

Appendix 1. Carbon dioxide and GHG emissions values; ecological footprint values; life cycle assessment data sources.

Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
GLASS						
		791	0.18	---	0.18	FEVE European Container Glass Federation, 2012. Life cycle inventory—data availability. http://www.feve.org/index.php?option=com_content&view=article&id=79&Itemid=18
		843; 823	0.19	---	0.19	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dübendorf CH.
		900	0.20	---	0.20	Hekkert, M., Joosten, L., Worrell, E. and Turkenburg, C. 2000. Reduction of CO ₂ emissions by improved management of material and product use: the case of primary packaging. <i>Resource, Conservation and Recycling</i> 29: 33–64.
		1,250	0.28	---	0.28	PE Americas, 2010. Environmental Overview. Complete life cycle assessment of North American container glass. Glass Packaging Institute.
		1,795	0.40	---	0.40	Edwards, D. and Shelling, J. 1999. Municipal Waste Life Cycle Assessment Part 2: Transport Analysis and Glass Case Study. <i>Transactions of the Institution of Chemical Engineers</i> 77 Part B September: 259–274.
	600					Humbert, S. Rossi V. Margni M. Jolliet O. and Loerincik Y. 2009. Life Cycle assessment of two babyfood jars vs. plastic pots. <i>International Journal of Life Cycle Assessment</i> 14, 95–106.
	940					Liu, X., Fu, Y., Xu, W. & Meng, L. 2011. Research on the carbon footprint of glass beverage packaging vessel. <i>Journal of Beijing Institute of Graphic Communication</i> , 19 (4), 23–25.
ALUMINUM						
		7,900	1.77	---	1.77	PE Americas, 2010. Final Report—Life Cycle Impact Assessment of Aluminum Beverage Cans prepared for Aluminum Association, Inc. Washington, D.C.
		8,570	1.91	---	1.91	Leroy, C. 2009. Provision of LCI data in the European Aluminum industry Methods and examples. <i>International Journal of Life Cycle Assessment</i> 14 (Supplement 1), S10–S44.

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
		9,530	2.13	---	2.13	Althaus H., Blaser S., Classen M., and Jungbluth N. 2007. Life Cycle Inventories of Metals. Final report eco-invent 2000. Dubendorf CH: Swiss Centre for LCI, EMPA-DU.
		12,000	2.68	---	2.68	Choate, W. and Green, J. 2004. Modeling the Impact of Secondary Recovery (Recycling) on U.S. Aluminum Supply and Nominal Energy Requirements, <i>Light Metals 2004</i> , 913–918. The Minerals, Metals and Materials Society.
	21,562	18,184	4.06	---	4.06	Gao, F. Nie, Z., Wang, Z., Li H., Gong., and Zuo, T. 2009. Greenhouse gas emissions and reduction potential of primary aluminum production in China. <i>Science in China Series E: Technological Sciences</i> 52, (8) 2161–2166.
	9,800					International Aluminum Institute, 2007. Life cycle assessment of aluminum: Inventory data for the primary aluminum industry. Year 2005 update.
STEEL						
		1700	0.38	---	0.38	Steiner, R. and Frischknecht R. 2007. Life Cycle inventories of Metal Processing and Compressed Air Supply. Final report ecoinvent Data v2.0 Dubendorf and Uster, CH.
		1720	0.38	---	0.38	Emi, T. and Min, D. 2005. Strategies and achievements for moving towards minimum wastes and emissions in Asian Steel Industry. <i>Ironmaking and Steelmaking</i> 32(3) 242–250.
		1840; 2469	0.54	---	0.54	Bushi, L., Young, S., and Meil, J. 2003. ATHENA for US Life Cycle Database. ATHENA Sustainable Materials Institute.
		2100	0.47	---	0.47	Yellishety, M. Mudd, G., Ranjith, P. and Tharumarajah, A. 2011. Environmental life-cycle comparisons of steel production and recycling: sustainability issues, problems and prospects. <i>Environmental Science and Policy</i> —article in press.
		2290	0.51	---	0.51	Steiner, R. and Frischknecht R. 2007. Life Cycle inventories of Metal Processing and Compressed Air Supply. Final report ecoinvent Data v2.0 Dubendorf and Uster, CH.
		2520	0.56	---	0.56	Hekkert, M., Joosten, L., Worrell, E. and Turkenburg, C. 2000. Reduction of CO ₂ emissions by improved management of material and product use: the case of primary packaging. <i>Resource, Conservation and Recycling</i> 29: 33–64.

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
		3490; 4025	0.78	---	0.78	World Steel Association, 2010. World Stainless Steel LCI. Contact World Steel Association for data.
		2850; 3570	0.64	---	0.64	European Confederation of Iron and Steel Industries, 2010. Annual Report. Accessed at www.eurofer.eu .
		2600; 3500	0.78	---	0.78	Huang, Z., Ding, X., Hao, S. and Liu, S. 2010. Identification of main influencing factors of life cycle CO ₂ emissions from the integrated steelworks using sensitivity analysis. <i>Journal of Cleaner Production</i> 18, 1052–1058.
		3600	0.80	---	0.80	Johnson, J., Reck, B., Wang, T. and Graedel, T. 2008. The energy benefit of stainless steel recycling. <i>Energy Policy</i> 36, 181–192.
	1600; 2000					World Steel Association, 2011. Life cycle assessment methodology report. ISBN 978-2-930069-66-1. World Steel Association: Brussels, Belgium.
	2010					American Iron and Steel Institute, 2012. Accessed at http://www.steel.org/en/Sustainability/Life%20Cycle%20Information.aspx . Data from World Steel Association, World Steel Association Life Cycle Assessment Global Hot Rolled Coil.
	2300					Norgate, T., Jahanshahi, S. and Rankin, W. 2007. Assessing the environmental impact of metal production processes. <i>Journal of Cleaner Production</i> 15, 838–848.
PAPER						
Graphic paper		420	0.09	2.53	2.62	SCA Ortviken, 2011. Carbon Profile GrahpoCote, GraphoLux, GraphoMatt. SCA Ortviken: Sundsvall, Sweden.
		500	0.11	2.53	2.64	Demharter, W. 2011. ERA Conference Presentation. “Carbon Dioxide balance of print products—view of the industry.”
		763; 772; 1012; 1031; 1315; 1457	0.17	2.53	2.70	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
	1200	1200	0.27	2.53	2.80	Dias A., Arroja, L., and Capela, I. 2007. Life Cycle Assessment of Printing and Writing Paper Produced in Portugal. <i>International Journal of Life Cycle Assessment</i> 12 (7) 521–528.
		1410; 2478	0.32 0.55	2.53 2.53	2.85 3.08	Newell, J. and Vos, R. 2011. Papering over space and place: Product carbon footprint modeling in the global paper industry. <i>Annals of the Association of American Geographers</i> 101 (4), 730–741.
		3117	0.70	2.53	3.08	Yan, Y. 2011. Life cycle assessment and analysis of disposable plastic cups and paper cups. <i>Environmental Science and Management</i> , 36 (6), 174–179.
	2200					Pickin, J.G., Yuen, S.T.S. and Hennings, H. 2002. Waste Management options to reduce greenhouse gas emissions from paper in Australia, “ <i>Atmospheric Environment</i> 26, 741–752.
	1100					Suzano Pulp and Paper, 2011. Sustainability Report 2010. Suzano Pulp and Paper: Sao Paolo, Brazil.
	520					Domtar, 2009. Sustainability, Environmental Responsibility, Climate Change, Table: Pulp and Paper Mills GHG Intensity Trends 2002 to 2009. www.domtar.com/en/sustainability/8856.asp .
Newsprint	1071;	784; 955; 1232	0.18	1.97	2.15	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
		833	0.19	1.97	2.16	Ekvall, T. 1999. Key Methodological issues for life cycle inventory analysis of paper recycling. <i>Journal of Cleaner Production</i> 7, 281–294. Data in this paper is from a paper published in Swedish: Bauman, H. Ekvall T, Eriksson E. Kullman M. Rydbergu T. Ryding A. Svensson G, Steen B. Miljomassiga skillnader mellan atervinning/ateranvandning och forbranning/deponering. FOU No. 79 Malmo: REFORSK, 1993.
		1580	0.35	1.97	2.32	Norske Skog, 2009. Norske Skog Australasia Newsprint Sustainability. Publishers National Environment Bureau.
		1667	0.37	1.97	2.34	Chen, S., Ren, L., Liu, Z., Zhou, C., Yue, W., and Zhang, J. 2011. Life cycle assessment and type III environmental declarations for newsprint in China. <i>Acta Scientiae Circumstantiae</i> , 31, (6) 1331–1337.

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
	800					Laurijssen, J., Marsidi, M., Westenbroek, A., Worrell, E. and Faaij, A. 2010 in press. Paper and biomass for energy? The impact of paper recycling on energy and CO ₂ emissions. <i>Resources, Conservation and Recycling</i> 54(12):1208–1218.
Cardboard and Boxboard	660; 967; 1082	615, 889, 998	0.14	2.57	2.71	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
	560; 1620					Norske Skog, 2010. Norske Skog 2010 Annual Report.
	580					PE-Americas and Five Winds International, 2010. Corrugate Packaging Life-Cycle Assessment Summary Report. Prepared for Corrugated Packaging Alliance: Fibre Box Association, American Forest and Paper Association, Association of Independent Corrugated Converters.
	788					Ongmongkolkul A., Nielsen P.H., and Mousa, M.N., 2002. Life Cycle Assessment of Paperboard Packaging Produced in Thailand. First National Environmental Conference, Environmental Engineering Association of Thailand (EEAT). Chiang Mai, January 2002. pp. 330–339.
	750					Ross, S. and Evans, D. 2002. Use of life cycle assessment in environmental management. <i>Environmental Management</i> 29 (1) 132–142.
PLASTICS						
PET	n/a	1890; 1950	0.44	---	0.44	Hekkert, M., Joosten, L., Worrell, E. and Turkenburg, C. 2000. Reduction of CO ₂ emissions by improved management of material and product use: the case of primary packaging. <i>Resource, Conservation and Recycling</i> 29: 33–64.
	1447	1072	0.24	---	0.24	Franklin Associates, 2010. Final Report—Life Cycle inventory of 100% Postconsumer HDPE and PET recycled from postconsumer containers and packaging. Prepared for The Plastics Division of the American Chemistry Council Inc., the Association of Postconsumer Plastic Recyclers (APR), the National Association for PET Container Resources (NAPCOR) and the PET Resin Association (PETRA).

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
	2897	2377	0.53	---	0.53	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
	2785	2000	0.58	---	0.58	PlasticsEurope, 2011. Eco-Profiles and environmental product declarations of the European Plastics Manufacturers. Polyethylene Terephthalate (PET) bottle grade. Plastics Europe: Brussels, Belgium.
	2660					Franklin Associates, 2011. Cradle to Gate Life Cycle Inventory of Nine Plastics Resins and Four Polyurethane Precursors. Prepared for the Plastics Division of the American Chemistry Council.
PVC		1410	0.31	---	0.31	Chen, X., Xi, F., Geng, Y. and Fujita, T. 2011. The potential environmental gains from recycling waste plastics: Simulation of transferring recycling and recovery technologies to Shenyang, China. <i>Waste Management</i> 31, 168–179.
	2140	1815	0.41	---	0.41	Franklin Associates, 2011. Cradle to Gate Life Cycle Inventory of Nine Plastics Resins and Four Polyurethane Precursors. Prepared for the Plastics Division of the American Chemistry Council.
		1800	0.40	---	0.40	Ostermayer, A. and Giegriich, J. 2006. Eco-profiles of the European Plastics Industry, Polyvinylchloride (PVC) Suspension Polymerisation. Prepared for The European Council of Vinyl Manufacturers and PlasticsEurope.
	1,800					Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
	1765					Tian, B., Xu, X., Fu, H. & Wang, S. 2012. Assessment and accounting the product carbon footprint based on the life cycle. <i>Chinese Journal of Environmental Management</i> , 1, 21–26.
Polystyrene	3383	2745	0.58	---	0.58	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
	n/a	3385	0.76	---	0.76	Chen, X., Xi, F., Geng, Y. and Fujita, T. 2011. The potential environmental gains from recycling waste plastics: Simulation of transferring recycling and recovery technologies to Shenyang, China. <i>Waste Management</i> 31, 168–179.

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
PE film	n/a	3143	0.70	---	0.70	Chen, X., Xi, F., Geng, Y. and Fujita, T. 2011. The potential environmental gains from recycling waste plastics: Simulation of transferring recycling and recovery technologies to Shenyang, China. <i>Waste Management</i> 31, 168–179.
	4660					Ross, S. and Evans, D. 2002. Use of life cycle assessment in environmental management. <i>Environmental Management</i> 29 (1) 132–142.
	1950					James, K. and Grant, T. 2005. LCA of degradable plastic bags. Centre for Design at RMIT (Royal Melbourne Institute of Technology) University, Melbourne Australia.
PE Plastic Bag	n/a	4102	0.92	---	0.92	Lv, Y., Huang, F., Qiu, Y. & Wang, L. 2002. Environmental impact evaluation of plastic and wooden products with LCA. <i>Environmental Pollution and Control</i> , 24 (6), 382–384.
HDPE	1814	1,370	0.31	---	0.31	Franklin Associates, 2011. Cradle to Gate Life Cycle Inventory of Nine Plastics Resins and Four Polyurethane Precursors. Prepared for the Plastics Division of the American Chemistry Council.
	n/a	650; 510	0.15	---	0.15	Hekkert, M., Joosten, L., Worrell, E. and Turkenburg, C. 2000. Reduction of CO ₂ emissions by improved management of material and product use: the case of primary packaging. <i>Resource, Conservation and Recycling</i> 29: 33–64.
		581	0.13	---	0.13	Franklin Associates, 2010
	1950					Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
LDPE	2100	n/a	0.38	---	0.38	Boustead, I. 2005
	2100	n/a	0.38	---	0.38	Hischier, R. 2007. Life Cycle Inventories of Packaging and Graphical Papers. ecoinvent-Report No. 11, Swiss Centre for Life Cycle Inventories, Dubendorf CH.
	1870	n/a	0.32	---	0.32	Franklin Associates, 2010. Final Report—Life Cycle inventory of 100% Postconsumer HDPE and PET recycled from postconsumer containers and packaging. Prepared for The Plastics Division of the American Chemistry Council Inc., the Association of Postconsumer Plastic Recyclers (APR), the National Association for PET Container Resources (NAPCOR) and the PET Resin Association (PETRA).
	2650	n/a	0.59	---	0.59	James, K. and Grant, T. 2005. LCA of degradable plastic bags. Centre for Design at RMIT (Royal Melbourne Institute of Technology) University, Melbourne Australia.
TEXTILES						
Cotton	n/a	15, 570	3.48	5.5	8.98	Grace, P., Gane, M., and Navarro Garcia, F. (2009) Life Cycle Assessment of a 100%Australian cotton t-shirt. Queensland University of Technology.

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Material	kgCO ₂ /t	kgCO ₂ /t	Energy land gha/t	Forest/cropland gha/t	EF gha/t	References
	n/a	12,760	2.85	5.5	8.35	Steinberger, J., Friot, D., Jolliet, O. and Erkman, S. 2009. A spatially explicit life cycle inventory of the global textile chain. <i>International Journal of Life Cycle Assessment</i> 14, 443–455.
	n/a	15000; 16000	3.35	5.5	9.07	Levi Strauss and Company, 2010. Levi Strauss and Company life cycle approach to examine the environmental performance of its products. Accessed at http://levistrauss.com/sites/levistrauss.com/files/librarydocument/2012/6/e-evaluate-web-content-2012-05-23.pdf
	27092	22042	6.05	5.5	11.55	Althaus, H.J., Dinkel F., Werner, F. 2007. Life Cycle Inventories of Renewable Materials. Ecoinvent Swiss Centre for Life Cycle Inventories, Dubendorf CH
	25,000					Pyke, B. 2009. The Impacts of Carbon Trading on the Cotton Industry Cotton R&D Corporation of Australia. PP Presentation, 6 ^{8th} ICAC Plenary.
DIAPERS	n/a	2600	0.58	0.36	0.94	Hakala, S., Virtanen, Y., Meinander, K. and Tanner, T. 1997. Life-cycle assessment, comparison of biopolymer and traditional diaper systems. ISSN 1235-0605. Technical Research Centre of Finland.
	n/a	4390	0.98	0.36	1.34	Aumonier, S. and Collins, M. 2005. Life cycle assessment of disposable and reusable nappies in the UK. Environment Agency: Bristol, UK.
	3754					Aumonier, S., Collins, M. And Garrett, P. 2008. An updated lifecycle assessment study for disposable and reusable nappies. SC10018/SR2. Environment Agency: Bristol UK.