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WHO NEEDS TO KNOW WHAT ABOUT ENERGY USE? THE PALM OIL BIOFUEL CASE

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ABSTRACT

In life cycle assessments and energy analyses of palm oil biofuel, the choice of energy use indicators has been found to be arbitrary, poorly motivated and poorly described. This paper discusses the system boundaries represented by different energy use indicators and their appropriateness in terms of different environmental concerns. The paper also discusses the need of different energy use information for different actors in the product life cycle and the resulting need to tailor-make assessments and presentations of assessment results to different audiences.

INTRODUCTION

Access to energy is an important precondition for many societal activities and is closely coupled to human development. However, the energy sector can be attributed a large share of the pressures on natural systems. Resource limitations and climate impacts have increased the interest for non-fossil fuels. For bio-based fuels, however, environmental impacts from production can be both larger and of different kind than for fossil fuels. For bio-fuels, energy use has been highlighted as one of the most important environmental impacts to assess (Buchholtz *et al.* 2009). When describing the energy use of a product system, appropriate indicators are needed, which may vary depending on which types of energy that are involved and which types of concerns around energy use that should be emphasized. Furthermore, different actors in the product life cycle may need to be provided energy use information of different kind, depending on which types of decisions that they are involved in.

In this study, energy use indicators that have been reported in studies on palm oil biofuel form the basis for a discussion on the appropriateness of different energy use indicators in different situations and for different audiences.

METHOD

This study is based on an earlier literature review of existing life cycle assessments (LCAs) and energy analyses of palm oil biofuel (palm oil methyl ester; PME) that has been reported elsewhere (Arvidsson *et al.* 2012). The paper reported the different energy use indicators found and the difference in system boundaries that they imply, and it illustrated, quantitatively, the impact of the choice of energy use indicator on the results using literature data. In the study reported here, the material has been further analyzed in terms of the meaning of different energy use indicators, their appropriateness in describing different concerns and their relation to the differing information needs for different actors in the palm oil biofuel product life cycle.

RESULTS

A review of energy use indicators used in different assessments of palm oil biofuel revealed that in LCAs and energy analyses, the choice of energy use indicators has been somewhat arbitrary, and which energy use indicators that are used is both poorly motivated and poorly described (Arvidsson *et al.* 2012). The review identified the energy use indicators listed in the first column of Table 1. Terminology is here slightly different from in Arvidsson *et al.* 2012; common names have been replaced by more descriptive ones in order to facilitate communication. Fossil energy includes mined energy resources: coal, oil, natural gas and uranium. Renewable energy includes biomass, solar, wind and water. Secondary energy only accounts for the energy amount used in the final stage, e.g. as electricity or diesel oil, while primary energy is given as the original energy source and including also losses in the energy sector. Product energy is the energy content of the product. Extracted biomass is all biomass removed from nature, e.g. biomass removed from the field during harvest.

The different indicators highlight different concerns; see the second column in Table 1. An indicator that, for example, only accounts for primary use of fossil fuels, sees the scarcity of fossil fuels (and potentially also the climate impacts that are closely connected to burning of fossil fuels and the resulting carbon dioxide emissions) as the most important challenge, while an indicator that accounts also for primary use of renewable resources does typically not differentiate between renewable and non-renewable energy sources but emphasizes instead the overall restrictions of energy made available to human society. When a technology is assessed for its inherent properties, the use of secondary energy use indicators may seem more relevant than primary energy use indicators, since primary energy use indicators may reveal more about the surrounding infrastructure (background) system than about the actual technology assessed. By adding or subtracting different energy contents, more detailed indicators can be designed. When subtracting the energy content of the product, one may assess whether a product system makes more energy available for further use than is required along the product chain. When adding the energy content of the extracted biomass to the energy use, the scarcity of biomass energy and land for such growth are emphasized.

Several authors have recently emphasized the need to focus on the actors in the product life cycle and select appropriate indicators and system boundaries to make the presented data meaningful to them in relation to their concerns and fields of influence (see e.g. Efrogmson *et al.* 2013). The identified energy use indicators were therefore reflected on in comparison to different potential actors. Table 1 also contains a third column in which different actors in the

palm oil biofuel life cycle that may need this type of information for their decisions are suggested.

Table 1. Different energy use indicators identified in a review of LCAs of palm oil biofuel, the concern that is addressed by each indicator, and the actor that may need this information in decision-making.

Energy use indicator	Main concern addressed	Actors that may need this information
Fossil primary energy	Scarcity of fossil fuels; considers both local energy use and surrounding energy system	Countries relying heavily on fossil fuels; industries whose products have a high fossil energy use; actors experiencing fossil fuel scarcity; policy makers striving to decrease fossil fuel use; companies and organizations that want to report carbon footprint and similar type parameters e.g. as part of GRI reporting.
Fossil and renewable secondary energy	Total energy availability in society; considers only local energy use	Actors mainly interested in e.g. the production phase, e.g. in technology development; companies that want to market their products globally and want to provide data that does not depend on national conditions in terms of e.g. the energy system
Fossil and renewable primary energy	Total energy availability in society	Industries whose products have a high energy use; companies and organizations that include total energy use in their reporting
Fossil and renewable primary energy minus product energy	Total energy availability in society; energy still present in product not seen as energy use	Producers of biofuels and similar energy-providing products; consumers with holistic understanding and concerns that are purchasing a new car; policy-makers that decide on research funding and policy measures
Fossil and renewable primary energy with extracted biomass energy	Total energy generation capacity	Actors foreseeing high biomass scarcity; policymakers and researchers striving for long term sustainable energy solutions, policy-makers deciding on policies for land-use

Fossil energy use is thus of particular importance to countries relying heavily on fossil fuels, as this prevents them from escaping their reliance on fossil fuels. Similarly, companies that produce products with a high fossil energy use has obvious interests in this indicator. Note that for such products, the fossil energy use and the fossil and renewable energy use become almost the same. There are also actors that already experience fossil fuel scarcity, for example in rural developing countries, and for those, fossil energy use is also a relevant indicator. Secondary energy use does not include the full life cycle of energy products, and is of particular importance for actors with an influence on a studied product or technology but no influence on the surrounding system, e.g. the energy system in the region. This indicator is of particular interest in technology development, as the secondary energy is strongly related to the technology itself. Other parts of the system may very well have changed before the product even reaches the market. For actors like policy makers, responsible for regions and systems, that do not only require fossil energy but also a considerable share of renewable energy, the fossil and renewable energy indicator is of obvious importance. The energy use indicator where the energy content of the fuel is subtracted from the fossil and renewable

energy use is designed for fuels or similar energy-providing products. It is thus relevant primarily to actors that produce or use such products, such as producers of biofuels and the automotive industry. Adding all extracted biomass as energy use further emphasizes biomass scarcity, and is therefore of particular interest for actors that experience or perceive high biomass scarcity as a concern in their long-term planning. Clearly, there is a need to tailor-make assessments and presentations of assessment results to different audiences.

DISCUSSION

The presented energy use indicators may seem simple enough to use. However, there are differences in how they have or might be applied. The extracted biomass, for example, may include anything from only the palm fruits to everything that is removed from the field, potentially even including branches that fall to the ground and are moved. The devil can thus be said to be in the details, which requires careful description and explanation by the assessor. All assessors must therefore not only carefully select energy use indicators but also very clearly describe and motivate which energy use indicator that is being used and how it has been derived.

We experience that the perspective of the actor to which energy use indicators are to provide information has, so far, not been much considered in LCA studies, although this has, as earlier mentioned, been discussed in more recent studies. We believe that to employ such a perspective – i.e. to tailor-make assessments and presentations of assessment results to specific actors – could further increase the use and usefulness of LCAs in society.

There may also be a need of additional energy use indicators to account for some current and upcoming concerns that are not addressed by the five indicators presented here. Today, there are, for example, no energy use indicators that account for the differences between different renewable resources, namely the fund-type (e.g. biomass) and the flow-type resources (e.g. solar energy).

CONCLUSIONS

As different energy use indicators address different concerns, it is important to carefully choose an energy use indicator that is appropriate for the specific situation and the actor that it is to be presented to. There is also a need to develop new energy use indicators that address current and upcoming concerns that are not addressed by the indicators used today.

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