PRODUCT ENVIRONMENTAL FOOTPRINT APPROACH: A GAP ANALYSIS

The purpose of this paper is to assess whether the Product Environmental Footprint (PEF) methodology will be able to calculate the key resource consumption indicators for products, as laid out in SERI / Friends of the Earth position papers, and described in the Annexes of the Resource Efficiency Roadmap.

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BACKGROUND

In the past three years, Friends of the Earth (FoE) has cooperated with the Sustainable Europe Research Institute (SERI) to derive a set of indicators to measure and reduce its natural resource use. This set was designed to be implemented in key European Union policy strategies, notably the “Resource Efficiency Roadmap”.

The purpose of this paper is to identify and describe the gaps between the data obtained through the Product Environmental Footprint (PEF) approach as developed by the European Comission Joint Research Centre and the data required for the FoE/SERI indicators, and how these gaps could be filled.

The FoE/SERI Indicators cover four key categories of resource use:
Materials: Material Footprint or Rucksack, i.e. the total tonnage used, divided into renewable (biotic) and non-renewable (abiotic) materials
Water: Water Footprint, measured in litres
Land: Land Footprint, i.e. the total area used in hectares
Climate: Carbon Footprint, measured in tonnes of CO_2 equivalents

ENVIRONMENTAL FOOTPRINT IMPACT CATEGORIES

Table 1 provides a default list of the impact categories defined in the **Environmental Footprint methodology** and related assessment methods to be used within a Product Environmental Footprint Analysis according to the analysed document [1] (see p. 31):

Environmental Footprint Impact Category	Impact Assessment Model	Source
Climate Change	Bern model - Global Warming Potentials (GWP) over a 100 year time horizon.	Intergovernmental Panel on Climate Change, 2007
Ozone Depletion (OD)	EDIP model based on the ODPs of the World Meteorological Organisation (WMO)	WMO 1999
Ecotoxicity – aquatic, freshwater	USEtox model	Rosenbaum et al, 2008
Human Toxicity - cancer effects	USEtox model	Rosenbaum et al, 2008
Human Toxicity – non-cancer effects	USEtox model	Rosenbaum et al, 2008
Particulate Matter/Respiratory Inorganics	RiskPoll model	Rabl and Spadaro, 2004
Ionising Radiation – human health effects	Human Health effect model	Dreicer et al. 1995
Photochemical Ozone Formation	LOTOS-EUROS model	Van Zelm et al, 2008 as applied in ReCiPe
Acidification	Accumulated Exceedance model	Seppälä et al.,2006, Posch et al, 2008
Eutrophication – terrestrial	Accumulated Exceedance model	Seppälä et al.,2006, Posch et al, 2008
Eutrophication – aquatic	EUTREND model	Struijs et al, 2009 as implemented in ReCiPe
Resource Depletion – water	Swiss Ecoscarcity model	Frischknecht et al, 2008
Resource Depletion – mineral, fossil	CML2002 model	Van Oers et al 2002
Land Transformation	Soil Organic Matter (SOM) model	Milà i Canals et al, 2007

Table 1: Default list of indicators

[1] Product Environmental Footprint Guide; DRAFT ONLY FOR THE USE IN STAKEHOLDER CONSULTATION

An Environmental Footprint (EF) impact assessment groups and aggregates the collected inventory data according to the respective contributions to the impact category. EF impact assessment methods use models for quantifying the causal relationship between the material/energy inputs and emissions associated with the product life cyle and each EF impact category. Each impact category hence builds on an EF impact assessment method that stands on its own.

In contrary to the FoE/SERI indicators which – apart from the Carbon Footprint – focus on input-oriented indicators, the indicators in the PEF methodology are generally output-oriented indicators. They focus on issues such as pollution of air and water and toxicity. In addition some categories of resource depletion related to water and minerals/fossils are included in the indicator set.

The European Commission's "Roadmap to a Resource Efficient Europe" has chosen two levels of indicators:

1. A provisional lead indicator - "Resource Productivity" - to measure the principal objective of this Roadmap, of improving economic performance while reducing pressure on natural resources;

2. A small set of complementary indicators (so-called "Dashboard") on key natural resources such as water, land, materials and carbon, that will take account of the EU's global consumption of these resources.

The Roadmap document later precises that the "provisional lead indicator only gives a partial picture, it should be complemented by a 'dashboard' of indicators on water, land, materials and carbon and indicators that measure environmental impacts and our natural capital or ecosystems as well as seeking to take into account the global aspects of EU consumption.

In addition to those headline indicators, a third level of indicators is being framed (provisionally called "Scoreboard") focusing on issues such as the links of resource use and resource efficiency to economic indicators, such as competitiveness, green markets and employment; as well as to monitor progress towards existing targets in other sectors, as detailed in the Staff Working Paper accompanying the Roadmap.

Annex 6 of the Staff Working Paper[2] elaborates on the dashboard concept – emphasising that " … indicators such as Domesic Material Consumption would not register or 'indicate' if improvements of domestic resource efficiency are made by delocalisation of resource intensive or less resource efficient steps in the production chain to countries outside the EU. Thus indicators that have a life cycle or value chain perspective are needed to trace such potential effects. Therefore, the dashboard complementing the lead indicator needs to comprise both perspectives." It states that the Commission intends to develop consumption/global supply chain related embodied Land,

[2] SEC(2011) 1067 final. COMMISSION STAFF WORKING PAPER: Analysis associated with the Roadmap to a Resource Efficient Europe, Part II. 20.9.2011

Water and Carbon Footprint indicators as well as Raw Material Consumption (RMC), capturing the indirect effects (embodied resources used) outside the EU. All of these are intended to be measured at industry, product, and national and European level.

In order to be consistent with the overarching strategy and the future Resource Use indicators outlined in the Roadmap and its related working processes, it is important to follow this structure also on the product resource use measuring level. Thus the dashboard will require resource productivity indicators **measuring resource use in physical units such as input-oriented indicators for land use (Land Footprint), water (Water Footprint) and abiotic and biotic materials (Material Footprints or Rucksacks) to be implemented** in addition to the indicators focusing on specific environmental impacts or natural ecological capital dimensions.

In the existing set of impact categories of the PEF methodology, the category of 'resource depletion (minerals, fossil and renewable energy resources, water)' comes closest to the issues covered by the FoE/SERI indicator set. Within the method of ´resource depletion´, resources are characterised in terms of an abiotic depletion potential (ADP). This factor is derived for each extracted element and each type of fossil fuel and is a relative measure with the depletion of the element 'antimony' as a reference. In this method the Lifecycle Inventory (LCI) results on extractions of elements and fossil fuels (in kg) are multiplied with the characterisation factor (in kg antimony equivalents/kg extraction) to obtain the indicator result in kg antimony equivalents (Van Oers 2002). Special attention is given to the estimation of the reserves. The size of the reserves depends on what is considered to be technically and economically feasible (based on literature such as that from the U.S. Bureau of Mines). A distinction is made between ultimate reserves (resources in the earth crust), base reserves (resources that have a reasonable potential for becoming economically and technically available) and (economic) reserves (part of the reserve base which could be economically extracted or producd at the time of determination) (Van Oers 2002)

On the country level, indicators on resource use quantities as suggested by FoE/SERI, show some correlation with the overall environmental impacts related to resource use. However, on the level of single materials this correlation does not hold as different materials have very different impacts per kilogram. **The FoE/SERI set of indicators complement impact indicators through providing the information on the underlying volumes. In fact, in several cases, the indicator set is the physical basis for calculating such impact indicators** (Giljum et al. 2011).

It is strongly suggested to measure and illustrate different aspects of resource use in the original units (e.g. material consumption and carbon emissions in mass, water use in litres, land area in hectares), without transforming them into a single artificial unit of measurement.

The PEF methodology does not cleary recommend to normalize and weight the measured indicators against each other. It is thus not a required step for a PEF study. If those steps are applied, though, the methodology recommends that the results shall be calculated using the provided normalization factors. (Unfortunately the ‘provided normalization factors’ mentioned in the draft of PEF methodology are not yet available).

Within the FoE/SERI set of indicators a normalzation is not recommended either. It is more robust to interpretate the different (not normalized) indicators and thus be able to disclose synergies and possible trade-offs between the environmental categories.

THE UNDERLYING METHODOLOGICAL STANDARDS

The requirements for Product Environmental Footprint studies according to the analysed document have been chosen taking into consideration the recommendations of the following list of **methodological standards**:

- ISO 14044: Environmental management -- Life cycle assessment -- Requirements and guidelines
- ISO 14067: Carbon footprint of products
- ILCD: International Reference Life Cycle Data System
- Ecological Footprint
- Product and supply chain standards, Greenhouse Gas Protocol (WRI/ WBCSD)
- Méthodologie d'affichage environnemental (BPX 30-323)
- Specification for the assessment of the life cycle greenhouse gas emissions of goods and services (PAS 2050)

In addition to the guides already listed, we recommend to consider the following methodology guide for developing a method referring to the objectives of the European Commission's “Roadmap to a Resource Efficient Europe” (European Commission 2011).

- Material Input per Service Unit (MIPS) (Schmidt-Bleek 1998, Ritthof, 2002)

MIPS calculations allow comparisons of resource consumption of different options to produce the same service. When a single product is examined, the MIPS calculations reveal the magnitude of resource use along the whole life-cycle and help to focus efforts on the most significant phases to reduce environmental burden of the product. MIPS is an input-oriented indicator expressed in kg of material used per service unit.

Furthermore, we recommend including water use concepts such as:

- Water Rucksack, Water Footprint, Virtual Water (Chapagain 2004, Van Oel 2010)

On the product level, **water inputs** can be accounted applying the concept of Water Rucksack or Water Footprints. Water Rucksacks or Water Footprints can be applied consistently from the micro level of products and companies up to the macro level of countries and world regions.

The **actual land area** of products reflects the life-cycle wide demand on actual land area for the production of goods or services. National land cover and land use inventories allow illustrating the land use of whole countries. As with the material indicator, it is recommended to illustrate major categories of land use (such as agricultural land area, forest land area, permanent pasture area and built-up land area) separately (Giljum et al. 2011). Recently, there is increasing interest in quantifying the land area embodied in internationally traded products (Erb et al. 2009; Würtenberger et al. 2006).

The same methodology is used to illustrate the Global Warming Potentials (GWP) over a 100 year time horizon. Calculating the **Carbon Footprint** of products should not neglect CO_2 implications of land occupation (see Schmidinger, 2012).

Furthermore, the suggested set of indicators from FoE/SERI has a strong link to the statistical system in contrary to the environmental impact categories of the Product Environmental Footprint. The set includes indicators that are close to real statistical data and do not require transformation and modeling of data. This **strong link to the statistical system increases the acceptance of indicators by policy makers.**

THE SCOPE OF THE ANALYSIS

According to the PEF guidelines as proposed by the EC Joint Research Centre, the threshold for the **cut-off criteria** (p.36) shall be set at 90% inclusiveness. Within an initial screening phase, any cut-offs must be justified and their potential influence on final results assessed. In contrary to other methodological standards (such as PAS 2050), the cut-off criteria of the PEF allows for the integration of processes such as the employee commuting or capital goods. This is a very positive as well as valuable development.

Furthermore the definition of the **system boundaries** is comprehensive and ambitioned. A comprehensive analysis is very much welcomed by the scientific community.

> **Definition: System Boundary** – Definition of aspects included or excluded from the study. For example, for a "cradle-to-grave" environmental footprint analysis, this should include all activities from extraction of raw materials through processing, manufacturing, use, repair and maintenance processes as well as transport, waste treatment and other purchased services such as e.g. cleaning and legal services, marketing, production and decommissioning of capital goods, operation of premises such as retail, storage, administration offices, staff commuting, business travel, and end-of-life processes. (p.94)

Within an analysis of the FoE/SERI set of indicators the cut-off criteria and system boundaries are as wide as in the methodology of a PEF. For example, employees commuting and nutrition as well as capital goods (such as machinery used in production processes, buildings or transport vehicles) are included in the analysis if feasible in the implementation.

Another valuable development is the detailed proposal on how to handle **multi-functional processes** as this is often neglected in standards and applied in various ways in different studies. A special approach for by-products and recycling processes is suggested (decision hierarchy: subdivision, substitution, allocation based on physical flows, allocation based on other relationships) (p.67).

When assessing the FoE/SERI set of indicators, multi-functional processes are handled by allocating via a physical relationship or, if not possible, an economic allocation is estimated (e.g. based on market shares or prices of by-products). The PEF methodology suggests the same procedure and even points out to perform an economic allocation only if other options are not possible. However, developing a decision hierarchy for multi-functional processes as outlined in the PEF methodology is not a standard used within analyses based on the FoE/SERI set of indicators.

Conclusively it can be said that, on the one hand the methodological standard of Product Environmental Footprints is very comprehensive

and well founded. It will help to reach the goal of more comparable results of the environmental impacts on the product level. From a scientific point of view we appreciate the recommended detailed methodology.
On the other hand, from a company perspective, following all requirements of the standard makes these studies highly work- and reporting-intensive. Especially as all externally communicated results have to be third party reviewed. It should be taken into consideration how practicability, a wide applicability and acceptance for businesses can be guaranteed.

SYNERGIES AND DIFFERENCES

It is important to note that the FoE/SERI set of indicators is not a completely different approach than the PEF methodology. Within a Product Environmental Footprint Analysis the basic data necessary to calculate the FoE/SERI indicators will be obtained and it would be easy to further derive communicable and meaningful indicators as suggested by FoE/SERI.

As for the PEF, the FoE/SERI set of indicators is based on the inventory data collected by the company. The inventory data is collected after establishing the process chain of the analysed product and defining the most important inputs to be assessed. Both methodologies try to include 90% of all inputs in the so called "Resource Use and Emissions Profile" (see p. 37 ff). The system boundaries of the FoE/SERI set of indicators are applied using the standards of the GHG Protocol, PAS 2050, ISO 14067. As these are also underlying methodologies of the PEF, the data collection (or the Resource Use and Emissions Profile) is the same.

The system boundaries as described in the PEF draft are very comprehensive and even include processes like employees commute or capital goods. When calculating the FoE/SERI set of indicators the system boundaries are ideally set as broad as possible (e.g. also including employees comute or capital goods). However, the feasability of such a broad approach is another important aspect to be considered: cut-offs have to be applied in the implementation phase, as sometimes no data collection on those aspects is practicably feasable (e.g. no questionnaires on employees allowed/wished by the contractor or no possibility to collect data on nutrition from the cantine).

The basic difference between the two methodologies lies in the next step of the calculation procedure. The PEF methodology uses the above described impact assessment models in order to calculate the EF impact categories and related indicators (e.g. abiotic depletion potential in kg antimony, or water use-to-availability ratios), whereas the FoE/SERI approaches use physical coefficients to measure resource use in the same physical units (e.g Material Rucksack measured in kg, Water Footprint measured in litres).

Again, it is strongly suggested to measure and illustrate different aspects of resource use in the **original units** (e.g. material consumption and carbon emissions in mass, water use in litres, land area in hectares).

For illustrating the impacts on climate change, the same impact assessment model is used in both methodologies. The Global Warming Potentials (GWP) over a 100 year time horizon illustrate the results of carbon equivalent emissions.

To sum up, the basic inventory data (called Resource Use and Emissions Profiles) collected in the PEF approach also provide the basic data necessary to calculate the FoE/SERI set of indicators.

A default list of impact categories is suggested and required within a PEF analysis. If some impact categories will be excluded, which is accepted if justified reasonable, then it is probable that the FoE/SERI set of indicators cannot be completely derived.

For example, if it is decided and justified that the impact category "Land transformation" is not relevant for the assessed product, and no data on land use collected, the land use indicator of the FoE/SERI set of indicators cannot be calculated as essential data will be missing.

CONCLUSIONS

In summary, it has to be emphasised that the PEF categories are impact-oriented indicators and thus have a different focus than the FoE/SERI indicators which are orientated towards inputs of natural resources over the global supply chain.

The PEF methodology serves the area of “Environmental Impacts of Resource Use” but has deficits with regard to measuring the complementary dashboard of consumption / global supply chain resource use indicators, which is a key area in the “Roadmap to a Resource Efficient Europe”. Thus the FoE/SERI indicators are an important supplement to the PEF methodology.

The data collection within the PEF methodology can contribute to delivering the inventory data needed to calculate the FoE/SERI set of indicators. From this perspective, a broad implementation of the PEF methodology is desirable, as this will also allow expanding the set of example calculations based on the FoE/SERI indicator set. However, in the case that only certain environmental categories are covered in a PEF assessment for specific products, as currently being discussed in the PEF methodological proposal, a risk remains that key basic data to calculate the FoE/SERI indicators are missing in the data inventory.

Concerning the methodological details (such as system boundaries, handling of multi-functional processes, etc.) the PEF methodology is evaluated as very positive. With regard to those aspects, no significant difference between the two approaches can be observed.

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Including case studies and/or academic publications that the Commission could use to quickly develop any missing methodologies.

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Online sources:

Wuppertal Institute: www.mips-online.org

Exemplary studies for both, focusing on products and services as well as focusing on national economies, can be found on this site.

Water Footprint Network: www.waterfootprint.org

Water Footprints exist for a large number of countries as well as for (mostly agricultural) products

Food and Agriculture Organization of the United Nations:

http://faostat.fao.org

Data on land demand of products is very patchy, with the exception of biomass products, for which the UN Food and Agricultural Organisation maintains a data base.

European Environment Agency:

http://www.eea.europa.eu/data-and maps/data#c5=all&c11=&c17=&c0=5&b_start=0

Data on actual land cover and land use is available for Europe through the European Environment Agency