up area) is a linked to a threshold (moderate certainty), and is directly related to the threshold phenomenon, is well suited to the EU scale of target setting and policy making, and targets for this indicator would be practicable.

However, the quality of the indicator is currently insufficient for measuring progress. As such, development of this indicator could also be prioritised.

Threshold Certainty



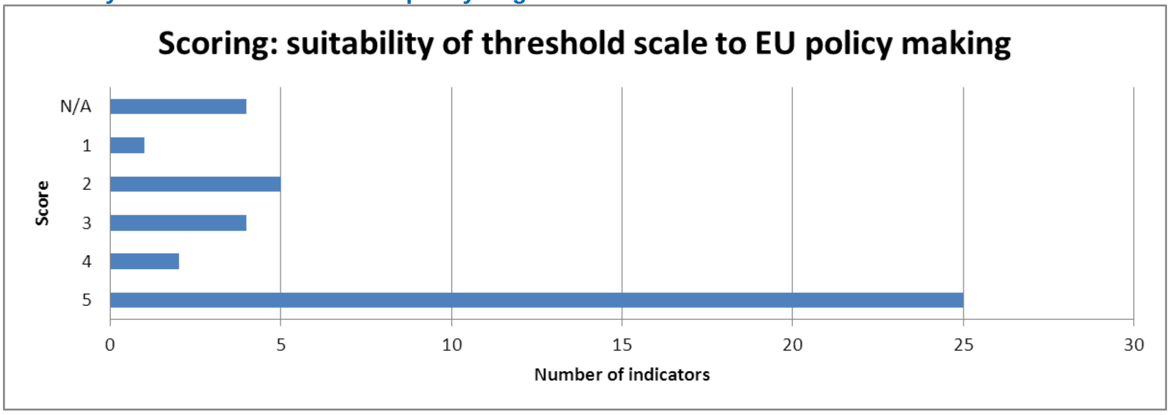
The level of certainty about the thresholds and management practices identified varies significantly. However, over half (24 of 41) of the indicators with identified thresholds are related to thresholds assessed to be certain/mature (score 5).

Seven of these indicators are related to climate change thresholds, and four are mature best practices. Indicators related to thresholds that have been assessed to be uncertain/ immature (score 1) are primarily concerned with material flows and scarcity estimates.

Four indicators are related to multiple and/or complex threshold risks, and as such are not directly suitable for target setting based on environmental thresholds. These are:

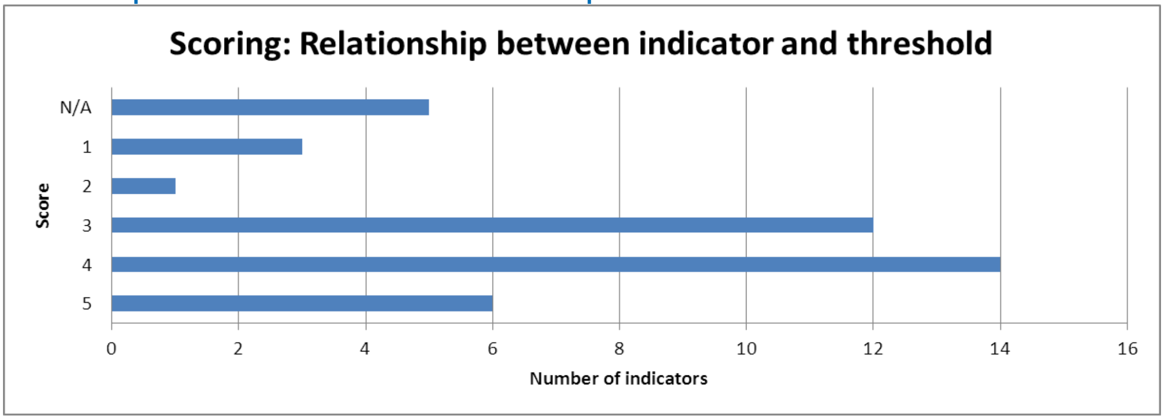
- **RE010 - A6-10** (Environmental impacts of resource use);
- **RE045 - A6-45** (Pollutant emissions (NO_x, VOC, PM) from the transport sector);
- **RE050 - Add2** (Substitution of dangerous chemicals);
- **RE052 - Add4** (Environmentally weighted material consumption (EMC)).

Suitability of threshold scale to EU policy targets



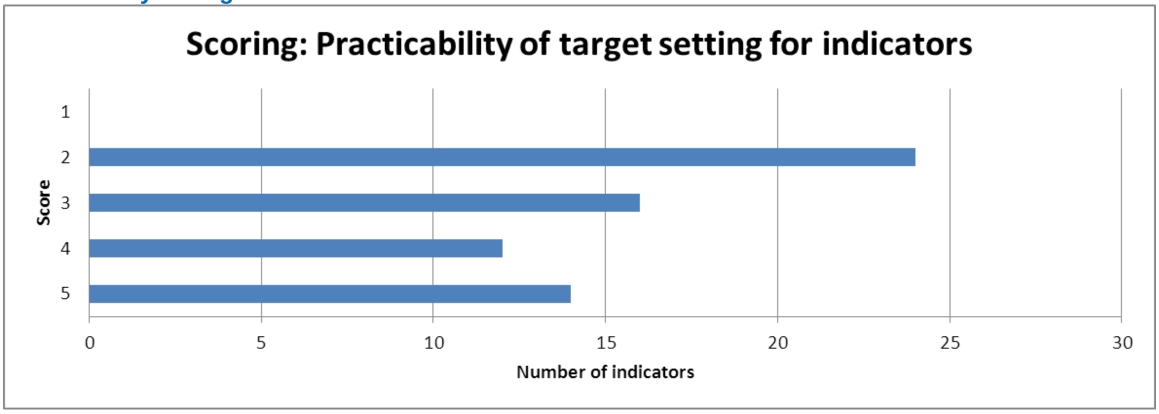
Twenty five indicators are assessed to be related to thresholds that occur at a scale perfectly suited to the formulation of EU policy targets. Those adjudged to be poorly suited to EU target setting are related to footprint type indicators. Those moderately suited to EU policy targets deal with material flows and scarcity.

Relationship between indicator and threshold/best practice



Few indicators are directly related to the identified threshold (3 indicators) and best practice (3 indicators). However, the majority of indicators exhibit at least a moderate relationship (Score 3 or above) with their identified thresholds or good management practices. Three of the four that do not (score 1 or 2) are related to thresholds in water scarcity.

Practicability of targets for the indicators



Unsurprisingly, no indicators were judged to be wholly impractical for target setting (i.e. that policy can not in any way affect the progress toward a target). However, over one third of indicators where assessed to measure phenomena that are difficult to influence through policy, primarily because of the number of competing drivers. Of the eleven indicators for which target setting was deemed particularly practicable (score 4 or 5), and which are related to a threshold or best practice, only one, **RE002 - A6-2** (Artificial land or built-up area), was not already related to an existing target.

References

- Agilis (2011) Methodology for the now-casting of Material Flow Accounts;
- Barrett, J and Wiedmann, T. (2010) A Review of the Ecological Footprint Indicator – Perceptions and Methods. Sustainability Accounting, Innovation Centre. York;
- BirdLife International, (2005) Priorities for developing the proposed EU forest action plan, European Forrest Task Force, October 2005. Last Visited http://ec.europa.eu/agriculture/fore/action_plan/birdlife.pdf;
- Bringezu (2011) Key Elements for Economy-wide Sustainable Resource Management. Responsabilité & Environnement N° 61 Jan. 2011;
- Bücking, W., (2003) Are there threshold numbers for protected forests?, *Journal of Environmental Management*, 67, pp. 37-45;Last visited http://www.china-sds.org/kcxfzbg/addinfomanage/lwwk/data/kcx779.pdf;
- Communication & Information Resource centre Administrator (CIRCA) Eurostat library Last visited http://circa.europa.eu/Public/irc/dsis/pip/library?l=/material_accounts/questionnaire_2011;
- Daly, H.E. (1990) Towards some operational principles of sustainable development. ecological economics volume 2. No. 1. pp1-6;
- Eby, M. Matthews, D. Weaver, A.J and Zickfeld, K. (2008) Setting Cumulative emission targets to reduce the risks of dangerous climate change. Proceeding of the National Academy of Sciences of the United States of America (PNAS), September 2009, vol. 106 no. 38, 16129 – 16134;
- European Commission (2009) GDP and Beyond Measuring progress in a changing World. Com(2009)433 Final;
- European commission (2011) RoadMap to a Resource efficient Europe. COM(2011) 571 final;
- European Commission (2002) Concerning the approval, on behalf of the EC, of the Kyoto Protocol to the United Nations Framework Convention on climate Change and the joint fulfilment of commitments thereunder. (2002/358/CE);
- European Commission (2006) Registration, Evaluation, Authorisation and Restriction of Chemicals, *European Commission*; Last Visited http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:32006R1907:EN:NOT;
- European Commission (2008) Waste Framework Directive;
- European Commission (2009) Part III: Annexes To Impact Assessment Guidelines. Last Visited http://ec.europa.eu/governance/impact/commission_guidelines/docs/ia_guidelines_annexes_en.pdf;
- European Commission (2012) Air Quality Standards. Last visited http://ec.europa.eu/environment/air/quality/standards.htm;
- European Commission Eurostat (2007) Handbook on Data Quality Assessment Methods and Tools. Wiesbaden, 2007;
- European Commission Eurostat Statistic Database Last visited http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home;
- European Commission, DG Environment (2008) Potential of the ecological Footprint for monitoring environmental impacts from natural resource use: Analysis of the potential of the Ecological Footprint and related assessment tools for use in the EU's Thematic strategy on the sustainable use of Natural Resources. Report to the European Commission's DG environment;
- European Commission. Staff Working Paper (2011) Analysis associated with the Roadmap to Resource efficient Europe Part I. SEC(2011) 1067 final;
- European Commission: Enterprise and industry (2010) Critical Raw Materials for the EU. Report of the Ad-hoc Working group on defining critical raw materials;

- European Communities (2000) Establishing a Framework for Community action in the field of water policy. Directive 2000/60/EC of the European Parliament and of the council. October 2000;
- European Environment Agency (2012) Annual Management Plan 2012. Administrative document No 1/2012. Copenhagen;
- European Environmental Agency (1998) Guidelines for Data Collection and Processing – EU State of the Environment Report. Annex 3;
- Eurostat (2012) Economy-wide Material Flow Accounts (EW-MFA). Compilation Guide 2012;
- Eurostat (2012) Economy-wide Material Flow Accounts (EW-MFA). Questionnaire. Last Visited http://epp.eurostat.ec.europa.eu/portal/page/portal/environmental_accounts/documents/EW-MFA_Questionnaire_2012_(Version_31_July_2012).xls;
- Eurostat (2012) Estimates for Raw Material Consumption (RMC) and Raw Material Equivalents (RME) conversion factors;
- Eurostat. Energy Data Formulas. Europa;
- Eurostat. Financial auxiliaries' statistics - NACE Rev. 1.1 & NACE Rev. 2;
- Giljum, S., Hammer, M. and Hinterberger, F. (2004) Resource use scenarios for Europe in 2020, SERI studies, No. 1, Sustainable Europe Research Institute, Vienna;
- Intergovernmental Panel on Climate Change (2007) Climate Change: Synthesis Report. Fourth Assessment Report;
- International Monetary Fund(2001) Data Quality Assessment Framework (DQAF) Glossary. Last Visited http://stats.oecd.org/glossary/detail.asp?ID=2216;
- Massachusetts Institute of technology News. Anne Trafton. From Yeast researchers learn how populations collapse. Last Visited http://web.mit.edu/newsoffice/2012/yeast-population-collapse-0601.html;
- Organisation for Economic Co-operation and Development (2002) Quality Framework for OECD Statistics. Paris, June 2002;
- Rockström et al (2009) Planetary Boundaries: Exploring the Safe Operating Space for Humanity. Ecology and Society 14(2): 32;
- Rockström et al, 2009. A safe operating space for humanity. Nature, Vol 461|24 September 2009;
- Rockström, J., Steffen, W., Noone, K., Persson, Å., Chapin, F. S., Ill, Lambin, E. F., Lenton, T. M., Scheffer, M., Folke, C., Schellnhuber, H. J., Nykvist, B., de Wit, C. A., Hughes, T., van der Leeuw, S., Rodhe, H., Sörlin, S., Snyder,P. K., Costanza, R., Svedin, U., Falkenmark, M., Karlberg, L., Corell, R. W., Fabry, V. J., Hansen, J., Walker, B., Liverman, D., Richardson, K., Crutzen, P. and Foley, J. A., (2009) A safe operating space for humanity. Nature. September 2009, vol 461, No 24;
- Schmidt-Bleek, F., (2009) The Earth, Natural Resource and Human Intervention, Haus Publishing Ltd, London;
- Stockholm Environment institute (2009) Development of a methodology for the assessment of global environmental impacts of traded goods and services. Final Report;
- Stockholm Environment Institute. Tipping Towards the Unknown. Last visited http://www.sei-international.org/-news-archive/1678;
- Sustainable Europe Research institute. Online database for Global resource flows. Accessed through http://materialflows.net/;
- von Weizsäcker, E., Hargroves, K., Smith, M., Desha, C. and Stasinopoululos, P., (2009) Factor 5: Transforming the Global Economy through 80% Increase in Resource Productivity, Earthscan, UK and Droemer, Germany;
- World Health Organisation (2005) Air Quality Guidelines for particulate matter, ozone, nitrogen dioxide and sulphur dioxide. Global Update: Summary of Risk assessment/ WHO publication. Switzerland.

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