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THEMATIC ISSUE

Product Footprinting

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Editorial

Working towards the full potential of product footprints

Product carbon footprinting (PCF) is an increasingly popular method of reporting sustainability impacts. There are a growing number of methodologies and labels addressing carbon footprints in Europe and worldwide, and PCFs are seen both as a way to better communicate and inform consumers and as a tool to reduce the global footprint related to production and consumption activities. The articles in this thematic issue of *Science for Environment Policy* explore the calculation and understanding of PCF, in order to guide effective policy.

The issue begins by questioning whether consumers really understand what a carbon footprint means. Like several other studies researching this subject, the study reported in **'Carbon labels on groceries need simplifying for consumers'** demonstrates that consumers may not understand carbon footprints. Even where they do understand them, there is no guarantee that they will act upon them. Taking a more top down approach, **'Capturing the full environmental and social impacts of products'** reveals problems with reporting a single environmental impact, as is the case with carbon footprinting. Carbon may not always be the best proxy for environmental impacts related to all product categories and this study recommends a new approach that captures the environmental and societal impacts from a complex supply chain of

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production associated with a product. Indeed, the European Commission is also of the opinion that to boost resource efficiency and sustainability of our economic models there is the need to move beyond carbon footprint only and look at the wider picture, by calculating – whenever possible and relevant – the environmental footprint of products and companies.

'Limitations of measuring product sustainability with carbon footprints' issues a similar warning, arguing that carbon footprints ignore the potential toxicity aspects in communicating environmental impacts of products.

Much research is being conducted into methodological issues concerning how to calculate PCFs. Japan is a global leader on a national level with its carbon footprinting scheme, and research from this country, reported in **'Global Carbon Footprints account for international emissions'** demonstrates an alternative approach to the classical lifecycle analysis (LCA) modelling practice that requires detailed process data for each relevant production process in the supply chain. In this process, data are taken from national statistics and a new approach to capturing international supply chains is developed.

If carbon footprinting is to become credible, comparable products must be calculated in a consistent way. This requires harmonising a wide range of, often diverse, national approaches. The EU-commissioned study described in **'Carbon footprinting methods need greater harmonisation'** looked at a range of national approaches. It commends the PAS 2050's standards, but this approach will be redeveloped to become more aligned with the GHG protocol developed by the World Business Council for Sustainable Development (WBCSD), which in turn seems to become well aligned with the, still developing, ISO 14067 standard on PCF. However, the question of calculating biogenic carbon is a sticking point in the debate surrounding the development of PCF methodologies. **'Methods for including biogenic carbon in footprints'** discusses a wide range of possible outcomes, should there be no agreement on how to calculate biogenic carbon.

The findings of these studies are not to say that PCF is to be abandoned, but instead provide some clear recommendations on how to take PCF forwards so that it fulfills its full potential. Namely, approaches should

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be harmonised under the ISO standard and the GHG protocol, as should product category rules. We must also seek to explain to consumers the credibility and comparability of PCFs, as well as explaining what carbon footprint labels mean in practice.

The product footprint issue is particularly timely in Europe. Recently, in its conclusion to 'Sustainable materials management and sustainable production and consumption' (Council of the European Union 2010), the European Council invited the Commission to 'develop a common methodology on the quantitative assessment of environmental impacts of products, throughout their life-cycle, in order to support the assessment and labelling of products'. This European methodology on the 'environmental footprint' will be part of the revision of the Sustainable Consumption and Production Action Plan, planned for 2012. The environmental footprint will build on the experience already gained in the framework of carbon footprints implementation, so the Commission needs to examine all the issues mentioned in the studies included here to establish how its findings may contribute to achieving the neccessary results.

We acknowledge the invaluable assistance of Mark Goedkoep of PRé Consultants B.V., in preparing this issue and editorial.

Carbon labels on groceries need simplifying for consumers

New research in the UK indicates that the public find carbon labels on grocery products difficult to understand. The study recommends that carbon label authorisation procedures should require producers to commit to continually reduce emissions, as otherwise consumers may wrongly assume that this is signified by the label.

Contact: paul.upham@manchester.ac.uk

Theme(s): Climate change and energy, Sustainable consumption and production

"Reducing the carbon intensity of grocery goods could help meet wider emission reduction targets."

Policies, such as the EU Sustainable Consumption and Production Action Plan[1], have highlighted the importance of providing information to consumers on the environmental impact of a product. Increasingly, products are displaying their carbon footprints.

The study recruited 24 people into focus groups. After watching an educational video on carbon labelling they were provided with figures on the footprints of various groceries, such as potatoes, tomatoes and orange juice, and on the carbon savings made by buying lower-carbon groceries.

All focus group participants were aware of the term 'carbon footprint', but their understanding varied. To understand footprints better, participants wanted to know what comprised a 'healthy' carbon footprint and most supported a traffic light style system, similar to existing guidelines on the recommended daily consumption of food types, i.e. a red label could suggest a large carbon footprint, and a green label a small footprint, as compared to similar products.

The researchers explored ways of communicating to the participants the impact of buying low-carbon goods. To put carbon savings from greener food shopping into context for the focus groups, the purchases were compared with emissions produced by a family flight.

For example, to save the same amount of emissions as produced by a family holiday to Spain, consumers would need to buy the equivalent of 2656 low CO_2 potato purchases, or 1.8 years of daily servings for a four person family (in this study, the low carbon potatoes considered were domestic, new potatoes and had a calculated carbon footprint of 140g of CO_2 per 250g serving, compared to 750g of CO_2 for a serving of ready-made mashed domestic potatoes). This produced quite a strong reaction from the focus group participants, who found the scale of difference daunting and were concerned that changing their grocery purchase behaviour may not be very effective. Ten average lower carbon groceries in a weekly basket would only reduce annual per capita emissions by 3 per cent. Only purchasing a substantial number of lower carbon groceries (40) would reduce the annual per capita emissions by a sizeable amount (10 per cent).

Reducing the carbon intensity of grocery goods could help meet wider emission reduction targets. However, the researchers argue that reduction strategies should not rely purely on consumer choice as only a minority of shoppers prioritise environmental concerns over other aspects, such as price and quality, or may find labels difficult to understand. They conclude that if carbon labels are to play a more significant role, they will need to be widely applied and indicate a commitment to ongoing reductions, not simply report current emissions. A carbon reduction label does not require the consumer to understand the significance of a carbon figure, merely that actions are being taken.

Source: Upham, P., Dendler, L. & Bleda, M. (2010) Carbon labelling of grocery products: public perceptions and potential emissions reductions. *Journal of Cleaner Production*. Doi: 10.1016/j.jclepro.2010.05.014.

1 See: http://ec.europa.eu/environment/eussd/escp_en.htm

Capturing the full environmental and social impacts of products

Contact: Jay.Golden@Duke.edu or m.anderies@asu.edu
Theme(s): Sustainable consumption and production

Carbon footprint labels communicate just one aspect of a product's environmental impact. A recent study has called for an enhanced ecolabelling scheme, called 'sustainable product indexing', that recognises the broader, complex social and environmental impacts of products.

"All social and environmental impacts in the production chain should be considered when developing a sustainable product index and national administrative structures should include a body responsible for ensuring sustainability is integrated with other policy initiatives."

Ecolabels are adopted voluntarily by manufacturers to assure consumers that a product has met strict production standards that improve a product's environmental impact. To date, most ecolabels relate to a single environmental issue, such as the overall carbon content of a product or whether timber products have been harvested from sustainable forests. The EU's Ecolabel[1] is an important exception as a multi-criteria label.

In this study, the researchers suggest that certification, or ecolabelling programmes should instead encompass a wide range of effects of production on the environment and society. This could help avoid any unintended change in behaviour of producers and consumers that result from focusing on just one single aspect of environmental impact. For example, in the US, corn-based ethanol receives a Renewable Fuels Standard (RFS) label. However, unintended consequences of growing corn for ethanol include intensive water use, oxygen-depletion in the Mississippi resulting from over-fertilisation and increased corn prices.

The study suggests a new approach that captures the environmental and societal impacts from a complex supply chain of production associated with a product. A sustainable product index could achieve this by having one or only a few labels that cover all impacts of production on the environment, providing incentives to reduce environmental impacts of production, measuring the life cycle effects of production on the environment and by involving national and local governments, industry, consumer groups and non-governmental organisations in ecolabelling programmes.

Certification schemes need to recognise the effect that labelling has on consumer, manufacturer and retailer behaviour. Labels can influence consumer purchases, business practices, and the technical development and innovation of products, which can all have different impacts on the environment and society.

The study makes a range of recommendations for policy makers planning ecolabelling programmes. Before policy makers introduce labelling legislation, there should be a greater understanding of the complex social and ecological relationship that results from labelling schemes. International retailers, industries and businesses should be part of the group developing sustainable product indexing as they have global knowledge of the supply chain of products.

All social and environmental impacts in the production chain should be considered when developing a sustainable product index and national administrative structures should include a body responsible for ensuring sustainability is integrated with other policy initiatives. Certification schemes should also contain incentives for innovation of sustainable product design and development in addition to setting standards that minimise the environmental risk posed by products.

[1] See: http://ec.europa.eu/environment/ecolabel/

Source: Golden, J.S., Dooley, K.J., Anderies, J.M. *et al.* (2010) Sustainable Product Indexing: Navigating the Challenge of Ecolabeling. *Ecology and Society.* 15(3): 8. This study is free to view online at: www.ecologyandsociety.org/vol15/iss3/art8

Limitations of measuring product sustainability with carbon footprints

Contact: mic@ipl.dtu.dk
Themes: Sustainable consumption and production

The carbon footprint method does not capture the overall environmental impact of manufactured products, according to a recent study which found it unsuitable for assessing the toxicity of pollutants generated by products.

"Life Cycle Assessment (LCA) evaluates the environmental impact over the entire life cycle of the product or service from 'the cradle to the grave'. However, LCA additionally assesses the impacts on the wider environment, not just carbon emissions."

Various methods are used to evaluate the environmental consequences of producing goods or services. Product carbon footprinting (PCF) methods estimate the amount of greenhouses gases emitted during the life cycle production of goods or the provision of services. This life cycle includes the extraction of raw materials, processing, transportation and storage and end-of-life disposal.

In a similar manner, Life Cycle Assessment (LCA) evaluates the environmental impact over the entire life cycle of the product or service from 'the cradle to the grave'. However, LCA additionally assesses the impacts on the wider environment, not just carbon emissions.

To see if PCF could also be used to predict wider environmental impacts of products, in terms of human toxicity of emissions, the study compared the results of PCF and LCA for a variety of commonly manufactured products, including metals, chemicals, plastics, textiles and paper. The LCA focused on the life cycle impacts on human health, or the HTI, (Human toxic impacts, which are non-cancer effects). HTI occurs when pollutants are released to the environment at any stage of the production process. They combined the HTI and PCF results to create an overall environmental indicator.

In general, the study found that the environmental impact, as measured by HTI, dominated the overall indicator. For plastics, textiles and paper goods the contribution of the HTI was considered to be 10 times greater than that of the PCF and 1000 times greater for metals and chemicals.

There were also wide differences within each product group, for example, the relative differences between using the HTI or the PCF varied by up to 10 times for a variety of aluminium, steel and nickel products. This implies that PCF makes only a small contribution to the total environmental impact.

The environmental impact of energy generation is often significant so the study investigated the influence of the energy supply source in the life cycle production of aluminium, copper (coupled with nickel) and carbon monoxide. Either natural gas or wind energy was used to replace coal as the energy source and natural gas was substituted for coal as the heat energy supply during production.

For all three products, the negative environmental impact fell if natural gas or wind power were used as the source of energy, as measured by both HTI and PCF. However, reductions in environmental impact occurred at different points of the product's lifecycle, depending on the product. For example, they could occur at the energy production stage or at the waste disposal stage. These variations suggest that PCF cannot be presumed to adequately measure toxic effects on human health, or any other environmental impacts. It is suggested that if PCF is used to assess products for sustainability, this needs to be conducted on a case-by-case basis.

Source: Laurent, A., Olsen, S.I., Hauschild M.Z. (2010) Carbon footprint as environmental performance indicator for the manufacturing industry. *CIRP Annals - Manufacturing Technology*. 59: 37-40.

Global Carbon Footprints account for international emissions

Product carbon footprinting (PCF) methods should account for international supply chains, according to a new Japanese study. The researchers used an 'input-output' analysis to develop Global Carbon Footprints for a range of food and drink products and suggest that this approach can help guide data-collection and calculations for PCF.

Contact: nansai.keisuke@nies.go.jp
Themes: Climate change and energy, Sustainable consumption and production

"The researchers used an 'input-output' analysis to develop Global Carbon Footprints for a range of food and drink products and suggest that this approach can help guide data-collection and calculations for product carbon footpinting."

Under its 'Disclosure of CO_2 emissions' programme, Japan has developed guidelines for calculating the carbon footprints of consumer products. These propose a bottom-up approach in which the actual processes associated with the product are analysed one-by-one and the CO_2 emissions from each process are calculated. A committee has been established to provide Product Category Rules, which provide guidance for collecting information and performing calculations, such as the cut-offs and boundaries for when emissions are included in a product's footprint and regional and seasonal variations.

However, there is a more top-down approach called input-output analysis where CO_2 emissions are not calculated from the actual technologies used to make the product, but from statistical data from industry sectors. The input-output data table specifies the trade between the sectors, and environmental data are added per sector, which enables modelling the supplies to each sector. The sector data is often redefined in terms of commodity datasets; some commodities come from more than one sector. This type of data is rather generic, but is helpful as all impacts for all activities are modelled at once. There are no data gaps, but there can be a problem when modelling imports. For instance, Japan does not produce fossil fuels, so there is therefore no statistical national data on the impacts of fossil fuel production available. The way to solve this is to create a global input-output dataset that can model all imports.

The study adopted the Global Link Input-Output (GLIO) Model to calculate the embodied emissions of Japanese food and consumables. This considers the CO_2 emissions from producing and importing the materials needed to make the product as well as from the transportation between Japan and overseas. This creates what the study referred to as a Global Carbon Footprint (GCF).

For example, it calculated that soft drinks have a GCF of 2.78 tonnes of CO_2 emissions per million yen spent; 28 per cent of this was emitted outside of Japan. The overseas share of the GCF varies with sector, from 16 per cent for vegetables, to 65 per cent for processed meat products. This indicates that it is more important to consider the international supply chain for some products than for others.

In conclusion, the study suggests that although the bottom-up approach is valuable for collecting data, it may be better to use a hybrid approach that applies an input-output analysis when creating Product Category Rules. The input-output analysis could inform the Product Category Rules about which products need to consider international supply chains and for which products the global aspect is relatively unimportant.

Source: Nansai, K., Kagawa, S., Kondo, Y. *et al.* (2010) Improving the completeness of product carbon footprints using a global link input-output model: the case of Japan. *Economic Systems Research*. 21(3):267-290.

Carbon footprinting methods need greater harmonisation

The wide range of methods used to calculate carbon footprints can cause confusion among consumers and stakeholders. A new report has analysed existing methods and suggested that the EU needs to provide continuing support to harmonise these methods, for example, by promoting a global framework.

Contact: eric.mugnier@fr.ey.com
Themes: Climate change and energy, Sustainable consumption and production

"...the EU policy must be clear about its objectives for product carbon footprints and include the appropriate methodological features to achieve these aims."

A carbon footprint of products could be introduced into EU environmental labelling instruments. With this in mind, this EC-commissioned report identified, analysed and compared a range of methods and initiatives to produce footprints.

Eleven methods were chosen for in-depth research, seven of which were already in use and four that were under development. The methods were evaluated on their ability to achieve four policy objectives:

- encouraging the use of product carbon footprints (PCFs) by companies
- encouraging communication to customers
- using market-based initiatives, such as bonuses and taxes, to promote products with low PCFs
- setting minimum requirements for producers in terms of eco-design

Significant progress in PCF methodology has been made in the last two years, and of the existing methods, the UK's PAS 2050 appears to perform the best in terms of achieving the different policy objectives. However, all current methods still lack precision on critical aspects, such as inclusion of emissions during the use phase of a product, and there is little consideration of environmental impacts other than climate change.

The evaluation indicated that none of the methods are mature enough to implement a mandatory scheme that sets minimum PCFs. Each method has its own strengths and weaknesses, and there is not yet enough consensus on critical issues, such as including land use in footprints, to achieve this goal.

Greater consensus and acceptance could be achieved by harmonisation efforts. The report suggested that the EU could support this by promoting a general framework method, such as the ISO 14067, which is currently under development. As an international initiative, this would also allow consistency across borders.

This general framework could be improved through discussions around the rules and guidelines for specific product categories. Once a common framework is accepted, an analysis could identify gaps with existing methods so that these can be corrected.

The report indicated that some footprinting methods perform better for different policy objectives, for example, PAS 2050 is good at encouraging the use of PCFs by companies, whereas the French BP X30-323 would seem to be more efficient at implementing market-based incentives to promote low carbon products. This indicates that the EU policy must be clear about its objectives for product carbon footprints and include the appropriate methodological features to achieve these aims.

Source: Ernst & Young France and Quantis on behalf of the European Commission – DG Environment.(2010) *Product Carbon Footprinting – a study on methodologies and initiatives.* Downloadable from http://circa.europa.eu/Public/irc/env/carbon_footprint/library?l=/ernstyoung_report/version_22112010pdf/_EN_1.0_&a=d

Methods for including biogenic carbon in footprints

Calculations of product carbon footprints (PCF) tend to focus on the emissions produced by fossil fuel use during production. A new study has explored three approaches which also include 'biogenic carbon' in footprints and found they can produce very different footprints to standard PCF methods.

Contact: Marjukka.Kujanpaa@vtt.fi
Themes: Forests, Sustainable consumption and production

"Biogenic carbon is the carbon produced and stored by living organisms or biological processes, and can therefore make a difference to the carbon content of products containing wood, for example."

Biogenic carbon is the carbon produced and stored by living organisms or biological processes, and can therefore make a difference to the carbon content of products containing wood, for example. Previously carbon footprint calculations have not incorporated biogenic carbon, assuming that it remains constant in the long run. However, biogenic carbon in the atmosphere varies in the short term. The assessment of carbon footprints does not set time limits which means attempts to incorporate biogenic carbon vary.

The study examined and compared three approaches for including biogenic carbon: the flow accounting approach (or carbon uptake), the lost carbon stock approach and carbon sequestration through net growth. It used softwood pulp from Finland as a case study which, according to the traditional method of PCF, produces 271 kg of CO_2 per tonne from the use of fossil fuels.

Flow accounting approach – This approach accounts for the carbon sequestered by trees before they are harvested. To produce one tonne of dry softwood pulp, about 1950 kg of CO_2 is released from the trees when they are harvested and the final product contains a further 1650 kg of CO_2. Combined with the 271 kg from the fossil fuel footprint, this creates a carbon footprint of 3029 kg CO_2.

Calculating lost carbon as emissions – This approach calculates the loss of carbon sequestration potential when the wood is harvested and allocates this to a product according to the amount of wood it uses. For one tonne of softwood pulp the loss of carbon storage in forests produces equivalent of 666 kg CO_2. Combined with the 271 kg from the fossil fuel footprint this makes a total footprint of 937 kg.

Allocating net carbon sequestration to typical softwood pulp – This is similar to the flow accounting approach, but also incorporates the annual forest net growth and allocates it to the forest product. The idea behind this is that wood products encourage a market for raw wood which stimulates sustainable forest management. This produces an additional sequestration of 3309 kg of CO_2, which added to the flow accounting figure produces a total footprint of 6338 kg of CO_2.

The study demonstrates the different footprinting results obtained from three approaches to incorporate biogenic carbon. It suggests that it is hard to give scientific credit to one approach and more research is needed to assess the effects of using materials, such as wood, which are part of the biogenic carbon cycle.

Source: Kujanpää, M., Pajula, T & Hohenthal, C. (2009) *Carbon footprint of a forest product – challenges of including biogenic carbon and carbon sequestration in the calculations.* Life cycle assessment of products and technologies. LCA Symposium. 27-39. This study is free to view at: www.vtt.fi/inf/pdf/symposiums/2009/S262.pdf (pp27-39).

A selection of articles on Product Footprinting from the *Science for Environment Policy* news alert.

Comparing the purchase of eco-labelled products across Europe (19/5/11)

Ecolabels can help encourage sustainable consumption. A new study has compared the national organisation of environmental (eco and organic) labels and its impact on purchases of labelled products in 18 European countries. Levels of ecolabelled product purchasing varied across the countries, with the highest rates in Northern Europe.

Carbon footprinting errors caused by differences in power supply (3/3/2011)

The actual carbon footprint of products and services can differ considerably according to how energy used to manufacture the product was generated – for example, whether it was generated by fossil fuel or renewable sources. A recent US study has therefore recommended that differences in regional power supply should be acknowledged by life cycle assessments of products and services.

How do consumers assess the eco-friendliness of food labels? (7/4/11)

A recent Swiss study compared consumer perceptions of the environmental friendliness of vegetables with the results of scientific assessments of the vegetables' environmental impact. The two did not always tally and findings from this study can provide useful information for sustainable consumption campaigns.

Choice of method for measuring carbon footprint can affect the result (20/1/11)

When calculating the carbon footprint of products, the methods and assumptions used should be made clear, according to a recent study, as the choice of assessment method can have a large effect on the final result of a carbon footprint.

New tool to analyse the greenness of products and processes (16/12/10)

Researchers have created a new Green Option Matrix (GOM) to describe and compare the ever growing number of options to develop green products and processes. The GOM was used to analyse 142 companies belonging to the Dow Jones Sustainability World Index.

Nutrient footprints of different food groups calculated (11/11/10)

Carbon footprints are an established means of communicating one aspect of a product's environmental impact. New research suggests additional 'nitrogen footprints' for food products could give consumers a more informed choice and help reduce eutrophication in water. However, it warns that there are environmental trade-offs for some food groups, for example, oil products have a small nitrogen footprint, but a fairly large carbon footprint.

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