The Reuse Impact Calculator:
Understanding the environmental impacts of household reuse.

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1. Background

Charitable Recycling Australia members are responsible for approximately 285 million product life extensions every year through an Australia-wide network of non-profit reuse shops. However, the carbon and embodied-energy impacts of this activity is not widely understood, and the current and potential contribution of reuse activity to reducing global carbon emissions remains unrecognised in government policy. Furthermore, individual consumers are not ordinarily provided with high-quality data on the climate-change implications of their purchasing decisions.

The intention of this research is to present consumers with a representative estimate of the carbon and energy impacts of choosing to reuse a given product instead of purchasing an equivalent new product, and for this information to motivate consumers to increase purchasing and donating of second-hand items through the charitable reuse and recycling sector.

2. Methodology

Carbon emissions and embodied energy figures for a range of commonly reused household items were calculated using free and publicly-available research, with a preference for peer-reviewed studies where possible. The majority of research consulted was conducted using the Life Cycle Assessment (LCA) methodology; however, the Reuse Carbon Calculator is an aggregation of existing research only, and does not aim to present original LCA findings.

All calculations are per-item; average item-weights used are provided if users wish to apply alterative per-item weights.

3. Inclusions and exclusions

Calculations do not include any carbon emissions created by charitable recyclers through transport, warehousing or shopkeeping activities. Calculations assume that consumers are choosing to purchase second-hand items instead of purchasing an equivalent new product. When deriving the impact of individual products, emissions associated with product use (for example, washing clothing) are not considered.

The boundaries of this analysis extend from raw materials extraction to manufacturing, distribution and sale of a new item. Accordingly, 100% of the carbon and embodied-energy impacts are attributed to the item's first life, and impacts of subsequent reuse cycles are derived from the displacement of an equivalent new item.

4. Equivalency of data

Based on the relative distances from places of production (primarily in China) and places of consumption, it is assumed for the purposes of this tool that carbon emissions and embodied energy figures for consumer items in Europe and North America can also be utilised in Australia where specific geographical figures are unavailable. As the majority of Life Cycle Assessment data presumes that materials are consumed in Europe and North America, further research is needed into the additional emissions factors (if any) that should be added to existing LCAs in order to account for additional transportation distances to Australia.

5. Data averaging

Where multiple data-points of equal validity were available, final figures were calculated as an unweighted average with a minimum of three data-points. Where limited data-points could be found, final figures were cross-referenced using additional references as noted in the relevant sections.

Where not provided by individual studies, average item weights were derived from FRN (2009). When the weights of equivalent items varied in different studies, a weighed average impact per kg was used, and the relevant item weights from FRN (2009) applied.

6. Item Data

T-shirt	
Assumptions and notes:	Weight is 250 grams
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria (AERESS) 2020, ‘Reuse Calculator’, accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Carbon Trust 2020, International carbon flows of clothing, p. 10, viewed 17th February 2020, <https://www.carbontrust.com/media/38358/ctc793-international-carbon-flows-clothing.pdf> Fisher K, James K & Maddox P, *Benefits of Reuse Case Study: Clothing,* Waste and Resources Action Programme, United Kingdom. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom. Rana S, Karunamoorthy S, Parveen S, Fangueiro R 2015, ‘Life cycle assessment of cotton textiles and clothing’ in *Handbook of Life Cycle Assessment (LCA) of textiles and clothing,* = Woodhead Publishing.
Carbon Footprint:	8.1 kg
Embodied Energy:	59.1mj

Wool Jumper	
Assumptions:	500g
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Bevilacqua, Maurizio & Ciarapica, Filippo & Giacchetta, G. & Marchetti, Barbara. (2011). A carbon footprint analysis in the textile supply chain. International Journal of Sustainable Engineering. 4. 24-36. 10.1080/19397038.2010.502582. Carbon Trust 2020, International carbon flows of clothing, p. 10, viewed 17th February 2020, https://www.carbontrust.com/media/38358/ctc793-international-carbon-flows-clothing.pdf Fisher K, James K & Maddox P, Benefits of Reuse Case Study: Clothing, Waste and Resources Action Programme, United Kingdom. Henry, B.K., Russell, S.J., Ledgard, S.F., Gollnow, S., Wiedemann, S.G., Nebel, B., Maslen, D. and Swan, P., 2015. LCA of wool textiles and clothing. In Handbook of Life Cycle Assessment (LCA) of textiles and clothing (pp. 217-254). Woodhead Publishing. James, K. 2011, A methodology for quantifying the environmental and economic impacts of reuse, Waste and Resources Action Programme, United Kingdom.
Carbon Footprint:	26.3 kg
Embodied Energy:	118.3 mj

General Clothing:	
Assumptions:	500g average weight per item (Jeans/ Jumpers/ Shirts/ Jackets/ Shoes/ Sportswear)
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Carbon Trust 2020, International carbon flows of clothing, p. 10, viewed 17th February 2020, https://www.carbontrust.com/media/38358/ctc793-international-carbon-flows-clothing.pdf Ecotricity 2020, 'The Carbon Footprint of Getting Dressed", accessed February 2020, https://www.ecotricity.co.uk/news/news-archive/2018/the-carbon-footprint-of-getting-dressed Fisher K, James K & Maddox P, *Benefits of Reuse Case Study: Clothing,* Waste and Resources Action Programme, United Kingdom. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom. Palamutçu, S., 2015. Energy footprints in the textile industry. In *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing* (pp. 31-61). Woodhead Publishing. Peters, G., Svanström, M., Roos, S., Sandin, G. and Zamani, B., 2015. Carbon footprints in the textile industry. In *Handbook of life cycle assessment (LCA) of textiles and clothing* (pp. 3-30). Woodhead Publishing.
Carbon Footprint:	13.9 kg
Embodied Energy:	86.4 mj

Small Home Electricals	
Assumptions:	Average weight per item is 8kg – i.e. computer screen, television, printer, toaster, kettle, laptop.
Sources:	Boustani, A., Sahni, S., Graves, S.C. and Gutowski, T.G., 2010, May. Appliance remanufacturing and life cycle energy and economic savings. In *Proceedings of the 2010 IEEE International Symposium on Sustainable Systems and Technology* (pp. 1-6). IEEE. Chen, J., Sun, L. and Guo, H., 2017, November. Product carbon footprint assessment supporting the green supply chain construction in household appliance manufacturers. In *IOP Conference Series: Earth and Environmental Science* (Vol. 94, No. 1, p. 012142). Gonzalez, A., Chase, A. and Horowitz, N., 2012. What we know and don't know about embodied energy and greenhouse gases for electronics, appliances, and light bulbs. *Natural Resources Defense Council*. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom. Marcin S, "Carbon footprint of electronic devices," Proc. SPIE 8902, Electron Technology Conference 2013, 890225 (25 July 2013) Olivetti, E., Duan, H. and Kirchain, R., 2015. 'Exploration of carbon footprint of electrical products: Guidance document for product to attribute impact algorithm methodology'. *Cambridge, MA*.
Carbon Footprint:	167.7 kg
Embodied Energy:	2232.3 mj

Books and Magazines	
Assumptions:	500g average weight per item
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Conservatree 2015, *How much paper can be made from a tree?,* viewed 2nd March 2020, <http://conservatree.org/learn/EnviroIssues/TreeStats.shtml> VTT 2010, *Carbon Footprint of a Hardback Book*, viewed 2nd March 2020, <https://papierenkarton.nl/wp-content/uploads/2018/10/VTT-book_cf_2010.pdf>
Carbon Footprint:	1.6 kg
Embodied Energy:	25.8MJ

Upholstered Furniture	
Assumptions:	Average weight is 37.7kg for a mid-sized sofa/ chair/ sofa-bed
Sources:	Antov, P & Pancheva, T 2017, Carbon Footprint Of Furniture Products, proceedings of XIXth International Scientific Conference on Management and Sustainable Development Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Ecotextiles 2010, 'Embodied Energy needed to make one sofa', accessed Feburary 2020, https://oecotextiles.wordpress.com/2010/01/06/embodied-energy-needed-to-make-one-sofa/ Furniture Industry Research Association, 2011. A Study into the Feasibility of Benchmarking Carbon Footprints of Furniture Products. González-García, S., Gasol, C.M., Lozano, R.G., Moreira, M.T., Gabarrell, X., i Pons, J.R. and Feijoo, G., 2011. Assessing the global warming potential of wooden products from the furniture sector to improve their ecodesign. *Science of the Total Environment*, *410*, pp.16-25. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom.
Carbon Footprint:	166.3 kg
Embodied Energy:	3513.1 mj

Other Home Furniture under 15kg	
Assumptions:	Average weight is 11kg, derived from items under 15kg in FRN (2009)
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Antov, P & Pancheva, T 2017, Carbon Footprint Of Furniture Products, proceedings of XIXth International Scientific Conference on Management and Sustainable Development Furniture Industry Research Association, 2011. A Study into the Feasibility of Benchmarking Carbon Footprints of Furniture Products. González-García, S., Gasol, C.M., Lozano, R.G., Moreira, M.T., Gabarrell, X., i Pons, J.R. and Feijoo, G., 2011. Assessing the global warming potential of wooden products from the furniture sector to improve their ecodesign. *Science of the Total Environment*, *410*, pp.16-25. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom.
Carbon Footprint:	22.4 kg
Embodied Energy:	910 mj

Other Home Furniture over 15kg	
Assumptions:	Average weight is 41 kg, derived from an average of all items over 15kg in FRN (2009)
Sources:	Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Antov, P & Pancheva, T 2017, Carbon Footprint Of Furniture Products, proceedings of XIXth International Scientific Conference on Management and Sustainable Development Furniture Industry Research Association, 2011. A Study into the Feasibility of Benchmarking Carbon Footprints of Furniture Products. González-García, S., Gasol, C.M., Lozano, R.G., Moreira, M.T., Gabarrell, X., i Pons, J.R. and Feijoo, G., 2011. Assessing the global warming potential of wooden products from the furniture sector to improve their ecodesign. *Science of the Total Environment*, *410*, pp.16-25. James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom. Treloar, G.J., McCoubrie, A., Love, P.E. and Iyer-Raniga, U., 1999. Embodied energy analysis of fixtures, fittings and furniture in office buildings. *Facilities*, 17: 1, pp. 403-409
Carbon Footprint:	83.4 kg
Embodied Energy:	3391.8 mj

Toys and Homewares	
Assumptions:	Assumed weight is 500g (one dinner plate or crockery item, set of cutlery, small-to-medium toy or board game)
Sources:	Ashby, M.F., 2012. *Materials and the environment: eco-informed material choice*. Elsevier. Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/ Rangaswamy, J., Kumar, T. and Bhalla, K., 2018. A Comprehensive Life-Cycle Assessment of Locally Oriented Small-Scale Toy Industries: A Study of traditional Channapatna Toys as Against Low-cost PVC (Poly-Vinyl Chloride) Toys Made in China. *Procedia CIRP*, *69*, pp.487-492. Postacchini, L., Bevilacqua, M., Paciarotti, C. and Mazzuto, G., 2016. LCA methodology applied to the realisation of a domestic plate: confrontation among the use of three different raw materials. *International Journal of Productivity and Quality Management*, *18*(2-3), pp.325-346. Quinteiro, P., Almeida, M., Dias, A.C., Araújo, A. and Arroja, L., 2014. The carbon footprint of ceramic products. In *Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1* (pp. 113-150). Springer, Singapore.
Carbon Footprint:	13.8 kg
Embodied Energy:	589.4 mj

References:

Antov, P & Pancheva, T 2017, Carbon Footprint Of Furniture Products, proceedings of XIXth International Scientific Conference on Management and Sustainable Development

Ashby, M.F., 2012. *Materials and the environment: eco-informed material choice*. Elsevier.

Asociación Española de Recuperadores de Economía Social y Solidaria 2020, 'Reuse Calculator', accessed February 2020, http://reutilizayevitaco2.aeress.org/en/=

Boustani, A., Sahni, S., Graves, S.C. and Gutowski, T.G., 2010, May. Appliance remanufacturing and life cycle energy and economic savings. In *Proceedings of the 2010 IEEE International Symposium on Sustainable Systems and Technology* (pp. 1-6). IEEE.

Carbon Trust 2020, International carbon flows of clothing, p. 10, viewed 17th February 2020, <https://www.carbontrust.com/media/38358/ctc793-international-carbon-flows-clothing.pdf>

Chen, J., Sun, L. and Guo, H., 2017, November. Product carbon footprint assessment supporting the green supply chain construction in household appliance manufacturers. In *IOP Conference Series: Earth and Environmental Science* (Vol. 94, No. 1, p. 012142).

Conservatree 2015, *How much paper can be made from a tree?*, viewed 2nd March 2020, http://conservatree.org/learn/EnviroIssues/TreeStats.shtml

Ecotextiles 2010, 'Embodied Energy needed to make one sofa', accessed Feburary 2020, https://oecotextiles.wordpress.com/2010/01/06/embodied-energy-needed-to-make-one-sofa/

Ecotricity 2020, 'The Carbon Footprint of Getting Dressed", accessed February 2020, https://www.ecotricity.co.uk/news/news-archive/2018/the-carbon-footprint-of-getting-dressed

Fisher K, James K & Maddox P, *Benefits of Reuse Case Study: Clothing,* Waste and Resources Action Programme, United Kingdom.

FRN 2009, Average Weights List
http://www.frn.org.uk/images/stories/FRN_2009_Average_Weights_List.pdf

Furniture Industry Research Association, 2011. A Study into the Feasibility of Benchmarking Carbon Footprints of Furniture Products.

Gonzalez, A., Chase, A. and Horowitz, N., 2012. What we know and don't know about embodied energy and greenhouse gases for electronics, appliances, and light bulbs. *Natural Resources Defense Council*.

González-García, S., Gasol, C.M., Lozano, R.G., Moreira, M.T., Gabarrell, X., i Pons, J.R. and Feijoo, G., 2011. Assessing the global warming potential of wooden products from the furniture sector to improve their ecodesign. *Science of the Total Environment*, *410*, pp.16-25.

Henry, B.K., Russell, S.J., Ledgard, S.F., Gollnow, S., Wiedemann, S.G., Nebel, B., Maslen, D. and Swan, P., 2015. LCA of wool textiles and clothing. In *Handbook of Life Cycle Assessment (LCA) of textiles and clothing* (pp. 217-254). Woodhead Publishing.

James, K. 2011, *A methodology for quantifying the environmental and economic impacts of reuse*, Waste and Resources Action Programme, United Kingdom.
Marcin S, "Carbon footprint of electronic devices," Proc. SPIE 8902, Electron Technology Conference 2013, 890225 (25 July 2013)

Olivetti, E., Duan, H. and Kirchain, R., 2015. 'Exploration of carbon footprint of electrical products: Guidance document for product to attribute impact algorithm methodology'. *Cambridge, MA*.

Palamutçu, S., 2015. Energy footprints in the textile industry. In *Handbook of Life Cycle Assessment (LCA) of Textiles and Clothing* (pp. 31-61). Woodhead Publishing.

Peters, G., Svanström, M., Roos, S., Sandin, G. and Zamani, B., 2015. Carbon footprints in the textile industry. In *Handbook of life cycle assessment (LCA) of textiles and clothing* (pp. 3-30). Woodhead Publishing.

Postacchini, L., Bevilacqua, M., Paciarotti, C. and Mazzuto, G., 2016. LCA methodology applied to the realisation of a domestic plate: confrontation among the use of three different raw materials. *International Journal of Productivity and Quality Management*, *18*(2-3), pp.325-346.

Quinteiro, P., Almeida, M., Dias, A.C., Araújo, A. and Arroja, L., 2014. The carbon footprint of ceramic products. In *Assessment of Carbon Footprint in Different Industrial Sectors, Volume 1* (pp. 113-150). Springer, Singapore.

Rangaswamy, J., Kumar, T. and Bhalla, K., 2018. A Comprehensive Life-Cycle Assessment of Locally Oriented Small-Scale Toy Industries: A Study of traditional Channapatna Toys as Against Low-cost PVC (Poly-Vinyl Chloride) Toys Made in China. *Procedia CIRP*, *69*, pp.487-492.

Rana S, Karunamoorthy S, Parveen S, Fangueiro R 2015, 'Life cycle assessment of cotton textiles and clothing' in *Handbook of Life Cycle Assessment (LCA) of textiles and clothing, =* Woodhead Publishing.

Treloar, G.J., McCoubrie, A., Love, P.E. and Iyer-Raniga, U., 1999. Embodied energy analysis of fixtures, fittings and furniture in office buildings. *Facilities*, 17: 1, pp. 403-409

VTT 2010, *Carbon Footprint of a Hardback Book,* viewed 2nd March 2020, <https://papierenkarton.nl/wp-content/uploads/2018/10/VTT-book_cf_2010.pdf>