Stone Paper S-Eco (RP) Sustainability Analysis

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General introduction

Stone Paper S-Eco (RP) is an innovative material, since 2008 with several product-names delivered in the Dutch market. It has a high distinctiveness compared to alternatives, like pulp-paper. Especially it's sustainability and durability is significant (waterproof, tear-resistance and CO2 footprint). The factory delivers her own Analysis and had certified them. Because of that we can announce differ claims to the material. One of these claims is the CO2 footprint reduction instead of pulp-paper.

Gaia-Concept BV asked me, the author of this analysis, to do research as an independent party. This paper should give a clear presentation about the method of my analysis and the results of that. Finally I made a presentation about the touchable results of this analysis, to understand these results for common interest.

1. Calculation CO2 footprint: cradle-to-gate life cycle analysis

Introduction

The first and main part of this document provides a calculation of all CO2 emission during the first half of the life cycle (up to delivery to printing industry or other customers) of the product Stone Paper, as produced by Taiwanees Lung Meng Technology (TLM) and imported by Dutch Gaia-Concept BV.

This so-called 'cradle-to-gate life cycle analysis' follows, where possible, guidelines for calculation of CO2 footprints, as stated in the Greenhouse Gas Protocol (GHG Protocol) by the Greenhouse Gas Protocol Initiative (2011)[14]. This is an international standard for calculating and reporting CO2-footprints.

Calculation method

The CO2 footprint is calculated per 1000 kg Stone Paper S-Eco (RP). The paper is available in different g/m2 (from 120 to 240). In the calculation an average value is applied, so the footprint gives an average outcome which can be applied to all g/m2.

The CO2-footprint is expressed in kg CO2 equivalents (CO2e) per 1000 kg Stone Paper. CO2e includes the greenhouse gasses CO2, CH4, N2O, CFK en HFK, which are all expressed in CO2 values. The global warming potential of 1kg CH4 emission, for example, equals the potential of 25 kg CO2. Thus, 1 kg CH4 equals 25 kg CO2e (Ecometrica, 2012)[7].

To determine the amount of CO2 emissions, conversion rates are used. These are rates which transform measurable units into CO2 emissions. For example, the conversion rate for 1 km driven in a passenger car equals 0,21 kg CO2e (Stichting Stimular, 2011)[13].

When, available, conversion rates of the supplier of a product or service are used. In case that this is not possible, standard rates, like these of Stichting Stimular (2011)[13], are applied.

Borders of CO2 footprint

The here presented footprint is a cradle-to-gate product footprint, this means that all emissions, resulting from the product Stone Paper from gathering of raw materials until delivery of Stone Paper to customers in the printing industry, are included in the footprint.

To be specific, the calculation considers the following items: gathering raw materials, processing raw materials, transporting raw materials, production Stone Paper, transport to distributor, transport to customer.

The second half of the life cycle is excluded in this calculation. Printing, onward transportation and end of life are not considered. Mostly because, at this moment, little is known about Stone Paper's end of life processes, this is still being investigated by Gaia-Concept BV. Additionally, CO2 emissions during printing differ strongly for different types of products, as well as between different printing companies. For these two reasons, the calculation is limited to the first half of Stone Paper's life cycle.

In accordance with the GHG Protocol (2011, pp. 35-36)[14], the following items are not included in the calculation, as their CO2 emissions are not directly connected the product's life cycle: capital goods (machinery, trucks etc.), overhead operations (lightning, heating etc.), corporate activities (administration, sales etc.), transport of employees and customers (commuting etc.).

Results

The total cradle-to-gate product footprint of Stone Paper S-Eco (RP) is 474 kg CO2e per 1000 kg Stone Paper. This footprint consists of: production and transport of raw materials (34 kg CO2e, or 7 percent of the footprint); production of Stone Paper ((379 kg CO2e, 80 percent); and transportation of Stone Paer to customers (61 kg CO2e, 13 percent). The exact outcomes of the calculation are provided in the table on page 4. An explanation for these values is given on the pages after the table.

Tabel Basic outcome of the CO2 footprint

production & transport basicmaterial	34 kg CO2/ 1000 kg	7%
Production Stone Paper	379 kg CO2/1000 kg	80%
Transport to custumer	61 kg CO2/1000 kg	13%
Total	474 kg CO2/ 1000 kg	100%

Item	Used per 1000 kg Stone Paper	Unit	Transportation distance in km (if applicable)	CO2 conversion rate	Unit of conversion rate	CO2e emission in kg per 1000 kg Stone Paper
Raw materials						
Calcium Carbonate	800	kg		0,000	kg CO2e/kg	0,000
Polyethylene	180	kg		0,049	kg CO2e/kg	8,820
Coating	20	kg		0,463	kg CO2e/kg	9,260
Transport calcium carbonate	800	kg	100	0,155	kg CO2e/1000kg/km	12,400
Transport polyethylene	180	kg	100	0,155	kg CO2e/1000kg/km	2,790
Transport coating	20	kg	100	0,155	kg CO2e/1000kg/km	0,310
Total raw materials						33,580
Production						
Used electricity	750	kWh		0,455	kg CO2e/kWh	341,250
Used Oil	10,0	kg		3,735	kg CO2e/ltr	37,350
Total production						378,600
Transport						
Truck: Plant-Harbour	0,048	TEU	80	0,984	kg CO2e/TEU/km	3,749
Ship: Taiwan-Rotterdam	0,048	TEU	18352	0,058	kg CO2e/TEU/km	50,250
Truck: Rotterdam-Warehouse	0,048	TEU	80	0,984	kg CO2e/TEU/km	3,749
Truck: Warehouse-User	1,362	pallet	50	0,055	kg CO2e/pallet/km	3,746
Total transportation						61,492
Total CO2e product footprint Stone Paper						**473,672**

CO2 emissions from raw materials

Raw materials for 1000 kg Stone Paper S-Eco (RP) are stated by TLM to be 800 kg of calcium carbonate, 180 kg of polyethylene (PE) and 20 kg of coating.

The calcium carbonate is gathered as waste material from quarries near TLM's plant. Since it involves waste from the life cycle of another product, the gathering of calcium carbonate is part of the life cycle of this other product. Therefore, the resulting emissions should not be accounted to Stone Paper but to the other product. Only from the moment that the waste leaves the other products life cycle and enters Stone Paper's life cycle should emissions be accounted to Stone Paper (GHG Protocol, 2011, p. 40)[14]. So in this case, only the missions resulting from transport are attributed to Stone Paper. For this a distance of 100 km is assumed and a conversion rate of 0,155 kg CO2e per 1000 kg per km (Stichting Stimular, 2011)[13] is applied. The resulting emission is 12,4 kg CO2e.

PE is a frequently used type of plastic. For the production of Stone Paper, TLM uses high density polyethylene (HDPE). A benefit of HDPE is that this is the most environmentally friendly type of PE, as found in an American comparison (Spray-All Corporation, 2010)[12]. Furthermore, TLM only uses recycled PE, which is friendlier to the environment than new PE. Unfortunately, no specific conversion rate for recycled HDPE is available, therefore a general rate, from Swedish research (Center for Environmental Assessment of Product and Material Systems, 2008)[6], for HDPE is applied.. This rate is 0,049 kg CO2e per kg HDPE and includes both gathering and processing raw materials. Like before, a transport distance of 100 km and a conversion rate of 0,155 kg CO2e per 1000 kg per km (Stichting Stimular, 2011)[13] are applied. For 180 kg of PE this means a total emission of 11,61 kg CO2e (8,82 kg for raw materials and production plus 2,79 kg for transport).

The third ingredient is a thin layer of coating to make Stone Paper printable. The exact nature of this coating is kept secret by TLM. Therefore, to calculate the CO2 emissions of this coating, a general conversion rate for inks and coatings is used. According to ClimateCalc (2011)[3], a CO2 footprint calculator for the printing industry, does 1 kg of coating equal 0,463 kg CO2e. This means an emission of 9,26 kg CO2e for 1000 kg of Stone Paper. Emissions from transport should be added tot his. Again assuming a distance of 100 km and a conversion rate of 0,155 kg CO2e per 1000 kg per km (Stichting Stimular, 2011)[13], the emissions from transportation are 0,31 kg CO2e. Added up, this means the emission of 9,57 kg CO2e for coating per 1000 kg of Stone Paper.

CO2 emissions from production

Stone Paper is produced in TLM's plant in Tainan City, Taiwan. According to TLM, it requires 750 kWh electricity and 10 kg of oil to produce 1000 kg of Stone Paper. To determine CO2 emissions, general conversion rates from Stichting Stimular (2011)[13] are applied. These are 0,455 kg CO2e per kWh electricity and 3,735 kg CO2e per kg of oil. This results in a total CO2 emission of 378,6 kg CO2e for the production of 1000 kg Stone Paper.

CO2 emissions from transport

Transport of Stone Paper consists of four stages. The first stage is container transport per truck from the plant in Tainan City, Taiwan to Kaohsiung Harbour, Taiwan. Conversion rate for container transport per truck is 0,984 kg CO2e per TEU (a TEU is a standard container of 6,1 m length) per km (Stichting Stimular, 2011)[13]. The distance is 80 km (via Google maps). One container fits about 21.000 kg of Stone Paper (see appendix 1). For stage 1, this means an emission of 3,75 kg CO2e per 1000 kg Stone Paper.

Stage 2 is transport on a container ship from Kaohsiung Harbour, Taiwan to Rotterdam Harbour, Netherlands. The distance by sea is 18.352 km (via sea-distances.com). The transport is carried out by Maersk Line, who states an emission of 0,058 kg CO2e per TEU per km (Maersk Line, 2012)[9]. Hence, the emissions of stage 2 equal 50,25 kg CO2e for 1000 kg of Stone Paper.

Stage 3 is container transport per truck from Rotterdam Harbour, Netherlands to the distributor in Diemen, Netherlands. Just like stage 1, the distance is 80 km (via Google maps). So, the emissions are equal to those of stage 1, 3,75 kg CO2e per 1000kg Stone Paper.

The final stage is the transport from distributor to customer. Here a distance of 50 km is assumed. Transportation now involves smaller quantities, a conversion rate of 0,055 kg CO2e per pallet per km (Milieubarometer, 2011)[13] is therefore applied. The weight per pallet depends on the size and g/m2 of Stone Paper, and average value is 734 kg per pallet (see appendix 1). So, for 1000 kg 1,36 pallet is required. This means an emission of 3,75 kg CO2e for the final transport of 1000 kg Stone Paper.

2. Comparison CO2 footprint Stone Paper and pulp paper

The second part of this document gives a comparison between the CO2 footprint of Stone Paper and that of traditional pulp paper. Just like the calculation of Stone Paper's footprint,

the footprint for 1000 kg of pulp paper is a cradle-to-gate footprint. It includes all emissions resulting, starting from gathering resources until delivery to customers in the printing industry.

A comparison based on weight is a fair comparison. Stone Paper and pulp paper have similar weight and thickness properties, as is shown by a comparison of specifications of Stone Paper, Hello Silk paper and ON Offset paper (see appendix 1 and 2). The latter two are frequently used brands of pulp paper. Both Stone Paper and pulp paper of 1 m2 area and 1µm thickness have a weight of 1,2 gram. Other properties, like opacity, are also similar.

As explained above, Stone Paper has a cradle-to-gate footprint of 474 kg CO2e per 1000 kg Stone Paper. Obviously, every product, and thus every brand of pulp paper, has a different CO2 footprint. To make a comparison between Stone Paper and pulp paper, an average footprint of many types of pulp paper is therefore examined. According to the American Forest & Paper Association (2010, p. 21)[1], the average cradle-to-gate footprint of pulp paper is 1431 kg CO2e per 1000 kg of pulp paper. In addition tot his average value, it has to be remarked that pulp paper with a high percentage of recycled pulp has a lower footprint than pulp paper which mainly consists of virgin pulp (Paper Calculator, 2013)[10].

3. Comparison other sustainability factors Stone Paper and pulp paper

Besides the CO2 footprint, there are also other factors that inform about a product's environmental friendliness. Therefore, these factors are here discussed for both Stone Paper and pulp paper.

A first factor is the required raw materials to produce paper. Stone Paper consists for 80 percent out of waste materials, and hence has a very limited impact on the environment. This is, for example, shown by the Silver cradle-to-cradle certificate, which has been awarded to Stone Paper (C2C Certified, 2013)[2]. A further 18 percent of Stone Paper is recycled PE. Pulp paper, in comparison, requires the presence of wood pulp. Obviously the amount of wood pulp depends on the percentage of recycled pulp. In case that paper is produced from 100 percent virgin wood pulp, 3000 kg wood is required for every 1000 kg of paper, this equals 18 cut trees (Paper Calculator, 2013)[10]. Trees are renewable, but only if they grow in sustainable managed forests, and even then it still takes a long time to grow. Data from the Confederation of European Paper Industries (CEPI) (2011, p. 30)[5] show that

92,2 percent of forests that are managed by European paper producers have certification (like FSC or PEFC) for sustainable forest management.

A second factor is the recyclability of raw materials. Both calcium carbonate and HDPE, the two main raw materials of Stone Paper, are fully recyclable. Calcium carbonate is part of various materials, like paper, plastic and glass, which are all recycled. In this way, in Europe a total of 58 percent of all calcium carbonate is recycled (Industrial Minerals Europe, 2013, p. 10)[8]. Plastics Europe (2012, p. 11)[11] states that in Europe 27 percent of all used PE is recycled. Paper pulp is also recyclable. According to CEPI (2011, p.32)[4], in Europe 69 percent of paper is recycled. However, paper pulp can only be recycled 4 to 8 times, after that it is no longer suitable to produce paper (CEPI, 2013)[4].

A third factor is water consumption during production. The production of Stone Paper does not require any water at all, consumption is 0 m3 per 1000 kg Stone Paper. To produce 1000 kg of pulp paper, European producer need an average of 35 m3 of water, of this 7,9 percent (2,77 m3) is consumed, the remainder is reused later on (CEPI, 2011, p. 44)[4].

A fourth factor is the amount of waste during production. Specifically, waste that cannot be reused during a next production batch. Stone Paper does not have any solid waste during production, all waste can be used again. Pulp paper has very limited waste, only 15,2 kg per 1000 kg of paper cannot be reused at a later time (CEPI, 2011, p. 43)[4].

4. Making sustainability understandable

In the last part of this document, all previously discussed sustainability factors are explained in such a way that they are more understandable to the general public.

A first variable is CO2 emission. 1 kg CO2e equals a distance of 4,67 km in a passenger car (Stichting Stimular, 2011)[13]. The footprint of 1000 kg Stone Paper (474 kg CO2e) equals 2256 km, a drive from Amsterdam to Bucharest, Romania (via Google maps). De footprint of 1000 kg pulp paper (1431 kg CO2e) equals 6812 km, a drive from Amsterdam to Kabul, Afghanistan (via Google maps). The difference between the two (957 kg CO2e, 4555 km) equals a drive from Amsterdam to Jerusalem, Israel (via Google maps).

A second factor is usage of raw materials. As previously explained, 1000 kg of pulp paper requires up to 18 trees.

A third factor is water usage. 0 litre of water is required to produce 1000 kg Stone Paper. Water consumption to produce 1000 kg of pulp paper is 2770 litre. 2770 litre of water equals the amount of drinking water (in coffee, tea, glasses of water etc.) that an average person consumes in just over 50 months (1,8 litre per day per person) ((Vereniging van Waterbedrijven in Nederland, 2012, p. 25))[15].

Sources

This document is a translation of the original, which was written in Dutch. For this reason, some of the used sources are in Dutch only. We apologize for any inconvenience.

1) American Forest & Paper Association (2010). Printing & Writing Papers Life-Cycle Assessment Summary Report (http://www.afandpa.org/docs/default-source/default-document-library/printing-and-writing-lca-report.pdf?sfvrsn=0), 4 december 2013.

2) C2C Certified (2013). Product scorecard (http://www.c2ccertified.org/products/scorecard/stone_paper), 4 december 2013.

3) ClimateCalc (2011). ClimateCalc Berekening en hulpmiddelen (http://nl.climatecalc.eu/1230.aspx), 26 november 2013.

4) Confederation of European Paper Industries (2013). CEPI Sustainability Report 2011 (http://www.cepi.org/system/files/public/documents/publications/recycling/2011/Sustainability_Report_WEB-20111110-00018-01-E.pdf), 4 december 2013.

5) Confederation of European Paper Industries (2013). We should only use and produce recycled paper (http://www.cepi.org/system/files/public/documents/myths_realities/onlyRecycled.pdf), 4 december 2013.

6) Center for Environmental Assesment of Product and Material Systems (2008). (http://www.cpm.chalmers.se/CPMDatabase/Scripts/sheet.asp?ActId=CPMXFRTOOL1998-06-11861), 28 november 2013.

7) Ecometrica (2012). Greenhouse Gases, CO2, CO2e, and Carbon: What Do All These Terms Mean? (http://ecometrica.com/assets//GHGs-CO2-CO2e-and-Carbon-What-Do-These-Mean-v2.1.pdf), 26 november 2013.

8) Industrial Minerals Europe (2013). Recycling Industrial Minerals (http://www.ima-europe.eu/sites/ima-europe.eu/files/publications/IMA%20Recycling%20Sheets%20FULL%20published%20on%2024.10.2013.pdf), 9 december 2013.

9) Maersk Line (2012). Maersk Line Sustainability Progress Update 2012 (http://maersklineroute2.com/pdf/Route2%20Sustainability%20Progress%20Update%202012.pdf), 25 november 2013.

10) Paper Calculator (2013) Calculation for 1 ton 0% and 1 ton 100% recycled coated groundwood (www.papercalculator.org), 4 december 2013.

11) Plastics Europe (2012). Plastics – the Facts 2012 (http://www.plasticseurope.org/documents/document/20121120170458-final_plasticsthefacts_nov2012_en_web_resolution.pdf), 9 december 2013.

12) Spray-All Corporation (2010). U.S. Plastics Production and Carbon Dioxide Emissions Capacity (http://www.sprayallcorp.com/carbon_pollutant_emissions.htm), 28 november 2013.

13) Stichting Stimular (2011). CO2 factoren in de Milieubarometer (http://www.milieubarometer.nl/uploads/files/CO2_factoren_2010,_mei_en_juni_2011_dd_26_juni_2011_NL.pdf), 25 november 2013.

14) The Greenhouse Gas Protocol Initiative (2004). Product Life Cycle Accounting and Reporting Standard (http://www.ghgprotocol.org/files/ghgp/Product%20Life%20Cycle%20Accounting%20and%20Reporting%20Standard.pdf), 25 november 2013.

15) Vereniging van Waterbedrijven in Nederland (2012). Drinkwaterstatistieken 2012 (http://www.vewin.nl/SiteCollectionDocuments/Publicaties/Drinkwaterstatistieken%202012/Vewin%20Drinkwaterstatistieken%202012%20lowres.pdf), 9 december 2013.

Appendix 1: Specifications Stone Paper S-Eco (RP)

Standard specifications Stone Paper S-Eco (RP)

Thickness	g/m2	Opacity
120 µm	144	>90
140 µm	168	>90
160 µm	192	>90
180 µm	216	>90
200 µm	240	>90

Available sizes

635 mm x 895 mm
635 mm x 940 mm
711 mm x 1020 mm
787 mm x 1100 mm
895 mm x 1200 mm

Area per sheet in m2 (length in m x width in m)

	Width in m				
Length in m	**0,895**	**0,940**	**1,020**	**1,100**	**1,200**
0,635	0,568				
0,635		0,597			
0,711			0,725		
0,787				0,866	
0,895					1,074

Weight per sheet in gram (area per sheet in m2 x g/m2)

	Sheet size				
g/m2	**635x895**	**635x940**	**711x1020**	**787x1100**	**895x1200**
144	82	86	104	125	155
168	95	100	122	145	180
192	109	115	139	166	206
216	123	129	157	187	232
240	136	143	174	208	258

Sheets per pallet

	Number
g/m2	
144	6500
168	5750
192	5000
216	4500
240	4000

Pallets per TEU

	Number
Sheet size	
635x895	36
635x940	34
711x1020	30
787x1100	28
895x1200	20

Weight per pallet in kg (weight per sheet in kg x number of sheets per pallet)

	Sheet size					
g/m2	**635x895**	**635x940**	**711x1020**	**787x1100**	**895x1200**	**Average**
144	532	559	679	811	1005	717
168	549	577	700	837	1037	740
192	545	573	696	831	1031	735
216	552	580	705	842	1044	745
240	545	573	696	831	1031	735
Average	545	572	695	830	1030	734

Weight per TEU in kg (weight per pallet in kg x number of pallets per TEU)

	Sheet size					
g/m2	**635x895**	**635x940**	**711x1020**	**787x1100**	**895x1200**	**Average**
144	19139	18999	20358	22696	20105	20260
168	19753	19608	21011	23424	20750	20909
192	19630	19486	20880	23278	20621	20779
216	19875	19730	21141	23569	20879	21039
240	19630	19486	20880	23278	20621	20779
Average	19606	19462	20854	23249	20595	20753

Appendix 2: Specifications comparable paper brands

technical information						
Substance g/m^2 (approx)	90	100	115	130	150	170
Caliper µm (approx)	74	82	94	107	125	141
Opacity (ISO) %	91	92.5	94.5	95	96.5	97.5
Brightness (ISO) D65	100	100	100	100	100	100
Whiteness CIE D65	127	127	127	127	127	127
Gloss (Gardner) 75° TS	45	45	45	45	45	45
Gloss (Gardner) 75° WS	45	45	45	45	45	45
Smoothness (Bendtsen) ml/min TS	5	5	5	5	5	5
Smoothness (Bendtsen) ml/min WS	5	5	5	5	5	5
Rigidity (Taber Stiffness Units) 15° MD	1.4	1.9	2.7	4	5.1	8.1
Rigidity (Taber Stiffness Units) 15° CD	1	1.3	2	3	3.3	5
Surface pH	>7.0	>7.0	>7.0	>7.0	>7.0	>7.0

Hello Silk (http://www.roberthorne.co.uk/products/hello-silk-paper/)

Technical specifications:

	Bulk	Caliper	Opacity	Brightness	Whiteness	Smoothness
		ISO534	ISO2471	ISO2470	ISO11475	ISO8791-2
	cm^3/g	MIC	%	%	(CIE) %	(Bendtsen) ml/min
60g/m^2	1.33	80	87.0	110	161	150
70g/m^2	1.31	92	91.0	110	161	150
80g/m^2	1.33	106	94.0	110	161	150
90g/m^2	1.29	116	95.0	110	161	150
100g/m^2	1.28	128	97.0	110	161	150
120g/m^2	1.26	150	98.0	110	161	150
135g/m^2	1.15	155	-	110	161	150
150g/m^2	1.15	172	-	110	161	150
170g/m^2	1.21	205	-	110	161	200
190g/m^2	1.21	230	-	110	161	200
225g/m^2	1.21	275	-	110	161	200
250g/m^2	1.21	305	-	110	161	200
275g/m^2	1.21	333	-	110	161	200
300g/m^2	1.21	365	-	110	161	200

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