Science of the Total Environment xxx (2017) xxx–xxx

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Product vs corporate carbon footprint: Some methodological issues. A case study and review on the wine sector

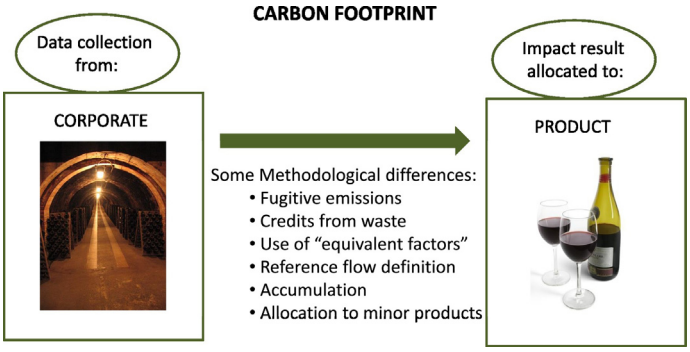
Alejandra Navarro [a,b], Rita Puig [a,*], Pere Fullana-i-Palmer [c,b]

[a] GIR, Escola d'Enginyeria d'Igualada (EEI), Universitat Politècnica de Catalunya (UPC, Barcelona tech), Pla de la Massa, 8, 08700 Igualada, Spain
[b] Cyclus Vitae Solutions, S.L., Avinguda Caresmar 33, 1, 08700 Igualada, Spain
[c] UNESCO Chair in Life Cycle and Climate Change, School of International Business (ESCI-UPF), Pg. Pujades 1, 08003 Barcelona, Spain

HIGHLIGHTS

- 6 methodological differences between corporate and product CF are discussed for the first time.
- Influence of these 6 issues in the impact results are exemplified with a wine case study.
- The case study includes inventory data and CF results of 18 wineries.
- Corporate data is usually gathered to perform a product CF, thus the 6 issues are important.
- Findings are important for any case study on CF evaluation.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 14 November 2016
Received in revised form 29 December 2016
Accepted 31 December 2016
Available online xxxx

Keywords:
Life cycle assessment (LCA)
Key performance indicators
Reference flow
Environmental credits
Vineyard
Winery

ABSTRACT

Carbon footprint (CF) is nowadays one of the most widely used environmental indicators. The scope of the CF assessment could be corporate (when all production processes of a company are evaluated, together with upstream and downstream processes following a life cycle approach) or product (when one of the products is evaluated throughout its life cycle). Our hypothesis was that usually product CF studies (PCF) collect corporate data, because it is easier for companies to obtain them than product data. Six main methodological issues to take into account when collecting corporate data to be used for PCF studies were postulated and discussed in the present paper: fugitive emissions, credits from waste recycling, use of "equivalent factors", reference flow definition, accumulation and allocation of corporate values to minor products.

A big project with 18 wineries, being wine one of the most important agri-food products assessed through CF methodologies, was used to study and to exemplify these 6 methodological issues.

One of the main conclusions was that indeed, it is possible to collect corporate inventory data in a per year basis to perform a PCF, but having in mind the 6 methodological issues described here. In the literature, most of the papers are presenting their results as a PCF, while they collected company data and obtained, in fact, a "key performance indicator" (ie., CO_2eq emissions per unit of product produced), which is then used as a product environmental impact figure.

The methodology discussed in this paper for the wine case study is widely applicable to any other product or industrial activity.

* Corresponding author.
E-mail address: rita.puig@eei.upc.edu (R. Puig).

http://dx.doi.org/10.1016/j.scitotenv.2016.12.190
0048-9697/

1. Introduction

1.1. LCA based carbon footprint methodologies

There is a huge ongoing effort to improve and promote the use of life cycle assessment (LCA) in Europe, through the PEF[1] and OEF[2] methodologies, within the Single Market of Green Products Initiative.[3] Application of this methodology in a great variety of industries, such as agri-food (Iribarren et al., 2011; Fantin et al., 2014; Rinaldi et al., 2014), waste management (Biganzoli et al., 2015; Ioannou-Ttofa et al., 2016; Styles et al., 2016) and energy supply (López-Sabirón et al., 2014; Gallejones et al., 2015) among others, can be found in the literature. However, there is an even higher worldwide trend of simplification (Baitz et al., 2013; Bala et al., 2010) focussing on a single indicator, carbon footprint, relevant to global warming, which is internationally considered as a critical environmental concern (Pattara et al., 2012; Weidema et al., 2008). Being a one-indicator methodology doesn't mean that there are no methodological pending issues in carbon footprint calculation; such as the accounting of organic carbon (Arzoumanidis et al., 2014). Carbon footprint may be assessed at product level, following the LCA methodology for only this one impact category and following standards such as: PAS 2050 (2011), ISO 14067 (2013) or GHG Protocol for products (2011). It can also be assessed at corporate level, following standards such as: ISO 14064 (2006) or GHG Protocol for organisations (GHG protocol corporate, 2004; 2011).

Corporate carbon footprint (CCF) can be calculated with three scopes (GHG Protocol corporate, 2004; 2011): 1) direct emissions, 2) indirect emissions from electricity production and other services, and 3) indirect emissions upstream and/or downstream on the production chain. There are a number of industrial sectors which have high greenhouse gas (GHG) emissions at their facilities (mainly due to combustion) or because of their intensity in electricity use. Those which are affected by EU Directives (DIRECTIVE 2003/87/EC) and the dominant scopes are 1 and 2. The rest of the economic sectors have diffuse emissions and they are mainly found within scope 3. In order to calculate any contribution (the so-called emission factors in carbon footprint terminology) from a process within scope 3, such as the emissions due to the production of fuel or a certain raw material, or the management of a certain waste, there is a need to use the LCA methodology (GHG Protocol corporate, 2011). Therefore, whether a product carbon footprint (PCF) or a scope 3 CCF is at stage, there is somehow a need for LCA methodology. LCA is generally performed in a process-oriented approach, a "bottom-up" approach which needs to build the supply chain of the process and get data from each process unit.

The process-oriented approach is not the only one used to evaluate the environmental impacts of a product, due to the difficulties to get data from companies in the value chain, the time needed to perform such LCA studies and possible truncation errors (Lenzen, 2000), other approaches are described in the literature derived from the Environmental Input-Output (EIO) methodology based on financial accounts (Huang et al., 2009; Penela et al., 2009; Cagiao et al., 2011; Alvarez et al., 2014; Kjaer et al., 2015; Alvarez and Rubio, 2015; Alvarez et al., 2015). The hybrid approach (using both process-LCA and EIO methodologies) is a "top down" approach in which inventories are quantified using monetary data at a high aggregation level, and hybridized with "bottom-up" process-based data collection, when more detail is needed (Berners-Lee et al., 2011). The advantage of such an approach is the use of readily available financial data as starting point for screening. For CCF, yearly financial accounts together with supplier invoices provide the data input. For PCF, life cycle costing (LCC) inventories are needed.

Nevertheless, some uncertainties are still described within this "top-down" approach (Kjaer et al., 2015), and they are related to the EIO model used or the data inputs. On the one hand, model related uncertainties are mainly: data age (monetary data is unstable and vary over time), geographic coverage (data availability is higher from some geographic areas than others in the world) and sector aggregation (match between the category where money is spent and the EIO sector found in the databases; ie., a very specific spend, a "coffee machine" for example, doesn't match well with a wide EIO sector, as "machinery and equipment"). On the other hand, data uncertainty arises when changes are implemented, because it is important for companies to be able to monitor the effect of these changes. So this approach is useful for screening studies, but needs further development for more accurate and specific results.

Although both approaches, process-LCA and hybrid EIO-LCA, have the ability to assess both corporate and PCF by first calculating a detailed CCF and then distribute the GHG emissions among the products and services dispatched to the market, only the hybridized approach claims to do it (Alvarez and Rubio, 2015).

There is a lot of literature on carbon footprint calculations of products and companies, most of them using the process-LCA approach. When a PCF is performed, inventory data of all processes related to the production of this specific product should be collected. Nevertheless, due to the fact that, for most companies, it is easier to report global annual consumptions and emissions instead of the product's specific inputs and outputs, our hypothesis is that some PCF calculations are performed distributing the company's inventory data among the different produced products. Most of the literature on PCF doesn't explain in detail the type of inventory data collected.

The aim of this paper is, first of all, to show some methodological issues which have to be taken into account when following the previous described procedure when calculating a PCF (company's annual consumption distributed among the different produced products) and, secondly, to perform a mapping of the wine CF literature, as an example, to see how these methodological issues are treated.

1.2. Carbon footprint in the wine sector

Wine production constitutes one of the most ancient economic sectors, being still nowadays a very important agri-food activity in Europe. Grape growing, similarly to other agricultural activities, has a significant impact on the environment due to the use of fertilizers, pesticides, water and energy and due to soil erosion and land use.

In this context, many publications assessing the different environmental burdens associated with wine production for improvement can be found in the literature (Rugani et al., 2013; Bonamente et al., 2016). Wine LCA studies vary on the type of wine, white (Fusi et al., 2014) or red (Gazulla et al., 2010; Pattara et al., 2012; Amienyo et al., 2014); the country where wine is produced, such as Spain (Gazulla et al., 2010; Vázquez-Rowe et al., 2012a, 2012b; Meneses et al., 2016), France (Bellon-Maurel et al., 2015), Italy (Benedetto, 2013; Benedetto et al., 2014; Iannone et al., 2016; Marras et al., 2015), Portugal (Neto et al., 2013), Australia (Thomas, 2011), Canada (Point et al., 2012; Steenwerth et al., 2015); and the life cycle stages included in the study, cradle to grave (Gazulla et al., 2010; Meneses et al., 2016) or cradle to gate (Pattara et al., 2012).

Many other published studies tackle only the CF of wine production systems, either PCF (Cholette and Venkat, 2009; Pattara et al., 2012; Vázquez-Rowe et al., 2013) or CCF: one vineyard in Italy (Marras et al., 2015) and a winery in Spain with no inventory data (Penela et al., 2009).

Wine LCA-related publications presenting inventory data (see Table 7) will be reviewed according to the above mentioned aim of the present paper. In addition, the authors have worked with 18 wineries within two research projects on CCF of the wine sector (CO2 VINO project, 2014 and VINECO project, 2014) and this experience will be used to show examples of the methodological issues described.

[1] Product Environmental Footprint.
[2] Organisation Environmental Footprint.
[3] http://ec.europa.eu/environment/eussd/smgp/.

Please cite this article as: Navarro, A., et al., Product vs corporate carbon footprint: Some methodological issues. A case study and review on the wine sector, Sci Total Environ (2017), http://dx.doi.org/10.1016/j.scitotenv.2016.12.190