Brændholt, 19. March 2018

1. Overall comments

In general, the LCA in this study follows state-of-the art LCA methodology and is well performed on most parts. But there are also some lacks of consistency, lack of transparency, lack of sensitivity considerations and unbalanced interpretation that leads to misleading result presentations and to rigid, misleading and also at places wrong conclusions.

Further, the report is a good example of a serious 'lack of protection against journalists' in the way results and conclusions are presented – and the way journalists have subsequently extracted and unbalanced part of results and conclusions without concerns for the necessary context and precautions. This has led to very misleading dissemination of the outcome of the study, partly caused by the report's own misleading communication of results and conclusions, partly by the journalists wish to select and only communicate surprising and contra-intuitive conclusions.

All in all, the report needs a significant makeover, before it gives a fair picture of the environmental performance of the studied grocery carrier bags, and it has been released to the public at a very premature state.

Inconsistent aims leading to unsustained conclusions

The aim of the study is stated as:

> "The analysis of the results was carried out with respect to the three main aims stated in the goal of the study: (1) identification of the best disposal option for each type of bag, (2) identification of the carrier bag with the best environmental performance, and (3) identification of the required number of primary reuse times based on the environmental assessment".

These three aims contain a problematic inconsistency. The first aim is fine, and so are the second and third aim when each seen in isolation, but these latter aims cannot go hand in hand. The aim to find the 'break-even' number of primary reuse of the multiuse bags is in principle fine, i.e. to find the number of uses for each impact category that would render a given bag equal to the reference bag. Following this aim, the study refrains from judging and identifying a real life number of primary uses for the multiuse bags, but stops at identifying this break-even number. But this, of course, implicitly means that it is not possible to point out the bag with the best performance.

So the results and conclusions containing a ranking of bags cannot be done like this, cf. the conclusion in the summary of the report:

> **"Which is the carrier bag providing the lowest environmental impacts?**
> In general with regards to production and disposal, LDPE carrier bags, which are the bags that are always available for purchase in Danish supermarkets, are the carriers providing the over-all lowest environmental impacts for most environmental indicators"

By using the wording “with regards to production and disposal”, the authors probably mean to say, that the statement is a comparison of all bags given a single use only, i.e. with no regards for the number of multiple uses – but if so, this is ‘lost in translation’ and should have been stated much more clearly – especially as it comes in a section with the title “Which is the carrier bag providing the lowest environmental impacts?“.

No weighting of impact categories leading to false and extreme break-even calculations

On top of this, the LCA refrains from weighting impacts, and it treats all assessed impacts as equally important. This is specifically problematic for some of the impact categories giving rise to very high break-even number. Obviously, if a given impact is very close to zero for the reference bag, the break-even number can be extremely high (because the break-even number is then found in a formula where the denominator is close to zero). This is e.g. the case for ozone depletion, which leads to a very high break-even number on this impact category for the cotton bags – but this is a complete artefact, when realizing that also from the cotton bags, the emissions contributing to this impact category are insignificant. This is a very severe problem and it is enforced by the way these break-even results are presented in the report and the summary, i.e. the column in the table saying ‘all indicators’, where cotton and organic cotton comes out with a break-even reuse number of 7,000 and 20,000 respectively. Any quick read through the summary and any journalist will understand this as a finding that the cotton bags need to be reused this number of times when considering all indicators – but the truth is that this number is related to ozone depletion only (not all indicators) and that it is completely false and only a consequence of dividing by (almost) zero.

It is all in all a very premature release of the study. It should have been exposed to a much better review including stakeholders with an interest in the multiple use bags who would definitely have ensured a better representation of these.

2. Modelling approach

The approach to the modelling is stated to be consequential LCA and the temporal scope is said to look 10 years ahead. This is in principle fine, but unfortunately it is not followed consistently, some of the key problems being:

- the identification of reference flows related to the provision of the functional unit by each alternative is not following a consequential modelling approach, see next section on the Functional Unit and reference flows
- the temporal scope of 10 years is not applied for all parts of the system, e.g. in the identification of the marginal district heating supply. The applied data does not take account of the ongoing rapid change in district heating supply these years, moving away from fossil fuels and towards renewable energy. Only very few district heating grids today still have coal based units, and soon this will be phased out – e.g. Copenhagen municipality aims at being fully based on renewable energy in their district heating in 2025. This will mean a lot to the LCA in terms of less environmental benefits of waste incineration of the disposable bags, see later section on data quality and district heating.

3. Functional unit and reference flows

The functional unit (FE) specifies a volume and carrying capacity to be provided by all alternatives, and this is in principle fine. But these quantities are treated as lower threshold limits, which is unconventional for

LCA and when identifying the resulting reference flows of the various alternatives, this leads to significant disfavor of those alternatives that for some reason are designed to supply a volume or carrying capacity just lower than the specified quantities. In such cases, 2 bags are taken as the reference flow in order to supply the required minimum of service, but it leads to these alternatives then supplying much higher quantities than required, e.g.:

- The cotton bags can carry 50 kg which is 4.2 times more than the FE and other bags
- The Simple LDPE bag needs a reference flow of 2 bags, because the volume and carrying capacity are ca. 15% lower than the FE, meaning that 2 bags overperform significantly on either the volume or weight criterion
- The organic cotton bag contains only 20 L as opposed to the 22 L specification in the FE, i.e. only 10% less, and 2 bags overperform by around 90% on the volume

Instead, a more consequential modelling should be aimed for, i.e. striving to model customer behavior when using one or the other bag. Often, the bags are filled with lower content than the upper limit, and the smaller bags in practice give an equal service as the larger bags. In real life, the volume and/or weight do not need to be identical, rather the user of the bags tend to manage the carrying of the goods as a function of the bag. So maybe the user overfills the lower volume bag slightly or he/she will carry the bag more gently in case it is filled a bit over its carrying capacity. Further, whenever a larger volume is called for, the customer in the supermarket will of course not take 2 bags instead of one in every case, but maybe sometimes 4 instead of 3. Often, also, the customer can choose between 2 bag types, and may use them for different tasks, i.e. the stronger bag will be used to carry the heavier goods, whereas the weaker bags will be used for lighter goods.

In the section on 'critical assumptions' in the study, this way of identifying the reference flows is mentioned as critical – but it is not taken any further and the significance of it is not taken through to conclusions. It is a problem that the results and conclusions in summary are presented without taking the necessary precautions, and the reader will see the presented results as the baseline – which should not be so. It influences some of the alternatives more than others, e.g. the organic cotton bag, and it leads to the impacts from this bag to be almost twice as high as they should be in the comparison to other alternatives.

The cotton bags included are very heavy and overperform by a factor of 4.2 on the carrying capacity criterion as mentioned. I made a test on the stock of old cotton grocery carrier bags, we have piled up at home – 15 bags in all. Their weight distributes as follows (weight in grams): 49, 50, 51, 56, 62, 62, 63, 64, 80, 134, 152, 168, 180, 190, 265, see Figure 1 below. These bags are quite old, some date back to 1995. The lighter weight ones in the 50 g scale are in no way more worn out than the heavy bags. The report mentions that it should be an aim of future bag design efforts to minimize weight while optimizing volume and carrying capacity. This point is right, but it should be taken all the way up front and mentioned in the same sections as conclusions and comparisons of the bags included in the study. It must be noted that the 50 g cotton bag has a fully compliant carrying capacity and that it – with the same data assumptions as in the study – would require only 10 times use in order to achieve break-even on the climate change impact category. The ones, we have in our home, have been used many hundred times. Note also that a cotton bags is often used for carrying other goods when travelling and smaller trips when bringing clothes and

stuff to and from places, and somehow this of course also displaces some tear and wear of alternative products. Including this would potentially lower the calculated break-even number of uses significantly.

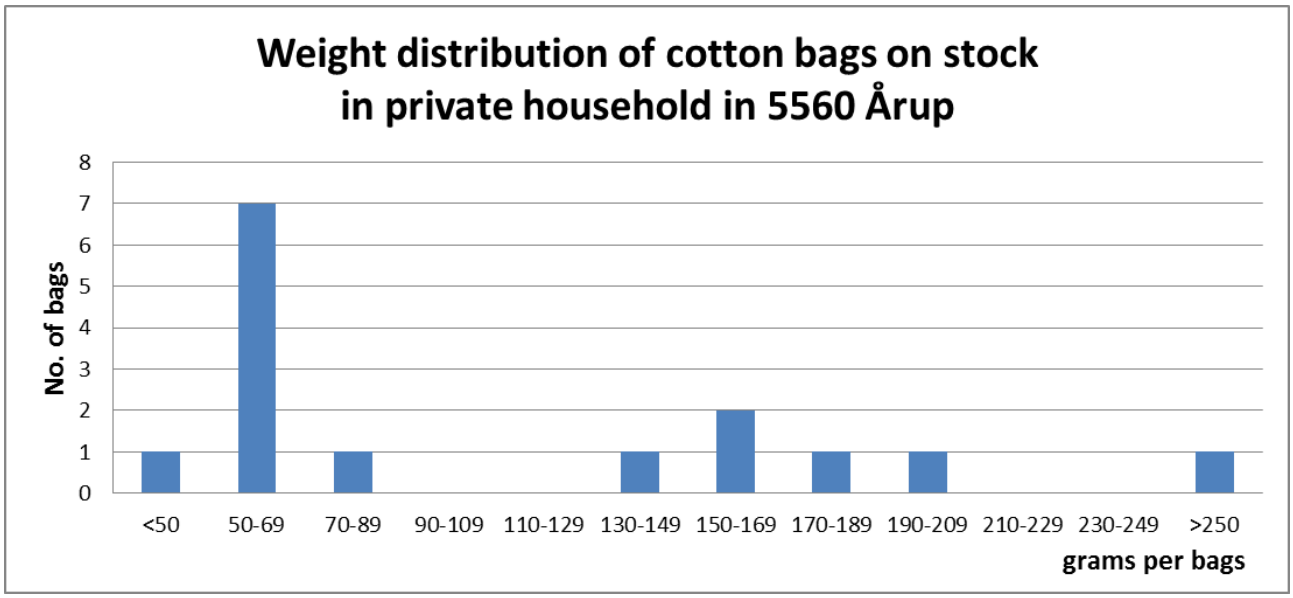

Figure 1. Weight distribution of old cotton bags on stock in my household

This lack of taking the significance of the cotton bags overcapacity transparently through to the final results and conclusions sections in the summary is a strong example of the unbalanced way results and conclusions are presented. The study would fully justify a conclusion statement like:

> "The cotton bags found available in supermarkets today are designed with a much too large carrying capacity and bags with only 20% of the weight would be fully sufficient to supply the functional unit. Such bags would need only 10 times reuse to perform better than the reference LDPE bag on the climate change impact category"

This statement would give the complete opposite signal to the reader – including the journalist – and it would completely avoid the selective and unbalanced extract of the results and conclusions that the news media have been guilty of in the press release of the study.

4. Data quality, delimitation and data gaps

Cotton production (and jute)

The cotton production process data is essential to the comparison between cotton bags and plastic bags. In this light, there is a large lack of transparency on the data for this process, and data may well be of an insufficient quality. Given the decisive significance of this, the cotton data should have been presented and discussed in detail. Wrt the data source, the report stated: "Both carrier bag types were modelled as textiles materials (Riber et al., 2009)". This statement is difficult to understand.

A contribution analysis to all impacts categories for the cotton production phase should be done explaining which emissions contribute to the various impacts and analyze carefully their plausibility and uncertainty, and the data should be thoroughly scrutinized by cotton production experts.

Further, there seems to be a lack of regards for effect of land use change. Any agricultural production takes up land and has thereby an influence on marginal land use change, which should be included. This is, of course, the case for the jute part of the composite bag as well.

Biopolymer production and paper production

The authors conclude:

> "For climate change, the carrier bags scoring the lowest climate change impacts were un-bleached paper, biopolymer and LDPE carrier bags"

It is not clear, which biomass type and production is behind the biopolymer, and data should be more transparently presented. Any agricultural biomass production should include impacts from land use change.

The marginal paper feedstock is probably tropical or subtropical Eucalyptus production, which is known to have a significant impact from land use change – which does not seem to be included.

District heating

Assumptions on district heating supply include coal and seem to be historical, not projected 10 years ahead like it is claimed to be in the methodology section of the report. At least a scenario with 100 % renewable energy for district heating should be included. It is important that assumptions are consistent and aligned with policies, i.e. that decisions taken by politicians are based on scenarios reflecting the expected development (like on the energy system) due to other related policies. If e.g. politicians of Copenhagen municipality wishes to influence shopping bag policies in Copenhagen, the scenarios behind the LCA must reflect policies for adjoining systems in Copenhagen - and a scenario including the expected district heating system in Copenhagen must be included, so the politicians can see the consequences of alternative shopping bags in the light of the expected future systems in Copenhagen.

A scenario assuming fully renewable energy in district heating would be to the advantage of the multiuse bags, as the environmental benefit of waste incineration would decrease significantly.

Disposal pathways

It should be explained why secondary reuse gives rise to lower Climate Change impact than recycling for most of the bags. The explanation given in the discussion section says that it is due to the fact that an LDPE

waste bin bag is displaced. But if one assumes that by recycling a heavier LDPE virgin grocery carrier is displaced, then this would entail lower net impacts that secondary reuse – so what is the reason?

Further, it is not easily understood what is implied by the statement that recycled LDPE is modelled as virgin – should be better illustrated by process flow diagrams.

Finally, it should be better explained and with full transparency how paper bag incineration can give rise to lower Climate Change impact than recycling. This is contradicting former studies, but may of course lie in some system assumptions.

Recycling of textiles is not included – but this is much discussed and probably on the way in many municipalities. A 'do not burn' (stockpiling or material recycling) disposal pathway should be included for the cotton bags, as keeping the cotton in techno-sphere would mean a very significant carbon sink making the cotton bag superior on the climate change impact.

5. Impact categories and their interpretation

All impact categories are treated as equally important, no weighting is done and no discussion of significance or thresholds. This is important for e.g. ozone degradation from emissions assumed to be released from cotton production, as ozone depleting emissions may well be insignificant, but still counted in the study as equally important. Also the use of water resources is decisive for the break-even no. of uses (for the composite bag), and problems related to water use are very site specific and should be discussed in this light.

Some categories like climate change, resource consumption and land use related impacts are inherently highly relevant for this type of LCA. But other impact categories may be less relevant, either because emissions are much below threshold or because the type of emissions and emission points are typically targeted and dealt with by point source measures, such as e.g. stipulation of emission standards for flue gas treatment etc.. In my view, the impacts of climate change, resource consumption and land use related impacts are the most important for the study in question.

6. Contribution analysis missing

Finally, a better contribution analysis should be included for the sake of transparency. As an example, it would help the understanding and the assessment of data quality, if impacts from cotton production were clearly related to specific emissions of substances and fully explained. I would e.g. like to understand, which emissions contribute to the ozone depletion impact of cotton growing.

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