6.7 External Peer Review and Responses

An external peer review has been conducted to ensure compliance with the requirements of the ISO 14040 and 14044 standards for making a comparative environmental claim. The external peer review panel was comprised of Dr. Gontran Bage, Ms. Marylène Dussault and Dr. Anthony Halog. Their comments following an initial and final review are appended to this report. Comments from the original review panel's response are shown below in plain type. Responses to the comments are shown in italic type. The original correspondence from the panel is attached. All points in the panel's final statement have been modified as suggested.

Life Cycle Assessment Methodology

Section 2.1

1. In accordance with the philosophy of LCA approach, it should be explicitly stated at the beginning of the report that the environmental impacts associated with each product system are **potential** and not real.

   Statement added in section 2.1

Section 2.2

2. In section 2.2, it is stated that the functional unit represents "a typical service rate for a single installation of any of the systems over a 10-year lifetime". Hence, all product systems studied use one unit over the studied time frame. No justifications for the product lifetimes are provided. This should be clearly stated in the report, especially since many assumptions are taken from the Environmental Resources Management (2001) and this report considered a 5- year lifetime for both the paper dispenser and hand dryer system, which is not consistent with this present LCA study.

   The 10 year lifetime was used based on the input of Excel Dryer inc., whose input was that each system in question is likely to last at least *that amount of time. No known source of information is available on the true lifetime of these systems. Review of the initial results of the study did not implicate this as a variable to which the directional conclusion of the study might be sensitive within the range of reasonable inputs, as for each system the initial production impacts are a minor component and of a similar scale. A note on the selection of 10 years has been included in section 2.2*

Section 2.3

3. What is the justification in the choice of product system alternatives? Are there no other product systems in the market, besides those mentioned in this LCA document? Were the considered product system alternatives in this LCA study selected in random or they based on actual market share of various hand drying systems?

   The alternatives considered are representative of the great majority of the market share. While other systems exist, their market share is extremely small and it is not felt that there is any interest on the part of the client or their customers in seeing such a comparison. Other systems include single-use cloth towels and multi-use cloth rolls.

4. The product system for the conventional dryer is said to be "typical of the leading options in this market over the past several decades". However, the conventional dryer studied specifications include wattage of 2300 W. This seems to be at the high end of the wattage range of the available hand dryer models in the market. A quick search in the available models from different companies showed variation in wattage from 1300 W to 2400 W. Product's wattage greatly influences the electricity requirements of the use phase for which this study has shown to have the most important potential environmental impact for the dryers' life cycle. Hence, the panel thinks that the wattage for the conventional hand dryer should be justified and represent the typical product type in the market. On the other hand, Excel Inc. could specify that the XLERATOR is comparable with the conventional hand dryer that they manufacture with 2300 W wattage and state the specific model studied in the report.

   Electric dryers on the market tend to cluster in two categories: those represented by the high efficiency (XLERATOR) and the conventional dryers. All dryers in the conventional category use primarily evaporation and a lower air speed. These systems are all designed around a motor type that will draw somewhere in the range of 2300 to 2500 watts. The higher efficiency dryers achieve dryness primarily by blowing water off the hands and then evaporating what remains. These fans require a higher air speed achieved by a higher efficiency motor. All dryers of this type will have a wattage of around 1100 to 1500

watts. The 1300 W dryers you have found are therefore more similar to the XLERATOR than to the standard dryer.

5. Several comments should be added to the elements in Table 1.

5.1. For the product characteristic considered, wattage use is stated in motor power (e.g. "1500 Watt motor"). Usually, motor power is lower than the product wattage. Is the considered wattage adequate?

The wattage given is intended to refer to the electrical draw of the dryer unit rather than as a power rating of the motor. The wording in Table 1 has been clarified.

5.2. It should be clearly stated that the energy needed for each electric dryer includes both the electricity during the use (maximum power) and the electricity during the shutdown (fraction of the power) phases.

This has been added to Table 1

5.3. The energy given for the XLERATOR (1165 kWh) is for the use phase of 10 seconds (plus the shutdown) and not a 12 seconds run time as stated.

The proper value has been added. The other value was from a prior draft. The update was needed for the table only and there is no change to the results.

5.4. The amount of paper required to fulfill the functional unit should be revised and recalculated. 260 000 usages of 2 towels with 0.073 m2 per towel gives a total of 37,960m2 of paper.

Similar situation as the above item. The update has been made to the table; no update needed to results.

5.5. It should be explained in the report why the average distance for all components for the supply chain of the XLERATOR is smaller than for other compared product systems. Without any explanation, this could be seen as a bias in favor of the XLERATOR system.

Excel Dryer sources over 90% of their components by weight from within the US, which is uncommon for their industry. However, since no accurate data is available regarding the supply chain or distribution systems of the other components, all the systems have been adjusted to have the same inbound and outbound shipping distances (750 km by both ship and truck for all components). This prevents any advantage being given to the XLERATOR due to the uncertainty and variability in the transportation logistics of the other systems.

5.6. The modeling of the transportation phase of the conventional dryer and the paper towel options is not clear. In table 1, transport distance stated is "750 km" average for all components while in section 6.3 inbound shipping distances is stated as "750 km by truck, 750 km by ship". Are these distances additional or have portions of the transport distance been modeled by truck and others by ship? The panel thinks this needs clarification.

As noted in the above response, these values have been changed and the descriptions have also been updated and clarified based on the revised values. The transport includes 750 km by truck and *750 km by ship for all components.*

5.7. Run time for both types of dryer systems is a critical parameter in this study and should be clearly and thoroughly justified. For example, elements such as the way these run times have been evaluated, the data quality, accuracy and uncertainty should be discussed. It is noted that run time for dryer similar to the conventional hand dryer system in the Environmental Resources Management (2001) report has been set to 30 seconds despite the fact the manufacturer reported 20 seconds. These authors felt that the run time reported by the manufacturer (20 seconds) wasn't reliable enough and then chose a conservative hypothesis of 30 seconds when comparing with paper towel. In this study, such run time estimate (35 seconds) can favor the product for which the commissioner of the study wants to demonstrate the environmental superiority of this dryer over any other product systems considered.

Extensive research conducted by Excel Dryer, Inc. (by Aisenberg and Freedman) during the design of the XLERATOR has shown a range of 10 to 15 seconds for the XLERATOR and 30 to 45 seconds for conventional air dryers to achieve equivalent and satisfactory dryness. A report summarizing this research is being provided to the peer review committee and is available to others by request to Excel Dryer, inc. A reference to this report has been added to the report where appropriate. To be inclusive of the 20 second number given in the ERM 2001 report, the "low intensity user" scenario has been changed from 25 seconds to 20 seconds, although the information from the Aisenberg and Freedman report suggest this is well below the range that will achieve adequate dryness. For purposes of comparison, it should be pointed out that the push-button driers that were

prevalent before those with optical controls ran on a Standard cycle of 35 seconds.

6. In order to aid the reader or the audience of this LCA study to understand the scope of each product system, it is common to define the reference flows for each system. In this study, the reference flows are given in appendix (ref. 6.2) as a list of processes associated with impacts per unit of each process. It is recommended to define and quantify the reference flows for each product system and to state that information in the goal and scope definition section.

   We feel that inclusion of a full list of all reference flows in the middle of the report will break the flow of information and is more material than many readers would be interested to see. Further, we think it is best to present this information alongside the estimated impacts, both to make the calculations of the study more transparent and to provide the reader with the impact information in addition to the reference flow amount in their assessment of what flows are significant. To respond to your concern, we have rather added flow charts in Section 2 that indicate the nature and amounts of all processes that individually contribute 2% or more to any of the impact categories studied.

Section 2.4

7. In Section 2.4, it is stated that "components may have been omitted only if their impacts are anticipated to fall well below 1% of the total system impacts". It is unclear to the panel if this is the only cut-off criterion considered in the study.

   This is the only cut-off criteria. A clarifying statement has been added to section 2.4.

8. The geographic and temporal boundaries of the study should be clearly stated in Section 2.4.

   A reference to the US market and 2009 have been added to section 2.4.

9. Considering that the product is manufactured and distributed in the US or North America region, is there an attempt on the part of the LCA practitioner to use the National Renewable Energy Laboratory (NREL)'s USLCI or Franklin Associates databases instead of European ecoinvent database? If an attempt has been made, this should be stated in the report to avoid question in regards to data relevance for US region.

   In addition to the consideration of geographic relevance, one must also consider temporal relevance, consistency, completeness and other quality criteria. It is our opinion that ecoinvent is superior to these other data sources on these other criteria by a considerable enough margin to overshadow any concern over geographic relevance. In addition, although ecoinvent is of European provenance, it contains information representing many regions of the world. For example, the data we have used to represent electricity use is data created to represent the US electrical grid, even though it is a part of the ecoinvent database. An explanation has been added in section 2.5.

10. Table 2 presents a summary of the components considered, but some life cycle stages descriptions are not adequate to provide a good comprehension of the modeling approach. For example, the activities included in the material production and manufacturing phases for the towels are not clear. Also, the end-of-life modeling is difficult to follow through. More details in this section would help to improve readers' comprehension. A diagram of the system boundaries would also help to understand what have been considered and left out of the study.

    As noted above, we have added a system diagram to provide this additional detail.

11. No maintenance in the use stage is mentioned in all of the product system alternatives. This should be discussed and included in the report, if relevant.

    Maintenance is considered as a replacement of 1% of the all components of the dryer or towel dispenser during its life. This is based on an upper bound estimate made by Excel Dryer of the number of replacement parts they ship relative to the units sold. It has also been applied to the other systems in the absence of any other data and the lack of a reason to assume any difference. A reference to this assumption has been added to the appendix table.

12. By internet research, the panel has found that most automatic paper towel dispensers use 2 D batteries (with a lifetime of 6 months) rather than AA batteries. Even if the batteries do not seem to have a significant impact in this study, the panel strongly recommends to re-evaluate the assumption made regarding the type of battery. Since the D battery potentially contains more chemicals than AA battery, this could change the conclusion made regarding the end of life of batteries.

We have modified the AA battery data by a factor equal to the ratio of weights between AA and D batteries.

12.1. Batteries have been known to have serious environmental impacts. How does the disposal of batteries in the case of paper tower system affect its results? Is the LCA result of batteries relevant or above the cut-off criteria that the results warrant to be reported as part of LCA of paper towel system? There is no brief discussion included in the report that the impacts of batteries are negligible.

Our principle in setting the boundary of the system has been to exclude only items that we did not have adequate information to properly characterize the impacts of and then to exclude them only if we were certain they were below 1% of the weight of the system and had no reason to think the proportion of impacts would be significantly different. In the case of batteries, we had an approximation of the number of batteries and available life cycle inventory data (from IDEMAT), although no data on the impacts of their disposal. Further, because they are materially of a different nature than the rest of the system, it was felt important to include their production, even though we are unable to fully characterize their impacts at end of life. A note has been added to section 2.4 noting the potential importance of battery disposal.

12.2. The end of life of batteries seems to have been modeled using a process associated with the disposal of municipal solid waste. Considering the chemical components in a battery, would it be more appropriate to use a process associated with the disposal of hazardous wastes?

An update has been made to change the data used for disposal to a generic hazardous waste category. Although it is unclear how representative this is of the constituents of batteries and it is disposal to a hazardous waste facility rather than to a municipal facility, we agree that it is a more appropriate classification than municipal solid waste.

13. Are there recycled plastics (e.g. polypropylene) used in manufacturing the product assembly or waste bins? If there is, this should be mentioned briefly in the report. Any decisions to omit life cycle stages, unit processes or data shall be clearly stated and justified. There is no brief statement on whether the effect of recycled plastics is considered negligible.

Although there are recyclable *materials in the dryers, dispensers and waste bins, it seems unlikely in many cases that these materials will* actually be recycled *in a substantial amount. The dispensers and dryers would require disassembly to recycle any parts. Although the amount of recycling of these materials is unknown, it was not a factor that was identified based on the initial results as warranting any sensitivity tests to explore its influence on the conclusions.*

14. Is Sulfate based technology a representative technology used for pulp and paper in North America? How about Kraft pulp production?

To our knowledge, the terms "sulphate process" and "kraft process" are synonymous and are distinguished from the less common "sulphite process" which uses sulfuric acid rather than sodium sulphide as in the sulphate/kraft process. See, for example, http://en.wikipedia.org/wiki/Kraft_process.

Section 2.5

15. The section 2.5 lacks a discussion on data requirements.

A description has been added in section 2.5.

16. In section 2.5, it is stated "in a few cases, approximations….". What are specific examples of those cases? Cite cases to understand the general reliability of data for this study.

An example has been provided, along with a note referring the reader to table 6.3.

17. Section 2.5 stated that data used in the study came from different sources. To interpret LCA results, specifications regarding data quality should be provided, at least in a qualitative manner.

A description has been added in section 2.5. Although the data regarding reference flow quantities has been gathered from different sources, it should be noted that with only one exception the supporting life cycle inventory data is all derived from a single source. It is rarely if ever possible to obtain information on the reference flows of a range of systems from a common source.

18. For the conventional dryer product system, care should be taken to ensure consistency with goal of the present study when using data from the Environmental Resources Management study, since this study was a screening LCA and quality of data might not be within the requirements of Excel. Again, giving examples or listing the specific

data taken from the previous study would help in understanding the reliability of data used in the LCA model.

Although a screening LCA, the data obtained from this source was in regards to the system made by the study commissioner, which would be expected to be of high quality even in a screening level study. Furthermore, the data points were validated by Excel Dryer, Inc., a manufacturer of similar systems to be reasonably accurate for characterizing products of that type. A reference has been added to table 6.3 for the data taken from each source.

19. Which processes use the US grid mix? Processes in use phase alone? Foreground processes? Background processes? All processes? Clarification is needed on whether US electricity grid mix (or wind power or coal) is used to model the use phase alone or all process technologies?

    A clarifying statement has been added to section 2.5.

20. Are the technologies used for hand drying systems in North America comparable to European version of hand drying systems? State similarities or differences.

    The same general technologies are available and in many cases the identical products are sold, with minor adaptations, such as for differences in voltage.. A statement has been added to section 2.5.

21. Include a qualifying statement on the reliability and data quality of IDEMAT database.

    A statement has been added to section 2.5.

Section 2.6

22. According to ISO 14044, when performing LCA for comparative assertion of product systems, life cycle impact categories should be as complete as possible. What's the basis of selecting the impact categories? For comparative life cycle assessments disclosed to the public, an additional requirement is that the choice of environmental categories shall be as complete as possible as well as appropriate and reasonable in relation to the goal of the study so that the comparison is fair and equivalent for the product alternatives.

    The selection of impact categories here are primarily at the endpoint level (human health, ecosystem quality and resource depletion). These categories cover a range of more than a dozen additional mid-point categories that are combined using scientific principles to yield these three endpoint indicators. The IMPACT 2002+ method separates climate change from these endpoint categories and reports it as a separate indicator, although it is a midpoint indicator. This is due to the high interest in this indicator and also the great uncertainty in attempting to include it in within the endpoint level indicators. We agree with this choice and have included climate change in this way, although an update has been made to the methodology to reflect current best-practice. As noted below, we have removed primary non-renewable energy use from among the primary impact categories we have reported on. We have added a section in the results showing the impact assessment at midpoint level based on two methodologies and non-renewable energy use has been retained there.

23. What's the basis in using IMPACT 2002+ methodology over other methods? Any justification?

    A statement describing the rationale for selecting this method has been included in section 2.6.

24. The list of "impact categories" include mid-point and end-point categories like human health, ecosystem quality and resource depletion which are aggregations of many impact categories. The panel believes that a description on what mid-point and end-point categories are would help the readers to understand the life cycle impact assessment (LCIA) methodology; and the uncertainty of characterization factors added to the model when converting from one to the other.

    A description of midpoint and endpoint categories has been added to section 2.6, along with a short statement regarding the trade-off in uncertainties among these levels.

25. ISO 14044 states that impact categories should be mutually independent to avoid double-counting. Non-renewable energy used and resource depletion seems mutually dependent. Justify why these two categories needed to be included.

    We have removed non-renewable energy use.

26. The use of the term "weighted" or "weighting" to describe conversion from mid-point impact categories to end-point should be avoided, since ISO 14044 defines Weighting as "converting and possibly aggregating indicator results across impact categories using numerical factors based on value-choices". Using this term might bring confusion considering that ISO 14044 states that "weighting should not be used in studies

intended to be use in a comparative assertions intended to be disclosed to public".

We have changed this terminology.

Section 2.7

27. Recycled content allocation method is not clearly described. For example, our understanding of the allocation used in the baseline scenario seems to be in conflict with the sentence written in the first paragraph of section 2.7: "The impacts in processing the recovered material into new paper pulp have been entirely attributed to the paper towel system". (See also comments in section 6.4 on allocation procedure).
The allocation methods have been updated and the descriptions have been clarified.

28. This sentence in the paragraph *Source of electricity (grid mix)* is not clear: "The default assumption is that is derived from average of the technologies (…)". Expound this description.

Description updated.

29. Wind power is one of the renewable sources of energy. In this LCA study, wind power is considered as the renewable source of energy for scenario analysis. In the "Energy Information Administration, Annual Energy Outlook 2006, Table D4", wind contributes only 2%, biomass energy contributes 46%, hydroelectric contributes 46%. Thus, wind power is not a representative technology for renewable energy source in the US. The LCA results might change.

Wind power has been selected as an example technology and is not necessarily intended to represent with precision the results of using other renewable technologies. We have adjusted the description throughout to be clear that the results shown are for wind power, that it is shown only as an example of one renewable energy source, and that the results for other sources might vary.

30. As stated earlier, justifications are needed for selection of drying time for both types of drying product systems.

See response to comment 5.7

31. Are there published works that can support the statement "While there is no clear scientific consensus …"?

Citation has been added.

32. The last sentence of this section should be removed: "*It is important to note that whereas the standard scenario results that are shown throughout this report show the moderate use for the electric dryers, they show the "low intensity" user for the paper towels systems (1 towel), therefore representing a lower bound for that system in this regard*." If not, paraphrase this statement and put this in the conclusion and/or summary section.

This statement was from a prior draft and should have been deleted. It has been deleted here.

Results Section 3.1

33. An interpretation of the life cycle inventory (LCI) results for each system is missing.

We have chosen not to interpret information at the level of the life cycle inventory (LCI). There are several hundred unique categories of resource use and pollutant emissions included at the level of the inventory. We do not believe it is appropriate or informative to present and discuss information at that level, except with regard to how those individual material flows may influence the life cycle impact assessment. The data sources and reference flows are presented in the appendix for use by readers who may have an interest in recreating and assessing flows of individual materials. We have added an assessment at the midpoint level which offers additional information for those readers who have the knowledge and interest to view the results in more detail.

34. The values in the text associated with Figure 1 should be revised. The paper towels have more impact (climate change score) than the standard electric dryer in the figure. However, the value is smaller as described in the text. Similar remark for the 100% recycled paper towel can be made too. This paragraph should be paraphrased.

This statement was from a prior draft and should have been updated. It has been updated here.

35. The text following Figure 2 states that "*the standard electric dryer performs the worst on all indicators*". This conclusion is true only when comparing the two electric dryers. However, it is not clear if this conclusion is made for all the systems (in such a case the standard electric dryer is not the worst for the climate change, the human health and the ecosystem quality impact categories) or only for the two electric systems. Show the right figure as obtained from LCA results and provide a conclusion as inferred from the figure.

This statement was from a prior draft and should have been updated. It has been updated here.

36. The text following Figure 2 states that the standard scenario for the paper towel "*assumes the use of only one towel*", while the assumption made in Table 1 is for 2 towels per use. Reread the whole report to maintain uniformity of descriptions.

This statement was from a prior draft and should have been updated. It has been updated here.

37. The total values for the 100% recycled content paper towels in Table 3 (appendix 6.1) do not tally with the summation of the impacts across all phases.

The table has been updated.

Section 3.2

38. The panel considers that Figure 3 may be confusing for several reasons.

38.1. The order of magnitude of the total climate change scores of the first two pie charts is not the same as the third pie chart. To prevent people in comparing the three systems by looking at the areas showing the contribution to the climate change for the material production, the total score should better be indicated under each chart.

The font of the total has been enlarged and bolded.

38.2. The pie chart for material production of the dryer systems and the towel system presented in figure 3 should be presented separately, since the towel system's stage of material production includes production of pulp and liner bags over a 10-year period. The panel believes that comparing environmental impact of these systems for this particular life cycle stage (because of processes included) is misleading. Production of pulp or manufacturing of towels can better be compared with the dryers' use stage (impacts all related to the action of drying hands over the study timeframe), but not against production of dryers unit. Consequently, statement regarding superiority of the dryer systems over the towel system in this life cycle stage should be removed (see last sentence of this sub-section) or reported with caveats.

The figures have been separated and the statement comparing their value has been removed. A statement has added in section 3.2 to warn users against drawing comparative conclusions based on results of only one life cycle stage.

39. In the materials production subsection, it is stated that "As noted above, the XLERATOR is represented as an equal mixture of the three housing options." This was not stated above.

The information mentioned is in Table 1. The reference has been made more specific.

40. Transportation section: When it is stated that "This is due to the much higher weight of materials?" what specific materials does it refer to? Trees, wood or other cellulosic biomass materials?

The statement has been updated. It refers to all materials considered in the finished products of each system. For the towels, it would include the towels, liners, packaging, etc. For the dryers, it includes the dryers and packaging.

Section 3.3

41. Recycled content: Interpretation of Figure 4 is not consistent with the accompanied graph: "climate change score for paper towels remains 65% above the impacts of the XLERATOR dryer system." AND "Regarding the comparison of the paper towels with the standard dryer, the trend shown in Figure 4 (paper towels showing a benefit for all percents of recycled content) holds true for all impact categories."

This statement was from a prior draft and should have been updated. It has been updated here.

42. Allocation of recycled content: Allocation method used for the standard scenario is not widely used and thus is not standard. The panel thinks that the term "standard scenario" is confusing on whether it refers to the total life cycle scenario or the recycling allocation scenario. Using the term "baseline scenario" would be clearer. (See comments on allocation method – section 6.3).

We have adopted the term baseline. For further discussion on recycling allocation, see response to comment 51 below.

43. Intensity of use: Last sentence needs to be changed to maintain consistency with the standard scenario: "(…) from Figure 7.The standard scenario for paper towels is based on the "low intensity user" (1 towel per dry)" case.

This statement was from a prior draft and should have been updated. It has been updated here.

44. Intensity of use: The range of variation between the low and high intensity user scenarios for the XLERATOR is smaller when compared to the one for standard dryer. The panel recommends to increase the range of variation in the run time for the XLERATOR or to reduce the one for the conventional dryer in order to avoid any bias in favor of it. The panel suggests to assess the run time that would be necessary for the XLERATOR to generate as much impacts (e.g. climate change) than the standard hand dryer.

The run times have been updated to 8, 12 and 16 seconds for the XLERATOR and 20, 30 and 40 seconds for the standard dryer. These are reasonably consistent with Aisenberg and Freedman, and include the values suggested in ERM 2001.

Section 3.4

45. Figure 8 should be revised as described in the text.

It has been updated here.

46. In the additional data provided in Excel spreadsheet format, are waste bins for paper towel system made of steel? The panel thinks that justifications are required for this choice of material instead of plastic. Are steel-made waste bins representative of the country considered in the study?

There are a wide range of materials used for trash bins in the US. While steel is a common material, other alternatives exist. Steel has been selected because it is consistent with one of the key reference studies, a weigh was readily available and there was no information available that suggested another material might be a better choice. While it would be possible to model the waste bins as either being a population of bins of various sizes and materials or to assess scenarios regarding the type of bin, the results showing that the steel bin production contributes less than 1% to the total impacts of the towel system do not seem to justify a greater focus on this aspect.

Appendices

Section 6.1

47. As described in section 2.6 the Resource Depletion impact category is the combination of Non-Renewable Primary Energy Used impact category with an "estimate of the increased amount of energy that will be required to obtain an additional incremental amount of that substance from the earth". However, Resource Depletion impact category shows lower scores than Non-Renewable Primary Energy used for some product systems and life cycle stages. For example, the stages of material production and manufacturing of Xlerator and standard dryers have resulted in less energy as shown in the Resource Depletion impact category than Non-Renewable Primary Energy impact category. This table should be revised; otherwise, these impact categories should be explicitly described and results discussed.

The titles for the two columns on this table had been reversed. As noted above, the results for non-renewable primary energy have been removed to maintain consistency of reporting at endpoint but not midpoint level.

Section 6.2

48. Table 4 shows that some ecoinvent waste treatments have been modified to account for energy recovery during incineration. What percentage of incinerated waste material-to-energy is applied to? Is this representative of the US or North American situation?

We have applied energy recovery to all materials (that have an energy content) sent to incineration. The U.S. EPA's Municipal Waste in the United States: 2007 Facts and Figures shows that 32 million tons (about 13%) of municipal solid waste were combusted in the U.S. with energy recovery in 2007. The amount combusted without energy recovery is not listed separately, but is referred to as a "relatively small amount"). Residential waste combustion (such as in so-called "burn-barrels"), which might be a significant source of combustion without energy recovery would not be expected to occur in the present systems because they are generally used in commercial or industrial facilities that will have municipal waste collection.

49. Table 4 shows that some ecoinvent waste treatments have been modified and named *XYZ: net impact*. This applies to incineration and recycling processes for certain materials. What are the modifications made on these processes? Include a note below this table.

The footnote to this table has been expanded to describe this.

Section 6.3

50. Total mass of XLERATOR is "9.4" which varies depending on cover type. Include the product weight range in the report.

The table in 6.3 has been updated with the range.

Section 6.4

51. Allocation methods have been widely discussed in LCA and many publications have described ways to deal with open-loop recycling based mostly on argument of accountability or on consequences. The method proposed for the standard scenario in this study does not seem to be based on any known allocation method. In addition, it is inconsistent with the allocation method used in ecoinvent (V 2.0) where cut-off method is applied. The panel believes that the cut-off allocation method should be used in the standard scenario of this study to maintain consistency with the database used.

It is perhaps partly our description that than our practice that is causing confusion. We have modified our "standard" (now "baseline") scenario for the allocation to the "cut-off" method. In short, for recycled content, all impacts of original production are given to the prior system(s), which the current system is allocated the impacts of processing the recycled material for its intended use. In the present case, because there is no recycling at the end of the product life, the present system is also attributed all end-of-life impacts. In ecoinvent, the impacts of producing recycled pulp and the impacts of producing paper products from the recycled pulp are not separated, so there is no distinct process for the production of recycled pulp separate from a larger process of producing recycled paper. See, for example, table 8.88 in the ecoinvent 2.01 documentation for Paper and Board. However, the ERM 2007 report does in fact include a value for the amount of electricity needed to produce market de-inked pulp from collected and sorted waste paper (174 MJ for 60.1 kg of pulp output; Figure 3.9 in that report). We have updated our results to include that amount of electricity as a proxy for the production recycled pulp. Scenarios have also been adjusted. Our descriptions of this in several places have been updated and results have been changed throughout.

52. Are there published works that can support the statement "There is no complete consensus on how to allocate impacts of the original…"?

See response to comment 31.

Missing sections

Coherence analysis

53. No coherence analysis has been done, or is included in the report. Such an analysis should be performed to make sure the systems are modeled in a coherent manner. This type of analysis is a recommended by ISO 14044.

We interpret your comment to refer to what ISO calls a "consistency check." We find no instance of the word coherence *in either ISO 14040 or 14044. A consistency check, similar to that suggested in ISO 14044 has been conducted and added as an appendix (section 6.5).*

Contribution analysis

54. A contribution analysis has been performed in the study. However, this report focused only on climate change impact. It would have been interesting to see whether the processes that contribute the most to this particular impact category are also contributing the most to other impact categories.

A more expanded results table has been added showing the results by process and life cycle stage for each of the indicators used.

55. The contribution analysis performed in the study helps to identify which phases of the life cycle have high environmental impacts. However, it would have been valuable to identify which processes in these phases are responsible for these impacts.

See response to comment 54.

Uncertainty analysis

56. Even if the XLERATOR shows small impacts compared to other systems, ISO 14044 requires that an uncertainty analysis should be performed since this study is intended for public disclosure. Such an uncertainty analysis was not conducted in this study.

An assessment of the uncertainty has been performed and included as an appendix.

Data quality assessment

57. Many data have been collected either in previous published or unpublished studies or directly from the producer of the XLERATOR. In order to adequately state the limits of the study, a data quality assessment is necessary.

An assessment of overall data quality has been included with the consistency check in section 6.5.

Limits of the study

58. The results of an LCA study are strongly linked to the assumptions made and the definition of the system boundaries. Therefore, it is highly recommended to discuss about the limits/caveats of the study in order to make sure the results will be properly used.

A discussion of study limitations has been added just before the conclusion.

General comments

59. On the cover page, it is written that this study is a screening LCA. The panel thinks that such kind of LCA (i.e. screening) is inappropriate with the objectives of the study, mainly the second one that is *to provide an accurate comparison of impacts*. It is recommended to classify this study as a full LCA.

The term screening should have been eliminated and was left from a prior draft. It has been removed here.

60. Using the moderate user scenario for all the systems studied is justifiable for consistency purposes. However, as the analysis of the "low user scenario" has been performed, it would enrich the report to add these results in the report and to add a statement about this scenario in the summary and conclusion.

Discussion of the high/low user scenarios has been made in the summary and conclusion. We feel it is not practical to include these results throughout all results figures shown, as it would increase the amount of information on each figure by 3-fold. We feel it is appropriately presented as a scenario.

61. A caveat regarding "the emissions of CO2 from products of biological origin are not considered in the study....." should be included in the summary and conclusion sections.

We feel such a statement will be confusing to the reader at the level of the summary and conclusions, where the key findings are intended to be presented rather quickly. Further, we think that emphasizing this without the full explanation of the methodology that appears in the body of the report could lead to added confusion. It is both the uptake and emission of CO2 from biological sources that are omitted and the net result is no different than having included them. We therefore feel it is not a significant enough qualification to include in the summary.

62. (In) appropriate Use of Words or Descriptions

62.1. Does the term "heating season" refer to the winter season and "heating season" to the summer?

We interpret your second "heating season" as "cooling season." The answer is mostly, but not exactly. The terms summer and winter are very precise ranges of dates, whereas the times during which it is typical to heat or cool buildings do not perfectly align with these dates and more importantly will vary significantly be location. We have therefore used "heating season" to mean "when the building is being heated" and "cooling season" to mean "when the building is being cooled." It will not be the same time for each location, which is partly what makes assessing the uncertainty that is mentioned difficult to address.

62.2. In Table 2, does the term "electrical use" mean "electrical energy use" or "electricity use"?

Updated to "electricity use"

62.3. In Section 2.6, the signification of "PAS" should be given.

Included.

62.4. Does the term "coal-burning electrical plants" mean "the electricity is produced from coal burning plants"?

Yes.

62.5. In Section 2.7, the statement "This can generally be regarded as worst case for the electric dryer systems regarding the electrical grid mix" should be rewritten. Does the term "electric dryer systems regarding the electrical grid mix" mean "electric dryer systems that consume electricity from the grid"?

We have struck the sentence, as it did not seem to add anything of value and could cause confusion.

62.6. In Section 2.7, does the term "comparative purposes" mean "for purposes of comparison"?

Yes. We have adopted your phrasing

62.7. In Section 2.7, does the term "incarnation" mean "manufacturing" or "production"?

We have changed the wording to avoid this term.

62.8. In section 2.7, instead of using the term "For a comparison", the term "For purposes of comparison" would be more appropriate.

Changed.

62.9. In Section 3.1, does the term “In total” mean “Generally” or “As a whole” or “In relative terms”?

It is intended to signify the total of the lifecycle. “As a whole” would have a similar meaning.

62.10. In Section 3.4 ", does the term "electrical consumption" mean "electricity consumption"?

“electrical” has been changed to “electricity” throughout

62.11. In Section 1.1, does the term "environmental performance metrics" more appropriate than "environmental metrics'?

Changed.

62.12. In Section 1.1, could the statement "In addition, there is a need to understand the comparative environmental impacts....", be interpreted as “relative environmental impacts”?

Changed.

62.13. In Section 2.1, the term "interested parties" would be more appropriate than ”interest parties" in accordance to ISO 14044 standard

Changed. This was a typo.

63. Grammatical and typo errors

63.1. In Section 2.4, delete the "in" in the first sentence "..... were divided into in".

Changed.

63.2. In Section 2.4, clarify the statement “it might assumed that an indirect effect on heating/cooling energy could be caused *by what*?

Updated.

63.3. In Section 2.7, “There is not complete consensus about how to approach this issue of recycled content allocation among scientists”.

We do not find this omission. It reads as you have it above.

63.4. Spelling mistake" They are shows", replace this with “they are shown".

Changed.

63.5. Drop the term "these" in the last 2nd sentence of the last paragraph of Section 3.4

We feel the “these” helps to clarify that we are referring to the two studies mentioned and not necessarily all prior studies that might have addressed this topic.

63.6. In Section 6.3 related to paper towels, the panel think “ratio” is the exact term that would be used in the sentence "Pulp to finished towel product ration "

Changed.

63.7. Figure 9: Add "in" in phrase "... may have occurred in an unknown number of times".

We find the current wording clearer.

July 24, 2009

Ecointesys- Life Cycle Systems
c/o Mr. Jon Dettling
PO Box 55071 #71794
Boston, MA 02205-5071
USA

Final statement from the critical review panel of the LCA study "Comparative Environmental Life Cycle Assessment of Hand Drying Systems"

Dear Mr. Dettling,

The reviewers have read the final version of your LCA study and the answers you provided to our comments and questions. We are glad that you were able to address almost all the elements that we have pointed out in our review.

With the modifications you have done to your report, the panel review considers this LCA comparative study to be compliant with ISO 14044, that the conclusions fulfil the objectives of the study and then, that the study can be used, within its limitations, for public disclosure.

However, we would like to point out some inconsistencies that we have noticed during our final reading of the report. We strongly recommend that you correct them, as well as any others not mentioned in this list, before this report will be released.

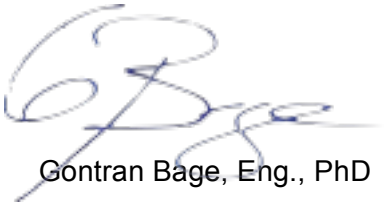
- There are still some inconsistencies on the duration of use for both electric dryers. For example, Table 1 (which pictures the moderate/baseline scenario) mentions that the use time for the XLERATOR and the standard dryer are 12 and 30 seconds, respectively. However, in Figure 12, these durations are reported to be 12 and 35 seconds, respectively. Moreover, in Figure 12, the durations for the low / moderate / high intensity scenarios are 8, 12, and 16 seconds for the XLERATOR and 25, 35, and 45 seconds for the standard dryer, while in section 2.7 these durations are reported to be 10, 12, and 15 seconds for the XLERATOR and 20, 30, and 40 seconds for the standard dryer. Please make sure these durations are consistent all over the report and that the results reflect the correct durations. Corrected.
- Still in Table 1, the amount of electricity required for the standard dryer to fulfil the functional unit is reported to be 5 938 kWh. This value is for 260 000 usages of 35 seconds each, while it is reported in the same table that a single usage last for 30 seconds. Corrected.
- Figure 6 presents the results for the five indicators you have finally selected. However, the legend of this figure still stated that six indicators have been studied. Be sure also that the statement describing below Figure 6 is on consonance with what is portrayed in Figure 6. Corrected.

- For this external review to be fully compliant with ISO, it is needed that you add in the appendix section our complete initial review (which includes the letter, the list of comments and questions with your answers and the ISO 14044 compliance checklist), and this final letter. Corrected.

We strongly recommend to reread carefully the report to make sure that any assumptions, values and hypotheses and that all references to figures and tables are correct.

On behalf of the review panel, I congratulate you for this study on an interesting subject.

Sincerely,



Gontran Bage, Eng., PhD

For the critical review panel composed of:

Gontran Bage, Eng., PhD (Montreal, Canada)

Marylène Dussault, MScA (Sylvatica, Montreal office)

Anthony Halog, PhD (University of Maine)

June 19, 2009

Ecointesys- Life Cycle Systems
c/o Mr. Jon Dettling
PO Box 55071 #71794
Boston, MA 02205-5071
USA

Critical Review of the LCA study "Comparative Environmental Life Cycle Assessment of Hand Drying Systems"

Dear Mr. Dettling,

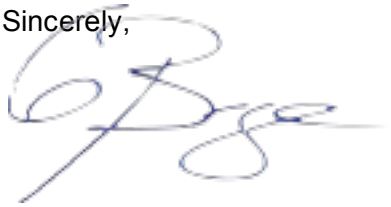
The critical review panel that I chaired has completed its work in reviewing the LCA study entitled "Comparative Environmental Life Cycle Assessment of Hand Drying Systems". Our critical review report is divided into two parts. In the first one, you will find our comments and questions that came out of the review process. As one of your explicit intentions in conducting this LCA study is to disclose the results to the public, the second part of our report provides a checklist showing the extent of compliance of your study in accordance with ISO 14044.

We found this study really good and interesting report for public disclosure. The panel thinks that the information is sufficient for the public to get a good understanding of the study. However, as this study is meant to support comparative assertions that could be made public, we strongly suggest to add sections or analyses recommended by ISO 14044 in view of enhancing the transparency of the report. Nevertheless, you should be able to do these modifications and provide to the study commissioner an ISO 14044 compliant study.

Besides me, the review panel members are Mrs. Marylène Dussault, MScA of Sylvatica and Prof. Anthony Halog, PhD of the University of Maine.

If you have further questions, or need any clarifications on our review, it is my pleasure to answer your queries. On behalf of the members of the review panel, I am looking forward to receiving your updated report with a document containing responses to our questions and explaining the modifications you have done regarding our comments.

Sincerely,



Gontran Bage, Eng., PhD.

The present review of the **Comparative Environmental Life Cycle Assessment of Hand Drying Systems** has been carried out in accordance with ISO 14044 for a full LCA study (with comparative assertion) to be published and intended to be disclosed to interested parties, including the public. The review contains two parts. Part 1 includes the comments and questions of the reviewers and part 2 is a checklist showing the extent of compliance of the study in conjunction with ISO 14044. This review has been done on June 2009 by the following members of the Critical Review Panel.

The chair of the panel:

Gontran Bage

Montreal, Qc, CANADA

Contributing members of the panel:

Anthony Halog

School of Forest Resources, University of Maine

Marylène Dussault

Sylvatica

PART 1

Life Cycle Assessment Methodology

Section 2.1

1. In accordance with the philosophy of LCA approach, it should be explicitly stated at the beginning of the report that the environmental impacts associated with each product system are **potential** and not real.

Section 2.2

2. In section 2.2, it is stated that the functional unit represents "a typical service rate for a single installation of any of the systems over a 10-year lifetime". Hence, all product systems studied use one unit over the studied time frame. No justifications for the product lifetimes are provided. This should be clearly stated in the report, especially since many assumptions are taken from the Environmental Resources Management (2001) and this report considered a 5-year lifetime for both the paper dispenser and hand dryer system, which is not consistent with this present LCA study.

Section 2.3

3. What is the justification in the choice of product system alternatives? Are there no other product systems in the market, besides those mentioned in this LCA document? Were the considered product system alternatives in this LCA study selected in random or they based on actual market share of various hand drying systems?

4. The product system for the conventional dryer is said to be "typical of the leading options in this market over the past several decades". However, the conventional dryer studied specifications include wattage of 2300 W. This seems to be at the high end of the wattage range of the available hand dryer models in the market. A quick search in the available models from different companies showed variation in wattage from 1300 W to 2400 W. Product's wattage greatly influences the electricity requirements of the use phase for which

this study has shown to have the most important potential environmental impact for the dryers' life cycle. Hence, the panel thinks that the wattage for the conventional hand dryer should be justified and represent the typical product type in the market. On the other hand, Excel Inc. could specify that the XLERATOR is comparable with the conventional hand dryer that they manufacture with 2300 W wattage and state the specific model studied in the report.

5. Several comments should be added to the elements in Table 1.

   5.1. For the product characteristic considered, wattage use is stated in motor power (e.g. "1500 Watt motor"). Usually, motor power is lower than the product wattage. Is the considered wattage adequate?

   5.2. It should be clearly stated that the energy needed for each electric dryer includes both the electricity during the use (maximum power) and the electricity during the shutdown (fraction of the power) phases.

   5.3. The energy given for the XLERATOR (1165 kWh) is for the use phase of 10 seconds (plus the shutdown) and not a 12 seconds run time as stated.

   5.4. The amount of paper required to fulfil the functional unit should be revised and recalculated. 260 000 usages of 2 towels with 0.073 m^2 per towel gives a total of 37,960m^2 of paper.

   5.5. It should be explained in the report why the average distance for all components for the supply chain of the XLERATOR is smaller than for other compared product systems. Without any explanation, this could be seen as a bias in favor of the XLERATOR system.

   5.6. The modeling of the transportation phase of the conventional dryer and the paper towel options is not clear. In table 1, transport distance stated is "750 km" average for all components while in section 6.3 inbound shipping distances is stated as "750 km by truck, 750 km by ship". Are these distances additional or have portions of the transport distance been modeled by truck and others by ship? The panel thinks this needs clarification.

   5.7. Run time for both types of dryer systems is a critical parameter in this study and should be clearly and thoroughly justified. For example, elements such as the way these run times have been evaluated, the data quality, accuracy and uncertainty should be discussed.

   It is noted that run time for dryer similar to the conventional hand dryer system in the Environmental Resources Management (2001) report has been set to 30 seconds despite the fact the manufacturer reported 20 seconds. These authors felt that the run time reported by the manufacturer (20 seconds) wasn't reliable enough and then chose a conservative hypothesis of 30 seconds when comparing with paper towel. In this study, such run time estimate (35 seconds) can favor the product for which the commissioner of the study wants to demonstrate the environmental superiority of this dryer over any other product systems considered.

6. In order to aid the reader or the audience of this LCA study to understand the scope of each product system, it is common to define the reference flows for each system. In this study, the reference flows are given in appendix (ref. 6.2) as a list of processes associated with impacts per unit of each process. It is recommended to define and quantify the reference flows for each product system and to state that information in the goal and scope definition section.

Section 2.4

7. In Section 2.4, it is stated that “components may have been omitted only if their impacts are anticipated to fall well below 1% of the total system impacts”. It is unclear to the panel if this is the only cut-off criterion considered in the study.
8. The geographic and temporal boundaries of the study should be clearly stated in Section 2.4.
9. Considering that the product is manufactured and distributed in the US or North America region, is there an attempt on the part of the LCA practitioner to use the National Renewable Energy Laboratory (NREL)'s USLCI or Franklin Associates databases instead of European ecoinvent database? If an attempt has been made, this should be stated in the report to avoid question in regards to data relevance for US region.
10. Table 2 presents a summary of the components considered, but some life cycle stages descriptions are not adequate to provide a good comprehension of the modeling approach. For example, the activities included in the material production and manufacturing phases for the towels are not clear. Also, the end-of-life modeling is difficult to follow through. More details in this section would help to improve readers’ comprehension. A diagram of the system boundaries would also help to understand what have been considered and left out of the study.
11. No maintenance in the use stage is mentioned in all of the product system alternatives. This should be discussed and included in the report, if relevant.
12. By internet research, the panel has found that most automatic paper towel dispensers use 2 D batteries (with a lifetime of 6 months) rather than AA batteries. Even if the batteries do not seem to have a significant impact in this study, the panel strongly recommends to re-evaluate the assumption made regarding the type of battery. Since the D battery potentially contains more chemicals than AA battery, this could change the conclusion made regarding the end of life of batteries.
    12.1. Batteries have been known to have serious environmental impacts. How does the disposal of batteries in the case of paper tower system affect its results? Is the LCA result of batteries relevant or above the cut-off criteria that the results warrant to be reported as part of LCA of paper towel system? There is no brief discussion included in the report that the impacts of batteries are negligible.
    12.2. The end of life of batteries seems to have been modeled using a process associated with the disposal of municipal solid waste. Considering the chemical components in a battery, would it be more appropriate to use a process associated with the disposal of hazardous wastes?
13. Are there recycled plastics (e.g. polypropylene) used in manufacturing the product assembly or waste bins? If there is, this should be mentioned briefly in the report. Any decisions to omit life cycle stages, unit processes or data shall be clearly stated and justified. There is no brief statement on whether the effect of recycled plastics is considered negligible.
14. Is Sulfate based technology a representative technology used for pulp and paper in North America? How about Kraft pulp production?

Section 2.5

15. The section 2.5 lacks a discussion on data requirements.
16. In section 2.5, it is stated "in a few cases, approximations….". What are specific examples of those cases? Cite cases to understand the general reliability of data for this study.

17. Section 2.5 stated that data used in the study came from different sources. To interpret LCA results, specifications regarding data quality should be provided, at least in a qualitative manner.

18. For the conventional dryer product system, care should be taken to ensure consistency with goal of the present study when using data from the Environmental Resources Management study, since this study was a screening LCA and quality of data might not be within the requirements of Excel. Again, giving examples or listing the specific data taken from the previous study would help in understanding the reliability of data used in the LCA model.

19. Which processes use the US grid mix? Processes in use phase alone? Foreground processes? Background processes? All processes? Clarification is needed on whether US electricity grid mix (or wind power or coal) is used to model the use phase alone or all process technologies?

20. Are the technologies used for hand drying systems in North America comparable to European version of hand drying systems? State similarities or differences.

21. Include a qualifying statement on the reliability and data quality of IDEMAT database.

Section 2.6

22. According to ISO 14044, when performing LCA for comparative assertion of product systems, life cycle impact categories should be as complete as possible. What's the basis of selecting the impact categories? For comparative life cycle assessments disclosed to the public, an additional requirement is that the choice of environmental categories shall be as complete as possible as well as appropriate and reasonable in relation to the goal of the study so that the comparison is fair and equivalent for the product alternatives.

23. What's the basis in using IMPACT 2002+ methodology over other methods? Any justification?

24. The list of “impact categories” include mid-point and end-point categories like human health, ecosystem quality and resource depletion which are aggregations of many impact categories. The panel believes that a description on what mid-point and end-point categories are would help the readers to understand the life cycle impact assessment (LCIA) methodology; and the uncertainty of characterization factors added to the model when converting from one to the other.

25. ISO 14044 states that impact categories should be mutually independent to avoid double-counting. Non-renewable energy used and resource depletion seems mutually dependent. Justify why these two categories needed to be included.

26. The use of the term “weighted” or “weighting” to describe conversion from mid-point impact categories to end-point should be avoided, since ISO 14044 defines Weighting as “converting and possibly aggregating indicator results across impact categories using numerical factors based on value-choices”. Using this term might bring confusion considering that ISO 14044 states that “weighting should not be used in studies intended to be use in a comparative assertions intended to be disclosed to public”.

Section 2.7

27. Recycled content allocation method is not clearly described. For example, our understanding of the allocation used in the standard scenario seems to be in conflict with the sentence written in the first paragraph of section 2.7: “The impacts in processing the recovered material into new paper pulp have been entirely attributed to the paper towel system”. (See also comments in section 6.4 on allocation procedure).

28. This sentence in the paragraph *Source of electricity (grid mix)* is not clear: “The default assumption is that is derived from average of the technologies (…)”. Expound this description.

29. Wind power is one of the renewable sources of energy. In this LCA study, wind power is considered as the renewable source of energy for scenario analysis. In the "Energy Information Administration, Annual Energy Outlook 2006, Table D4", wind contributes only 2%, biomass energy contributes 46%, hydroelectric contributes 46%. Thus, wind power is not a representative technology for renewable energy source in the US. The LCA results might change.

30. As stated earlier, justifications are needed for selection of drying time for both types of drying product systems.

31. Are there published works that can support the statement “While there is no clear scientific consensus …”?

32. The last sentence of this section should be removed: ”*It is important to note that whereas the standard scenario results that are shown throughout this report show the moderate use for the electric dryers, they show the “low intensity” user for the paper towels systems (1 towel), therefore representing a lower bound for that system in this regard*.” If not, paraphrase this statement and put this in the conclusion and/or summary section.

Results

Section 3.1

33. An interpretation of the life cycle inventory (LCI) results for each system is missing.

34. The values in the text associated with Figure 1 should be revised. The paper towels have more impact (climate change score) than the standard electric dryer in the figure. However, the value is smaller as described in the text. Similar remark for the 100% recycled paper towel can be made too. This paragraph should be paraphrased.

35. The text following Figure 2 states that “*the standard electric dryer performs the worst on all indicators*”. This conclusion is true only when comparing the two electric dryers. However, it is not clear if this conclusion is made for all the systems (in such a case the standard electric dryer is not the worst for the climate change, the human health and the ecosystem quality impact categories) or only for the two electric systems. Show the right figure as obtained from LCA results and provide a conclusion as inferred from the figure.

36. The text following Figure 2 states that the standard scenario for the paper towel “*assumes the use of only one towel*”, while the assumption made in Table 1 is for 2 towels per use. Reread the whole report to maintain uniformity of descriptions.

37. The total values for the 100% recycled content paper towels in Table 3 (appendix 6.1) do not tally with the summation of the impacts across all phases.

Section 3.2

38. The panel considers that Figure 3 may be confusing for several reasons.

    38.1. The order of magnitude of the total climate change scores of the first two pie charts is not the same as the third pie chart. To prevent people in comparing the three systems by looking at the areas showing the contribution to the climate change for the material production, the total score should better be indicated under each chart.

    38.2. The pie chart for material production of the dryer systems and the towel system presented in figure 3 should be presented separately, since the towel system’s stage of material production includes production of pulp and liner bags over a 10-year period.

The panel believes that comparing environmental impact of these systems for this particular life cycle stage (because of processes included) is misleading. Production of pulp or manufacturing of towels can better be compared with the dryers' use stage (impacts all related to the action of drying hands over the study timeframe), but not against production of dryers unit. Consequently, statement regarding superiority of the dryer systems over the towel system in this life cycle stage should be removed (see last sentence of this sub-section) or reported with caveats.

39. In the materials production subsection, it is stated that "As noted above, the XLERATOR is represented as an equal mixture of the three housing options." This was not stated above.

40. Transportation section: When it is stated that "This is due to the much higher weight of materials?" what specific materials does it refer to? Trees, wood or other cellulosic biomass materials?

Section 3.3

41. Recycled content: Interpretation of Figure 4 is not consistent with the accompanied graph: "climate change score for paper towels remains 65% above the impacts of the XLERATOR dryer system." AND "Regarding the comparison of the paper towels with the standard dryer, the trend shown in Figure 4 (paper towels showing a benefit for all percents of recycled content) holds true for all impact categories."

42. Allocation of recycled content: Allocation method used for the standard scenario is not widely used and thus is not standard. The panel thinks that the term "standard scenario" is confusing on whether it refers to the total life cycle scenario or the recycling allocation scenario. Using the term "baseline scenario" would be clearer. (See comments on allocation method – section 6.3).

43. Intensity of use: Last sentence needs to be changed to maintain consistency with the standard scenario: "(…) from Figure 7.The standard scenario for paper towels is based on the "low intensity user" (1 towel per dry)" case.

44. Intensity of use: The range of variation between the low and high intensity user scenarios for the XLERATOR is smaller when compared to the one for standard dryer. The panel recommends to increase the range of variation in the run time for the XLERATOR or to reduce the one for the conventional dryer in order to avoid any bias in favor of it. The panel suggests to assess the run time that would be necessary for the XLERATOR to generate as much impacts (e.g. climate change) than the standard hand dryer.

Section 3.4

45. Figure 8 should be revised as described in the text.

46. In the additional data provided in Excel spreadsheet format, are waste bins for paper towel system made of steel? The panel thinks that justifications are required for this choice of material instead of plastic. Are steel-made waste bins representative of the country considered in the study?

Appendices

Section 6.1

47. As described in section 2.6 the Resource Depletion impact category is the combination of Non-Renewable Primary Energy Used impact category with an "estimate of the increased amount of energy that will be required to obtain an additional incremental amount of that substance from the earth". However, Resource Depletion impact category shows lower scores than Non-Renewable Primary Energy used for some product systems and life cycle stages. For example, the stages of material production and manufacturing of Xlerator and

standard dryers have resulted in less energy as shown in the Resource Depletion impact category than Non-Renewable Primary Energy impact category. This table should be revised; otherwise, these impact categories should be explicitly described and results discussed.

Section 6.2

48. Table 4 shows that some ecoinvent waste treatments have been modified to account for energy recovery during incineration. What percentage of incinerated waste material-to-energy is applied to? Is this representative of the US or North American situation?

49. Table 4 shows that some ecoinvent waste treatments have been modified and named *XYZ: net impact*. This applies to incineration and recycling processes for certain materials. What are the modifications made on these processes? Include a note below this table.

Section 6.3

50. Total mass of XLERATOR is "9.4" which varies depending on cover type. Include the product weight range in the report.

Section 6.4

51. Allocation methods have been widely discussed in LCA and many publications have described ways to deal with open-loop recycling based mostly on argument of accountability or on consequences. The method proposed for the standard scenario in this study does not seem to be based on any known allocation method. In addition, it is inconsistent with the allocation method used in ecoinvent (V 2.0) where cut-off method is applied. The panel believes that the cut-off allocation method should be used in the standard scenario of this study to maintain consistency with the database used.

52. Are there published works that can support the statement "There is no complete consensus on how to allocate impacts of the original…"?

Missing sections

Coherence analysis

53. No coherence analysis has been done, or is included in the report. Such an analysis should be performed to make sure the systems are modelled in a coherent manner. This type of analysis is a recommended by ISO 14044.

Contribution analysis

54. A contribution analysis has been performed in the study. However, this report focused only on climate change impact. It would have been interesting to see whether the processes that contribute the most to this particular impact category are also contributing the most to other impact categories.

55. The contribution analysis performed in the study helps to identify which phases of the life cycle have high environmental impacts. However, it would have been valuable to identify which processes in these phases are responsible for these impacts.

Uncertainty analysis

56. Even if the XLERATOR shows small impacts compared to other systems, ISO 14044 requires that an uncertainty analysis should be performed since this study is intended for public disclosure. Such an uncertainty analysis was not conducted in this study.

Data quality assessment

57. Many data have been collected either in previous published or unpublished studies or directly from the producer of the XLERATOR. In order to adequately state the limits of the study, a data quality assessment is necessary.

Limits of the study

58. The results of an LCA study are strongly linked to the assumptions made and the definition of the system boundaries. Therefore, it is highly recommended to discuss about the limits/caveats of the study in order to make sure the results will be properly used.

General comments

59. On the cover page, it is written that this study is a screening LCA. The panel thinks that such kind of LCA (i.e. screening) is inappropriate with the objectives of the study, mainly the second one that is *to provide an accurate comparison of impacts*. It is recommended to classify this study as a full LCA.

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61. A caveat regarding "the emissions of CO_2 from products of biological origin are not considered in the study....." should be included in the summary and conclusion sections.

62. (In) appropriate Use of Words or Descriptions

    62.1. Does the term "heating season” refer to the winter season and “heating season” to the summer?

    62.2. In Table 2, does the term "electrical use" mean "electrical energy use" or “electricity use”?

    62.3. In Section 2.6, the signification of “PAS” should be given.

    62.4. Does the term “coal-burning electrical plants" mean “the electricity is produced from coal burning plants”?

    62.5. In Section 2.7, the statement “This can generally be regarded as worst case for the electric dryer systems regarding the electrical grid mix” should be rewritten. Does the term “electric dryer systems regarding the electrical grid mix” mean "electric dryer systems that consume electricity from the grid"?

    62.6. In Section 2.7, does the term “comparative purposes" mean "for purposes of comparison"?

    62.7. In Section 2.7, does the term "incarnation" mean "manufacturing" or "production"?

    62.8. In section 2.7, instead of using the term “For a comparison", the term “For purposes of comparison" would be more appropriate.

    62.9. In Section 3.1, does the term “In total” mean “Generally” or “As a whole” or “In relative terms”?

    62.10. In Section 3.4 ", does the term "electrical consumption" mean "electricity consumption"?

    62.11. In Section 1.1, does the term "environmental performance metrics" more appropriate than "environmental metrics'?

    62.12. In Section 1.1, could the statement "In addition, there is a need to understand the comparative environmental impacts....”, be interpreted as “relative environmental impacts”?

62.13. In Section 2.1, the term "interested parties" would be more appropriate than ”interest parties" in accordance to ISO 14044 standard

63. Grammatical and typo errors

63.1. In Section 2.4, delete the "in" in the first sentence "..... were divided into in".

63.2. In Section 2.4, clarify the statement “it might assumed that an indirect effect on heating/cooling energy could be caused *by what*?

63.3. In Section 2.7, “There is **not** complete consensus about how to approach this issue of recycled content allocation among scientists”.

63.4. Spelling mistake" They are shows", replace this with “they are shown".

63.5. Drop the term "these" in the last 2nd sentence of the last paragraph of Section 3.4

63.6. In Section 6.3 related to paper towels, the panel think “ratio” is the exact term that would be used in the sentence "Pulp to finished towel product ratio**n** "

63.7. Figure 9: Add "**in**" in phrase "... may have occurred in an unknown number of times".

PART 2
ISO 14044 COMPLIANCE CHECKLIST

1. General requirements and considerations related to the reporting of the study

ISO Requirements	Achieved	Comments
1.A- The results and conclusions of the LCA are completely and accurately reported without bias to the intended audience	✓	
1.B- The results, data, methods, assumptions and limitations are transparent and presented in sufficient detail to allow the reader to comprehend the complexities and trade-offs inherent in the LCA		Results and methods are transparent. However the assumptions associated with the use phase, mainly for both electric dryers, should be more detailed. In addition, no limitations of the study are indicated.
1.C- The report allows the results and interpretation to be used in a manner consistent with the goals of the study	✓	

2. Specific requirements and guidance for third-party reports

ISO Requirements	Achieved	Comments
2.A- General aspects		
1- LCA commissioner, practitioner of LCA (inter. or exter.)	✓	Cover page & verso
2- Date of report	✓	Cover page & verso
3- Statement that the study has been conducted according to the requirements of ISO 14044	✓	Section 1.2
2.B- Goal of the study		
1- Reasons for carrying out the study	✓	Section 1.1
2- The study's intended applications	✓	Section 2.1
3- The target audiences	✓	Section 2.1

ISO Requirements	Achieved	Comments
4- Statement as to whether the study intends to support comparative assertions intended to be disclosed to public		It is stated that it's a comparative LCA, and elsewhere it's stated that the study is intended to be disclosed to public. To achieve this requirement, it would be necessary to have a specific statement with both the comparative and the public aspects in the report.
2.C- Scope of the study		
1- Clear definition of the function	✓	The statement related to the function could be written in bold characters to be more visible
i- Statement of performance characteristics	✓	Section 2.2 & Table 1
ii- Any omission of additional functions in comparisons	✓	Section 2.2
2- Clear definition of the functional unit	✓	Section 2.2 & Table 1
i- Consistency with the goal and scope	✓	Section 2.2
ii- Result of performance measurement	✓	Section 2.2 & Table 1
3- Clear definition of the system boundary		Diagrams of each product system boundary are missing; these would help to understand the definition of the system boundary
i- Omissions of life cycles stages, processes or data needs		It would be necessary to add the data quality requirements in section 2.4. The quality of the data should reflect the objectives of the study.
ii- Quantification of energy and material inputs and outputs		Reference flows are only discussed and quantified in appendices (Tables 4 & 5). It should have a short presentation of the reference flows in the text with a reference to the appendices.
iii- Assumptions about electricity production	✓	Section 2.7. However, it could be useful to discuss about those assumptions for the standard scenarios earlier in the report than in the definition of the sensitivity tests
4- Description of cut-off criteria and assumption	✓	Section 2.4

ISO Requirements	Achieved	Comments
i- Effect of selection on results		Neither in the goal and scope nor the results sections
ii- Inclusion of mass, energy and environmental cut-off criteria	✓	Section 2.4. Environmental cut-off criteria is mentioned
2.D- Life cycle analysis		
1- Data collection procedures	✓	Section 2.5. List of the major sources for data is provided
2- Qualitative and quantitative description of unit processes		Not explicitly. Table 5 in appendix gives a list of processes and materials with their amounts for each product system. However, no discussion in the report refers to this table.
3- Sources of published literature	✓	Section 2.5
4- Calculation procedures		No calculation procedure is provided. ISO recommends to document explicitly all calculation procedures. In addition, the tools used to do the LCA calculations should be mentioned.
5- Validation of data		
i- Data quality assessment		No information provided
ii- Treatment of missing data		No information has been provided on how the missing data have been treated.
6- Sensitivity analysis for refining the system boundary	✓	Section 2.7 & Section 3.3
7- Allocation principles and procedures		
i- Documentation and justification of allocation procedures	✓	Section 2.7 & Appendix 6.4 for a complete justification.
ii- Uniform application of allocation procedures	✓	
2.E- Life cycle impact assessment		
1- LCIA procedures, calculations and results of the study	✓	
2- Limitations of the LCIA results relative to the defined goal and scope of the LCA	✓	Section 3.2
3- The relationship of LCIA results to the defined goal and scope	✓	Section 3.2

ISO Requirements	Achieved	Comments
4- The relationship of the LCIA results to the LCI results		As no LCI result has been presented, the relationship with LCIA result could not have been done.
5- Impact categories and category indicators considered, including a rationale for their selection and a reference to their source		References are provided for the selected impact categories. However, there is no justification regarding the reasons for their selection.
6- Descriptions of or reference to all characterization models, characterization factors and methods used, including all assumptions and limitations	✓	Section 2.6
7- Descriptions of or reference to all value-choices used in relation to impact categories, characterization models, characterization factors, normalization, grouping, weighting and, elsewhere in the LCIA, a justification for their use and their influence on the results, conclusions and recommendations	✓	Section 2.6 for the Fresh water use
8- A statement that the LCIA results are relative expressions and do not predict impacts on category endpoints, the exceeding of thresholds, safety margins or risks		Statement is missing and should be made at the beginning of the report
i- *If applicable,* a description and justification of the definition and description of any new impact categories, category indicators or characterization models used for the LCIA	NA	
ii- *If applicable*, a statement and justification of any grouping of the impact categories	NA	
iii- *If applicable*, any further procedures that transform the indicator results and a justification of the selected references, weighting factors, etc.	NA	
iv- *If applicable*, any analysis of the indicator results, for example sensitivity and uncertainty analysis or the use of environmental data, including any implication for the results	NA	
v- *If applicable*, data and indicator results reached prior to any normalization, grouping or weighting shall be made available together with the normalized, grouped or weighted results	NA	
2.F- Life cycle interpretation		
1- Results	✓	Section 3, however, no interpretation provided for the inventory

ISO Requirements	Achieved	Comments
2- Assumptions and limitations associated with the interpretation of results, both methodology and data related		Partially. Assumptions are analysed with several sensitivity analyses, however, the limitations of the study are not discussed
3- Data quality assessment		Missing. This should be added.
4- Full transparency in terms of value-choices, rationales and expert judgements	✓	
2.G- Critical review		
1- Name and affiliation of reviewers		To be added to the report
2- Critical review reports		To be added to the report
3- Responses to recommendations		To be added to the report

3. Further reporting requirements for comparative assertion intended to be disclosed to the public

ISO Requirements	Achieved	Comments
3.A- Analysis of material and energy flows to justify their inclusion or exclusion		There is no indication that flows have been excluded from the study even if the goal and scope section suggests the use of environmental cut-off criteria.
3.B- Assessment of the precision, completeness and representativeness of data used		Missing, should be performed
3.C- Description of the equivalence of the systems being compared	✓	Section 2.3 & Table 1
3.D- Description of the critical review process		Section 1.1 states that the study has been reviewed, but no information is provided on the purpose and objectives of this review
3.E- An evaluation of the completeness of the LCA		Missing
3.F- A statement as to whether or not international acceptance exists for the selected category indicators and a justification for their use	✓	Section 2.6
3.G- An explanation for the scientific and technical validity and environmental relevance of the category indicators used in the study	✓	Section 2.6

ISO Requirements	Achieved	Comments
3.H- The results of the uncertainty and sensitivity analyses		Results of the sensitivity analyses are provided, but no uncertainty analysis has been performed or reported
3.I- Evaluation of significance of the differences found	✓	Section 3.4, comparison with previous similar studies