Working towards a

PLASTIC FREE HOUSE

Plastic pollution is one of the most documented environmental crises of our time. Initially driven by a focus on ocean plastics, the international discussion is now evolving into a more comprehensive debate around city design and consumer behaviour, taking a complete lifecycle approach to the problem, and placing a greater emphasis on the materials with which we surround ourselves. Innovative solutions proposed to tackle plastic pollution have ranged from international projects such as The Ocean Cleanup Project, to biological interventions such as the possibility of wax worm caterpillars consuming plastics (1). However, little attention has been given to the role of the construction sector, and in particular, the design of our homes and the impact of plastics on our health.

With studies showing that only two types of polymer are routinely recycled, equating to only 9% of all plastic produced (2), there is a call for a renewed focus on alternative strategies and materials which reduce the use of plastics in the construction process.

As such WSP have developed a new model of sustainable healthy living. The "**Plastic Free House**" takes a traditional house construction and proposes alternative swap-out items that can be used instead of plastic and plastic-based materials. Using a holistic approach to assessment, each recommended non-plastic alternative is assessed for its environmental impact (embodied carbon) as-well-as its impact on human health. Where plastic items exist outside of the internal envelope, they have been assessed for their indirect impact on health through processes like bioaccumulation.

Health Impacts

New research on the health impacts of exposure to plastics is emerging, particularly around Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs), which have been linked with obesity, reduced fertility, low birthweights and asthma. SVOCs are found in many building products, for example plasticizers are used in vinyl flooring products. Equally, polychlorinated biphenyls (PCBs), have been linked with cancer of the liver and biliary tracts (3). Building materials such as corking, elastic sealants and heat insulation are known to contain PCBs, as well as electrical fixtures such as florescent lights. We have proposed solutions where these materials can be switched for items which do not contain potentially harmful plastics or chemicals, and may also be lower in their carbon footprint

Carbon Impacts

Our analysis found that in addition to the health benefits, in some cases plastic free or low plastic alternatives have a lower carbon impact than plastic-based materials. This is largely due to being derived from fossil fuel-based products; around 8% of world oil production is used to manufacture plastics (4). Another factor is the longevity of the materials. In the example of rainwater goods, while the steel alternative has a greater carbon impact at the point of construction, the PVC pipes are likely to degrade more quickly and may need to be replaced with greater frequency. Where plastic based materials can be replaced with FSC certified timber, there can be an added benefit of sequestering carbon. However, materials must be assessed for their carbon impacts on a case by case basis.

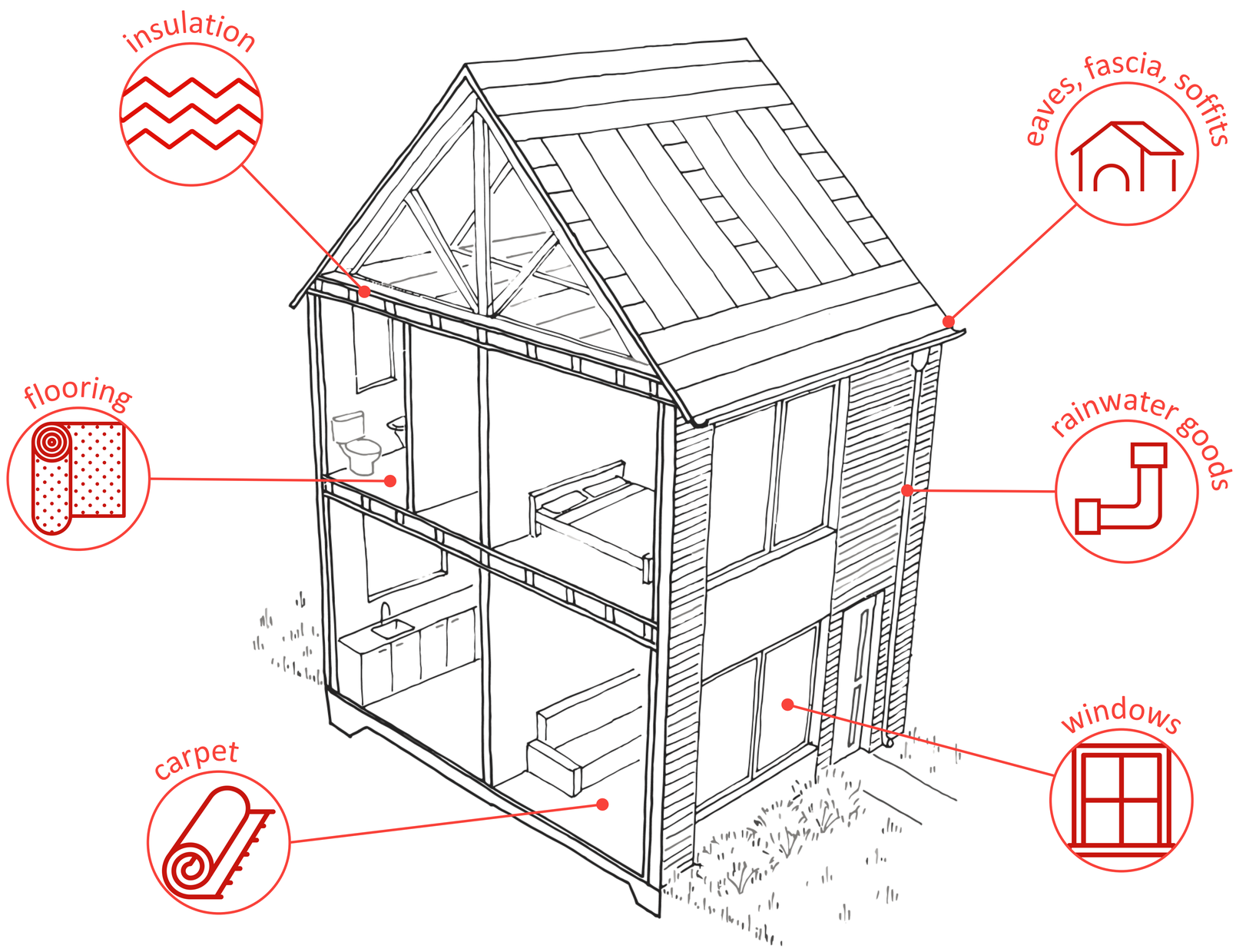
Material Transparency

There are a number of third party schemes allowing manufacturers to demonstrate the material content of individual products, including HPDs (Healthy Product Declarations), Declare labels and c2c certification. Clients and consumers can use these to gauge the health impacts of various building materials. However, material transparency is also critical to a move towards a circular economy, to ensure that harmful and toxic content is not continuously recycled or reused.

Alternative Materials

For the purpose of the assessment, one alternative has been tested per building element, where robust carbon data is available. However there are multiple plastic free / low plastic materials that could be used;

- Sheep wool insulation
- Recycled cotton fibre insulation
- Sisal carpet with natural latex backing
- Ceramic or stone tiles
- FSC certified flooring



Building Element	Plastic-based product	Health Impact	Carbon Impact (5)	Plastic free/low plastic alternative	Alternative Carbon Impact (5)
Insulation	Polyisocyanurate (PIR) insulation boards	Products of this type often contain harmful halogenated flame retardants, and may off-gas styrene, a suspected carcinogen (6).	34 $kgCO_2e/m^2$	Cork insulation (10)	170 $kgCO_2e/m^2$
Windows	Un-plasticised Polyvinyl Chloride (UPVC) framed double glazed windows	The vinyl chloride monomer in PVC (polyvinyl chloride) is a known carcinogen (6).	119 $kgCO_2e/m^2$	Painted timber framed double glazed windows	107 $kgCO_2e/m^2$
Flooring	Vinyl (PVC) sheet flooring	Vinyl flooring tends to contain harmful plasticizers called phthalates, which can disrupt the body's endocrine system (6).	36 $kgCO_2e/m^2$	Linoleum sheet flooring	10 $kgCO_2e/m^2$
Carpet	Polyamide-based carpet with 20% recycled content	Carpets of this type also tend to contain phthalates, which are semi-volatile organic compounds (SVOCs) and can be inhaled by consumers, installers and manufacturers (7).	43 $kgCO_2e/m^2$	Sheep wool-based carpet with felt (jute and hair) backing	21 $kgCO_2e/m^2$
Eaves, fascia, soffits	Extruded PVC boards	When products like these are replaced and enter the waste cycle the hazardous monomers, additive and chemical by products can bioaccumulate in the natural environment (8).	103 $kgCO_2e/m^2$	Treated timber cladding	2 $kgCO_2e/m^2$
Rainwater goods	PVC pipework	Recycling products like this at the end of their lifespan can be difficult, and additive chemicals have been shown to leach from landfills (9).	6 $kgCO_2e/m^2$	Galvanised steel pipework	3 $kgCO_2e/m^2$

References

(1) 'Wax worm caterpillar will eat plastic shopping bags: New solution to plastic waste?', Cell Press, 2017 www.sciencedaily.com/releases/2017/04/170424141338.htm
(2) 'The Future of Plastics Recycling', J. Garcia, M. Robertson, 2017, Science Vol. 358, Issue 6365, pp. 870-872
(3) Toxicological Profile for Polychlorinated Biphenyls, Agency for Toxic Substances and Disease Registry, accessed 2018 www.atsdr.cdc.gov
(4) 4% of world oil production is used as feedstock, and a similar amount used as energy in manufacture; 'Plastics, the environment and human health: current consensus and future trends', R. Thompson, C. Moore, F vom Saal, S. Swan, 2009 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873021/
(5) Carbon impacts are calculated per unit (e.g. m^2) over the lifespan of a building (60 years). Carbon data is taken from product EPDs and the ICE database, and the impact was calculated using the tool One Click LCA
(6) Healthy Materials Lab, at Parsons School of Design, www.healthymaterialslab.org
(7) 'Toxics in Carpets in the European Union', J. Onyshko, Dr R. Hewlett, 2018 https://circulareconomy.europa.eu/platform/
(8) 'Ingested plastic transfers hazardous chemicals to fish and induces hepatic stress', C. Rochman, E. Hoh, T. Kurobe, S. Teh, 2013 www.nature.com/articles
(9) 'Plastics, the environment and human health: current consensus and future trends', R. Thompson, C. Moore, F vom Saal, S. Swan, 2009 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2873021/
(10) Cork insulation calculation does not include carbon sequestration of material. Additionally, cork may also replace other construction materials, reducing the carbon impact further.

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