



Carpet Stewardship Toolkit: Accelerating Carpet Circularity in the USA

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1.0 Introduction

Carpets hold a 60 percent share of the U.S. flooring market, with 11 billion square feet sold per year¹. Most carpets are made primarily from finite resources in the form of oil-based plastics (polymers) that could be recycled. In 2002, the carpet industry established a non-profit organization, the Carpet America Recovery Effort (CARE), to work with the various stakeholders to develop voluntary solutions to recover carpet and padding, and divert this material from final disposal.

Over 15 years later and nationally only 5% of carpet is recycled and of that only 20% (i.e. 1% in absolute terms) is recycled in a closed loop back into carpet materials. The vast majority (over 90%) is currently landfilled according to CARE and the rest burnt in energy from waste facilities. Traditional carpet design is multi-material, with most consisting of a heavy backing of latex-based adhesives and filler materials holding together several polymers in the face fiber (pile) and primary weave backing. This makes material separation in recycling operations extremely difficult and/or uneconomic in most cases.

While the majority of US carpet is still made from nylon, which has a reasonably high residual value as a recycled material, over 40% of carpet is made from polyethylene terephthalate (PET) and polytrimethylene terephthalate (PTT) which is currently not recyclable due to the carpet designs, resulting reprocessing difficulties and the low material values of the recycled materials. Reuse rates are an even smaller fraction than recycling rates, almost entirely comprising of office carpet tiles.

There are also significant concerns about the hazardous substances they contain and the impact these can have on indoor air quality and health. In a recent study, the Healthy Buildings Network (HBN) identified 44 toxic substances frequently used in face fiber, backing, adhesives, and carpet pad²; and yet there are virtually no laws in the US helping to drive greater circularity other than the AB 1158 in California, which regulates the current carpet stewardship program, which is run by CARE; an organization which has been previously criticized for focusing too much on incineration.

Carpet recycling and reuse can be significantly expanded in the US utilizing an Extended Producer Responsibility (EPR) approach which will lead to job creation through the collection, processing, and marketing of discarded carpet and padding. The California legislature recently mandated that carpet recycling rates more than double to 24% by 2020. There are, however, systemic barriers to expansion of carpet recycling, many of

¹ "Scoring Flooring: Industry Stats for 2015." Floor Covering News, June 28, 2016, Volume 30, Number 26 edition. <http://www.fcnews.net/2016/06/scoring-flooring-industry-stats-for-2015/>.

² Healthy Building Network (2017), Eliminating Toxics in Carpet: Lessons for the Future of Recycling

which are interrelated with product design and content. Simplifying product design, avoiding adhesives, and detoxifying carpet backing and fibers are crucial steps toward carpet recycling optimization.

This Toolkit therefore sets out a range of suggested options to assist US States in developing better Carpet EPR Bills - taking a lead on this important product group, helping to fulfil the huge Circular Economy potential that carpets have and offering an example for other sectors to follow. While Extended Producer Responsibility (EPR) is one key element, other policy components are also suggested to drive circularity:

- progress on eco-design to facilitate reusability and recycling and where possible a reduction in the carbon and wider life cycle impacts of the materials used (e.g. through the use of substitute and recycled content materials, where they present no hazard);
- a reduction and ultimately complete removal of toxic components within the carpets themselves (which may also restrict the use of recycled materials in the transition phase, when there are risks associated with legacy chemicals);
- improved environmental management at end of life – i.e. collection, sorting and reprocessing (which may also be impacted by carpet fitting techniques); and
- an accompanying shift in the financial burden away from taxpayers/citizens to producers/consumers.

The intention is not to focus on voluntary initiatives but rather to focus on mandatory, or at least part mandatory options. Recycling rates in California under the mandatory initiative have exceeded those elsewhere in the US and hence we believe that similar approaches are required to drive progress more quickly and reduce barriers to the circular economy that are outside of the control of the carpet industry.

Box 1: Good Eco-Design for Carpets

What can be considered ‘good’ eco-design is important in terms of setting eco-design criteria in various policy instruments from EPR to Green Public Procurement. The following points are what can be considered key to a more ‘circular’ carpet design:

Low toxicity materials:

- Elimination of hazardous substances – e.g. those included under the US EPA LIST OF LIST³ not to exceed 0.01% w:w concentration (100ppm) when tested in a sample of carpet.

The use of sustainable/low-impact materials:

- Natural materials such as wool, jute and sisal

³ Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act

- Recycled plastic content (where legacy toxins can be eliminated); and potentially
- Bio-based materials – often preferable in carbon terms but can be problematic in terms of land take and other life cycle impacts.

Durability:

- Wool and nylon carpets are the most hard-wearing carpets (they can be used for 15 years or more with regular cleaning)
- Woven loop-pile carpets are more hard-wearing than tufted carpets
- Dark and mixed color carpets and those with random patterns are less likely to be ruined by small stains
- Carpet tiles allow easy replacement of work or damaged areas, extending the life of the carpet as a whole
- Carpet tiles with open cell cushion backing are more durable than those with rigid or closed-cell backing.

Reuse:

- Tile designs, and their size, make it easier to replace and repair damaged or soiled sections, and to store and reuse, than broadloom carpet, although reuse is not widely practiced.
- No-glue installation carpet tile facilitate reuse since the tiles are not damaged in removing them (systems such as the Interface TacTile)
- Recyclability (maximizing fiber recovery and high-value uses):
- Single polymer design – face fibers and backing
- Easily separable face fibers and primary backing from secondary backing (sometimes called cushioning)
- Use of materials for which closed loop recycling is possible
- Detailed information on the composition (materials and additives)
- Elimination of hazardous substances
- Easy installation and removal methods (without the use of permanent adhesives)

Several companies offer products with many of these features already, but the development of a level playing field for these and the required mainstream market scale has not yet been achieved. To give some examples:

Mohawk Everstrand Carpet claims to be engineered from one type of recycled PET and can also be recycled⁴ while the Mohawk Air.O, an entirely PET-based carpet, claims to be latex and VOC free and fully recyclable (although this generally has a Stainmaster

⁴ <https://www.mohawkflooring.com/carpet/brand/everstrand>

chemical treatment)⁵. Donkersloot (working with DSM-Niaga) have developed a carpet with an adhesive that allows reversible (heat-based) separation of the primary from the secondary backing⁶. The Net-Effect collection by Interface uses Aquafil Econyl recycled nylon from old fishing nets as well as used carpets⁷.

2.0 Stewardship Best Practice Principles

The stewardship systems developed over the last 20 years (e.g. for packaging, electronics, vehicles in the EU and parts of the US) have been effective up to a point in covering at least part of the costs of collection and treatment of products once they have become waste. However, cost-coverage has often been incomplete and there has been little to no incentive for better product design; individual producer responsibility (whereby the producer deals with its waste obligations directly) has been impractical and eco-modulation (using variable fees to reflect the environmental benefits of a product) rarely used (in Europe notably).

A new carpet stewardship program would be part of a second generation of legislation – making producers truly responsible for the products they place on the market, creating secure revenue streams for collection and recycling infrastructure to operate effectively and to incentivize product innovation towards better design, with penalties for less sustainable practices. As such, enhanced stewardship for carpets would mean that related taxes and fees are not just seen as a way to pay for recycling or disposal, but rather provide a meaningful incentive for better design and closed loop (circular) practices with high quality recovered materials.

There are a number of key principles that should apply to any carpet stewardship system and supporting instruments in the US. The system should:

- Shift the cost burden from municipalities and taxpayers to producers (manufacturers and importers) of the products
- Increase recycling and reuse rates in a progressive fashion
- Create a relatively secure financial stream to allow waste companies and recyclers to develop the required infrastructure

⁵ <http://www.floordaily.net/floorfocus/mohawk-introduces-airo-100-recyclable-easy-to-install-floorcovering-jan-2017>

⁶ <http://www.donkersloot-tapijt.nl/Circulair-tapijt.html>

⁷ <https://www.econyl.com/blog/case-studies-design/interface-net-effect-collection/>

- Physically provide, or cover the full cost of, primary and secondary collection and ‘proper’ treatment to meet targets
- Reward good Design for Sustainability (DfS), including health considerations, and disincentivize poor design
- Require full transparency on the material and chemical composition of the product with a view to eliminating harmful substances
- Reward reuse and Circular Economy models
- Help to create demand for the secondary materials from recycling
- Help to stimulate the economy and create jobs
- Be mandatory and limit ‘free-riding’ as far as possible
- Ensure transparency in terms of the financial aspects of the operations

In Europe, many of these principles are now enshrined in law through Article 8a of the new Waste Framework Directive (WFD)⁸ as minimum requirements for stewardship (Extended Producer Responsibility in EU terms). Most importantly for carpet stewardship, the costs of separate collection should be borne by producers and that fees should be modulated in accordance with Circular Economy principles. Illegal dumping of carpet costs would also ideally be covered by producers under any state legislation. It is also recommended that, where possible, a monetized reflection of all environmental and health externalities are included in the modulated fees to create a level playing field and enable scaling up of clean waste streams.

3.0 Current and Proposed Stewardship Bills

3.1 Introduction

California has the only Carpet Stewardship law-at present ([AB 1158](#)), and the state assembly has recently imposed far tougher recycling targets on the carpet stewardship program. The stewardship program, run by Carpet America Recovery Effort (CARE), is overseen by CalRecycle and has a state-appointed, independent Advisory Committee. In addition to California, New York State ([S 7147A](#)), Illinois ([SB 3546](#)) and Minnesota ([HF 865](#), see Sec. 2) have recently (as of October 2018) proposed carpet stewardship bills.

The California law and the three draft bills are essentially collective stewardship programs that use fees on new carpets to fund collection and recycling. The programs

⁸ DIRECTIVE OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL amending Directive 2008/98/EC on waste; Brussels, 27 April 2018

are mandated and have to produce Stewardship Plans, although with great flexibility for the stewardship schemes in question and only the threat of fines if progress is too slow. In the original California Act ([AB 2398](#)), the focus on 'landfill diversion' led to very slow progress spanning over 15 years, with most of the landfill diversion (around 10%) being actually energy from waste. This is a dirty process with high carbon impacts, particularly given the wide range of hazardous substances in a carpet.

Work done by Eunomia for Changing Markets⁹ showed that the benefits of recycling carpet are -2.36 metric tons CO₂ equivalent per ton, whereas incineration is associated with a contribution to climate change of 1.10 metric ton CO₂ equivalent per ton of carpet, whilst carpet sent to cement kilns leads to a contribution of 0.07 metric tons CO₂ equivalent per ton of carpet. This means that for every ton of carpet sent for incineration instead of recycling, the total missed environmental benefit is 3.46 metric tons CO₂ equivalent per ton of carpet.

3.2 California

California now has carpet recycling targets as noted (24% by 2020), and this is now mandated in the requirements for the Stewardship Plan, with the Plan having to contain quantifiable five-year goals and annual goals for how the recycling rate will be achieved, and how the carpet stewardship organization or manufacturer plans to:

- Increase the weight of postconsumer carpet that is recycled and reduce the disposal of postconsumer carpet.
- Increase the collection convenience for the recycling of postconsumer carpet and increase the collection of postconsumer carpet for recycling.
- Expand and incentivize markets for products made from post-consumer carpet.
- Increase processor capacity, including processor capacity in California.
- Increase the recyclability of carpet.

The legislation makes no mention of carpet design per se (although it does talk about increasing recyclability as noted above, and does not distinguish between open-loop / down-cycling and closed-loop recycling, although it does reference the state hierarchy that prioritizes reuse over recycling).

The California legislation outlines that the assessment (fee) will be used to fund the program (i.e. the stewardship scheme), and that this assessment is to be added to the purchase price of all carpet sold in the state. The California legislation defines the producer as the manufacturer or the importer and producers, as well as carpet recyclers, have to join a Stewardship Group or fulfil the obligations independently. CalRecycle is

⁹ The "Missed" Benefits of Recycling Carpet

currently trying to require a transition plan in case a Stewardship Group / Plan is not approved.

The Californian legislation includes some detail on state agency procurement rules, stating that “Carpet purchased by a state agency contains a minimum amount of postconsumer content that shall be determined by the Department of General Services (DGS) and published in the State Contracting Manual by July 1, 2018.”¹⁰ It is understood that this deadline was not met by DGS.

The Act does include some interesting funding mechanisms which need, for example, to provide sufficient funding to carry out the plan. It also requires incentives or grants to state-approved apprenticeship programs for training apprentice and journey-level carpet installers in proper carpet recycling practices. Importantly, any grants or subsidies provided for the recycling of postconsumer carpet shall be structured to incentivize carpet materials that have the highest recyclability - an important amendment from the previous law. In addition, there are provisions for education and outreach efforts to consumers, commercial building owners, carpet installation contractors, and retailers to promote their participation in achieving the purposes of the carpet stewardship plan.

3.3 New York State

The draft New York Senate Bill, currently a proposal only, outlines ‘The Stewardship scheme’, which requires manufacturers (as producers) to coordinate with wholesalers, retailers and installers to recycle old carpets, with those that are non-compliant having to pay a recycling surcharge. For those that exceed the target, they will receive a tradable credit. The legislation defines the producer as the manufacturer or the importer.

Carpet Stewardship Organizations have to be appointed by one or more manufacturers to design, submit and administer a Carpet Stewardship Plan. The Plan must outline some detail on carpet design, referring to the need for the Plan to include goals that address the use of virgin materials, water and energy in the manufacturing of carpet, and the use and generation of hazardous substances in the manufacturing of carpet. However, these goals are not quantified and recyclability is not explicitly addressed.

The Plan must also include mandatory recycling and reuse targets of 25% in 2020/21 up to 75% 2026/27, and up to 95% from 2028 onwards. However, these recycling targets do not specify whether they are open or closed-loop recycling. By 2020, any manufacturer that does not comply with these goals must pay a recycling surcharge. The Bill has a strong focus on acting to incentivize the market growth of carpet recycling facilities and of products made from recycled carpet materials, and to increase the ease of capture of post-consumer carpet. How these facilities will be financed in practice is not clear.

¹⁰ http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB1158

There is an obligation on state agencies to purchase recycled carpets from manufacturers, wholesalers or retailers who comply with the provisions of the proposed Bill. It states that from July 2019, a minimum of 35% of carpet purchased by state agencies must be recycled carpet, and this is to increase by 20% every year until it reaches 100%.

The draft Bill states the obligation of manufacturers to register with the New York State Department of Environmental Conservation ("DEC") by April 1, 2019 if the manufacturer wants to continue selling carpet in the state. Registration is effective upon filing with DEC a registration form, the carpet stewardship plan and the payment of the registration fee (\$10,000). A subsequent yearly fee of \$5,000 must also then be paid to the DEC. All fees are deposited to credit of the Environmental Regulatory Account. All surcharges and penalties raised go to the Environmental Projection Fund, with all civil penalties going to the municipality.

3.4 Illinois and Minnesota

The Illinois draft bill has no targets but requires a Stewardship Plan that is monitored through annual reporting of carpet collection provisions, recycling activity, funds used, a discussion of progress made toward achieving carpet design changes, consumer information etc.

This bill is also interesting as it includes mandatory state green procurement clause in that "at least 35% of carpet purchased by State agencies shall be carpet with post-consumer recycled content from discarded carpet and comply with the National Science Foundation/American National Standards Institute (NSF/ANSI) 140-2009 Standard on Sustainability Assessment for Carpet, Platinum Level, increasing by a rate of 10% per year until it reaches 75%."

The Minnesota legislation defines the producer as the manufacturer or the importer. There are no recycling targets, only that the Plan should include five-year performance goals and estimate the percentage of discarded carpet that will be collected, reused, and recycled during each of the first five years of the Stewardship Plan. It does not state which type of recycling it is referring to.

The Bill states that the Plan should outline carpet design changes that will be considered to reduce toxicity, water use, or energy use or to increase recycled content, recyclability, or carpet longevity. There is no mention of public procurement targets.

3.5 Summary

While the existing and proposed legislation has many good practice elements, there is a lack of consistency and various key elements missing, most notably strong drivers of:

- a rapid decrease in toxicity (to prevent future legacy chemicals issues and protect consumers' health)
- better design for durability, reuse and recyclability; and

- separate targets for reuse and closed loop recycling - or indeed any targets at all in some cases.

A swift scale-up of recyclable and non-toxic carpet is imperative since most used carpet can currently only be downcycled and the lifetime of carpet is relatively long. While downcycling can be increased quickly in the short-term, it is important to avoid downcycling lock-in; the aim should be to move to closed-loop recycling in the medium-term, where materials stay at the same quality level, making it possible to recycle it back into carpet. On the positive side, many companies already have such solutions, but they currently represent a small share of the market, which must be rapidly scaled up.

This Toolkit suggests building blocks that can help produce more comprehensive bills that will address many of the current gaps and better drive circularity in the US carpet sector.

4.0 The Stewardship Toolkit

4.1 Definitions

Un-ambiguous definitions are important in ensuring appropriate action and hence we suggest the following (based on the draft Illinois legislation):

"Carpet" means a manufactured article that is used in commercial buildings or single or multifamily residential buildings, is affixed or placed on the floor or building walking surface as a decorative or functional building interior or exterior feature, and is primarily constructed of a top visible surface of synthetic face fibers or yarns or tufts attached to a backing system derived from synthetic or natural materials. "Carpet" includes, but is not limited to, a commercial or residential broadloom carpet or modular carpet tiles, and artificial turf. "Carpet" includes a pad or underlayment used in conjunction with a carpet. "Carpet" does not include handmade rugs, area rugs, or mats.

"Producer" means a person that:

- 1) has legal ownership of the brand, brand name, or co-brand of carpet sold in this State;
- 2) imports carpet branded by a producer that meets the definition under paragraph (1) when the producer has no physical presence in the United State
- 3) if paragraphs (1) and (2) do not apply, makes unbranded carpet that is sold in this State; or
- 4) sells carpet at wholesale or retail, does not have legal ownership of the brand, and elects to fulfil the responsibilities of the producer for the product.

"Recycling" means the process by which discarded carpet is collected, processed, and returned to the economic mainstream in the form of raw materials or products. "Closed loop recycling" means recycling of materials back into carpet materials or equivalent

high quality products. "Recycling" does not include energy recovery or energy generation by means of combusting discarded carpet, and it does not include any use within the permitted boundaries of a municipal solid waste landfill unit.

"Reuse" means donating or selling a collected discarded carpet back into the market for its original intended use, when the discarded carpet retains its original purpose and performance characteristics.

"Recyclability", in the context of the suggested targets below, means readily separable materials in the context of mechanical processes, although this could involve subsequent chemical cleaning of materials and chemical processing back to monomers.

"Stewardship assessment" (SA) means the amount added to the purchase price of carpet sold in this State that is necessary to cover the cost of collecting, transporting, and processing discarded carpet by the stewardship group pursuant to a stewardship plan.

"Stewardship group" (SG) means an organization appointed by one or more producers to act as an agent on behalf of the producer to design, submit, implement, and administer a product stewardship plan under this Act.

"Stewardship plan" (SP) means a detailed plan written by a stewardship group, on behalf of one or more producers, that includes all the information required by this Act.

4.2 Mandatory Design Requirements

Minimum product requirements should be specified by the State to allow that product on the market in that State. The following minimum 'essential requirements' are suggested. These are complimented by the DfS Modulation Factors noted below under funding. It is important to note that, given the relatively long life of carpets, the elimination of hazardous substances use is very urgent if closed-loop carpet recycling is to be increased in the medium term without the risk of perpetuating the use of the legacy chemicals in the recycled materials. This is taken into account in the suggested timeline, to allow sufficient time for the market to adjust to the requirements.

Box 2: Proposed Essential (minimum) Requirements for Carpet

Hazardous Substances:

A ban on the following, in new carpets and carpet treatments (e.g. stain resistance etc. - maximum concentration limits as applied to treated carpet as fitted), by 2025, whilst maintaining safety requirements:

- All substances included under the US EPA LIST OF LIST¹¹ not to exceed 0.01% w:w concentration (100ppm) when tested in a sample of carpet.

Recycled Content:

- A minimum 20% of the plastic carpet fiber materials by weight need to be from post-consumer sources and 20% of the natural fibers from organic sources by 2022, and at least 40% by 2025.

Durability (minimum warranty):

- Carpet to be offered with a mandatory minimum all-inclusive wear and tear warranty from the producer with a period of 7 years, but with warranty claim exemptions for inappropriate use and damage.

Recyclability:

- At least 70% of the materials by weight should be readily separable and recyclable materials by 2022, increasing to at least 90% readily separable and recyclable materials by 2025.

Labelling:

- Mandatory product passport information for use by the stewardship organizations and recyclers by 2022 – including the name and contact details for the manufacturer, year of manufacture, place of manufacture, carpet composition and type of construction (face fibers, primary and secondary backing/cushioning, adhesives used etc.), and all chemical substances used.
- Mandatory Green Carpet Mark (GCM) labelling for consumers to be shown clearly at the point of sale and for consumers to take away.

Installation:

- By 2022, no use of permanent adhesives in bonding carpet to a floor so as to allow the carpet to be removed at end of life without significant damage. Clear standards and guidelines, if not mandatory regulation, should be used to ensure that carpet, including carpet tiles, can be easily removed at end of life.

¹¹ Consolidated List of Chemicals Subject to the Emergency Planning and Community Right-To-Know Act (EPCRA), Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) and Section 112(r) of the Clean Air Act

4.3 Stewardship Organizations and Registration

One or more Stewardship Group (SG) should be established and authorized by the State authorities to take on the collective responsibilities of the producers. The SG should be a type 501(c)3 non-profit organization (as defined by Internal Revenue Service (IRS)) and oversight of all stewardship arrangements should be provided by an advisory committee, with additional compliance enforcement authority and sanctions at its disposal.

Registration should be obligatory with an SG unless the producer offers take-back of carpet on the sale of a new carpet at no extra cost (at least explicitly) and complies with all other regulations (targets, design requirements etc.), in which case registration should be with the State authorities and reporting also.

4.4 Stewardship Plan

A stewardship Plan (SP) shall be produced that takes into account the following factors (4.4.1 to 4.4.6).

4.4.1 Collection and Take-Back

Collection from households (as bulky waste), businesses and designated carpet collection points (e.g. household waste recycling centers) should be free of charge to the consumer - with the collection and administration costs covered by the relevant SG or via the producer or their designated contractor where take-back is provided for; take-back being at the store or via the new carpet fitter or building contractor. Free collection should be available to 90% of the State population. Carpets should be separately collected to avoid contamination from other waste streams.

4.4.2 Reuse

Circular economy business models, including leasing and other product service models, should be promoted by the SG and its producer members, as a minimum for event carpets and tiles, to help drive demand for more durable and sustainable carpets.

As another incentive, reuse and leasing, either directly or after refurbishment, can be made exempt from the SA or other producer charges.

4.4.3 Targets

Targets would be defined in relation to the average of the previous three years of carpet placed on the market by area (ft²). The progressive targets will drive the development of infrastructure, when combined with an export ban for recovery (including recycling) outside of the US.

Table 4-1: Progressive Target Rates

% Rates	2025	2030	2035	2040
Recycling	15	35	60	75
Of which Closed-loop Recycling back into carpet	10	20	40	50
Refurbishment for Reuse	5	10	15	20
Other Recovery	30	20	10	5
Total diversion	50	65	85	100

Notes: the closed loop recycling rates (in blue) follow a lower trajectory than the overall rates to allow flexibility in finding suitable markets for the material. In one of its critiques of the CARE plan, CalRecycle argued that closed loop recycling should be prioritized as a more stable market for PCC materials than the (less environmentally beneficial) ‘downcycling’ efforts that have dominated CARE Plans submitted to date. The timeline here is ambitious but aims to allow sufficient time for the market to adjust to the requirements. The dates for the initial chemical changes are 2022; three years in advance as this matter is urgent from an indoor air quality perspective and to help facilitate higher levels of recycling. Different systems and timelines for residential, commercial and events (potentially tighter in the latter) should be considered, taking into account sector-specific challenges.

4.4.4 Treatment

The SG should ensure that the organizations charged with the collection/take-back should ensure proper traceability and treatment, within the US, in accordance with agreed ANSI standards (to be developed) so as to avoid bogus recycling, reuse and recovery.

4.4.5 Funding – Stewardship Assessment

A SA fee can be charged on all new carpet to cover the full predicted costs of free collection and proper treatment, to meet recycling and reuse targets in a given period and to provide advance funding for the SG in developing infrastructure and in covering operational costs. It should be noted that the clean-up costs associated with fly-tipping of carpets should also be covered by the scheme where possible, as well as grants to support relevant innovation. The fees should cover these costs only, as detailed in the SP, and should not include profit for the SG, although Membership Fees can be charged to cover the administrative costs of the SG.

As an alternative, the actual incurred SG costs can be charged back retrospectively on a quarterly basis to producers on a market share basis. This is better than a predictive tax for the producers potentially in the sense that actual incurred costs are charged (rather

than charges that may fall short or produce an excess), but less attractive in cash flow terms for the SG, although Membership Fees would still be charged in advance. In this instance no charges would be made for carpet where the producer provides a take-back system and ensures / evidences proper treatment – i.e. taking the individual producer responsibility route and fulfilling the same reuse and recycling rates as are set for the sector as a whole.

Any monies raised by the SG should be transferred to the state authorities, for subsequent carpet stewardship use by the state or the superseding SG, in the event that the SG ceases to trade or is not able to get its SP approved.

4.4.6 Modulated Fees

Whatever funding mechanism is used for cost recovery purposes, the fees should be 'modulated' (varied) to reflect the technical Design for Sustainability (DfS) characteristics of the carpet (when new and placed on the market) which allow or inhibit circularity. This could be done in advance in terms of the SA on the product itself or in a factored charge (in advance or retrospectively) to the producer company.

The degree of modulation needs to be substantial in absolute cost terms (i.e. in the annual impact on producers overall) to have any impact on design (as experience of modulation in France, for example, has shown in regards to textiles and furniture) and hence it is recommended that the whole fee is modulated; i.e. the charges used to cover both the costs of proper waste management (i.e. collection and reprocessing), plus any additional funding used to cover research and development grants (e.g. to investigate better infrastructure and carpet design).

It should be noted that the modulated fee approach is recommended to complement the mandatory 'essential requirements' noted above to offer an incentive to go beyond these minimum requirements (i.e. to drive innovation and faster progress) or as an alternative to mandatory design requirements to offer an incentive to drive better design.

The Modulated DfS Factor would be calculated based upon a scorecard that takes into account various criteria over and above the 'essential requirements', a comprehensive example being shown in Box 3. The DfS Modulation Factor would be used to adjust the fees on the carpet/paid by the producer as noted above. The fee modulation criteria and cost impact should be reviewed every few years (e.g. every three) to allow for market changes and to deal with any issues that have arisen in its application.

Box 3: Suggested Modulated DfS Criteria

The proposed scores are shown as a %.

- Elimination of all Sin-List Chemicals (i.e. going beyond EPA List of Lists). Yes or No – 100% or 0%
- Number of years extended warranty offered by the producer – over and above the 5 year minimum ER level and as a percentage of 25 years as a maximum (hence a 10 year warranty is 5 years extra out of a potential 20 years extra)
- Percentage of post-consumer recycled content (mechanical or chemical) in polymer fibers, and organic fibers in natural materials, over and above the minimum ER level up to 100%.
- Recyclability / reuse factors:
- Carpet type – broadloom (which is more difficult to reuse/recycle than tile designed for reuse and recycling) 0%, and tile (where it meets the ERs), 100%
- Percentage of overall carpet material weight that is readily recyclable back into the same material with no down-cycling, over and above the minimum ER % and up to 100%
- Single polymer fiber use throughout (face fiber, primary and secondary backing), score 100%
- Design for disassembly to simply release at least 90% of the face and primary backing fibers by weight – for example the use of reversible hot-melt adhesives rather than latex. Yes or No – 100% or 0%

Each of the criteria would be weighted evenly. An example is given in Table 4-2 DfS Modulation Scheme – Criteria Scoring Example.

Table 4-2 DfS Modulation Scheme – Criteria Scoring Example

Criteria	Specification	Score (out of 100)
Elimination of all Sin-List Chemicals	Yes	100
Warranty (years)	10	25 (5 years extra out of 20)
% PCR Content	20% (minimum)	0
Type	Broadloom	0
Material Recyclability	70% (minimum)	0
Single Polymer	Yes	100
Design for Disassembly	No	0

Score		225 out of a maximum 700
% Score		32% (100 x 225/700)
DfS Modulation Factor (%)		68% (100% - 32%)

Carpets intended (designed and marketed) for single and short-lived use e.g. at events as opposed to long term use in a conventional sense, would be considered as zero years of warranty.

4.5 Supporting Measures

We would recommend that the following policy tools (4.2.1 to 4.2.8) are used in combination with or part of the Stewardship Plan.

4.5.1 Mandatory segregation of carpets

Mandatory segregation of carpets during refurbishment and demolition of buildings (commercial and possibly domestic) could be required, possibly through Green demolition/renovation certification or Site Waste Management Plans (as per UK) integrating carpet segregation requirements. This could fit with wider requirements for partial deconstruction of buildings in general and the concept of “material building passes”, as in Austria, in which all recyclable materials and their specific position in buildings is noted to aid segregation and recycling.

4.5.2 Deposit Refund Schemes

Deposit return schemes (DRS) should be used to promote the high collection of short-lived carpets designed for use at events and carpet tiles so that reuse (which is more likely to result with tiles than broadloom carpet) is maximized as well as recycling.

Rather than making DRS mandatory at the outset, it could be used as an option if return rates don't meet expectations. It is worth noting that a redemption payment is far easier to arrange for a tile than a regular broadloom carpet as it can be done on a ft² or unit basis quite easily. Regular broadloom carpet would be more difficult than tiles as the carpet could potentially be rolled up or even cut into pieces making a weight-based approach necessary. This is probably impractical given that carpet is sold by the ft².

4.5.3 Product Passports

While the Green Carpet Mark (GCM - see below) is intended to inform consumers and procurement professionals in terms of their choices, more detailed information is often required by the recyclers and reuse organizations to make them more efficient and to allow them to comply with the latest chemicals restrictions.

It is recommended, therefore, that mandatory product passport information has to be provided by producers on carpets by 2022 – including the name and contact details for the manufacturer, year of manufacture, place of manufacture, full disclosure on the carpet composition and type of construction (face fibers, primary and secondary backing/cushioning, adhesives etc.), and all chemical substances used. This can also be regulated via Right to Know acts, similar to the one recently adopted in California on cleaning products.

This could be attached as a physical label with a QR code, printed at regular intervals (back stamping) or firmly attached to the carpet at the time of fitting, however this may presents difficulties because it can get damaged over time and can be forged, leaving room for counterfeits which can contaminate the material loop with hazardous substances.

Therefore, a digital information system, such as RFID+Blockchain is recommended as this more secure in the sense that it is very difficult to corrupt and provides a greater guarantee the carpet genuinely corresponds to the information logged in the material passport. Digital information can also allow automated information access and allow integration into any buildings information set. Furthermore, it can evolve to include more or different information.

In cases where a full carpet EPR bill, with all elements outlined in this toolkit, is not within reach, a first step could be to pass a bill that requires full transparency on materials and substances in the product (i.e. a 'Right to Know act').

4.5.4 Green Carpet Mark

Green product mark schemes, such as Energy Star and LEED, have demonstrated value in enabling consumers (both private citizens and businesses) to select products based on environmental performance, whilst at the same time, encouraging suppliers to invest in more environmentally responsible product design.

At present there is a complicated array of standards and labels covering different aspects of health, safety and environment including the Cradle to Cradle certification, CRI Green Label Plus, Environmental Product Declarations, Health Product Declarations and the Living Building Challenge™ Declare label. The processes are not always very transparent (in terms of category awards) and consumers are unlikely to understand the various criteria used and the pros and cons of each.

A Green Carpet Mark (GCM) could be devised to bring the key requirements together in one harmonized national standard, rather than a private standard/label, building on the existing NSF/ANSI 140 Sustainability Assessment for Carpet, using the same bronze to platinum categories but with a wider range of criteria to provide private consumers and procurement professionals with clearer information on the circularity performance and features of carpets.

This would be determined by a points-style system (similar to LEED for buildings) by using a self-assessment approach but with oversight and verification by an independent third party. Ideally the GCM would use the same set of core criteria used for the

‘essential requirements’ and modulated fees – i.e. a combination as shown in Box 4 below, and that would also be applied to State green procurement. The minimum essential requirements level, where mandated, would correspond to the bronze rating (i.e. compliance).

Box 4: Suggested Eco-Design Factors for the GCM (over and above the ERs)

- Elimination of all Sin-List Chemicals. Yes or No – 100% or 0%
- Number of years extended warranty offered by the producer – over and above the 5 year minimum ER level and as a percentage of 25 years as a maximum (hence a 10 year warranty is 5 years extra out of a potential 20 years extra)
- Percentage of post-consumer recycled content (mechanical or chemical) in polymer fibers, and organic fibers in natural materials, over and above the minimum ER level up to 100%.
- Recyclability / reuse factors:
- Carpet type – broadloom (which is more difficult to reuse/recycle than tile designed for reuse and recycling) 0%, and tile without a PVC or bitumen backing, 100%
- Percentage of overall carpet material weight that is readily recyclable back into the same material with no down-cycling, over and above the minimum ER % and up to 100%
- Single polymer fiber use throughout (face fiber, primary and secondary backing), score 100%
- Design for disassembly to simply release at least 90% of the face and primary backing fibers by weight – for example the use of reversible hot-melt adhesives rather than latex. Yes or No – 100% or 0%

Ideally the deployment of such a GCM would be mandatory, requiring all carpets to be assessed and labelled under the GCM scheme, although a voluntary approach would also be possible, for example with take-up by manufacturers being driven by GPP. Note that the eco-modulated fee criteria are linked to the GCM criteria for efficiency reasons.

4.5.5 Green Public Procurement

Green Public Procurement (GPP) offers significant potential to drive demand for products and CE business models with better environmental performance. The voluntary uptake of GPP limits its potential to impact on the sector, with a need for more binding objectives to ensure a more widespread adoption across the public sector.

GPP for carpets should therefore be made mandatory, with any State requirements for carpet based on the same core criteria set as described for the GCM above, and additionally requiring ‘no-adhesive installation’. Carpet tile leasing should also be made the default option, with a case having to be made not to do so and in the context of whole-life-costing. GPP requirements could be linked to the GCM directly, offering

procurement professionals a simple means to specify 'green' carpet; e.g. requiring a minimum of a Gold rating for example.

Box 5: Green Public Procurement in San Francisco

In March 2018, the City & County of San Francisco adopted a comprehensive new regulation requiring that all carpet installed in city-funded construction projects be Cradle to Cradle Certified™ Silver (i.e. mid-scale below Gold and Platinum) or better the aim being to help San Francisco address its priorities for sustainability and material health in its flooring. The resulting regulation also limits flooring purchases to carpet tiles given that they are easily replaceable and help minimize waste. In addition to C2C certification, carpet tiles must also have a CRI Green Label Plus certification, an Environmental Product Declaration®, and a compliant Health Product Declaration at 1,000 ppm or a Living Building Challenge™ Declare label. Furthermore, products must not contain intentionally added antimicrobials, flame retardant chemicals, or highly fluorinated compounds. At this time, only a small number of brands (Shaw Contract, Patcraft and Tandus), have product available that meet the requirements. Similar rigor was used to determine the minimum requirements for the adhesives used.

4.5.6 Infrastructure Support

The infrastructure required to meet the expected increase in carpet recycling needs to be developed, including collection and treatment facilities, and this will be costly. The capital cost of this infrastructure (as well as the actual operational costs of collection and recycling) can be recouped through fees and unclaimed Deposits (from DRS where applied). Additional State funding may also be necessary in the way of grants and low interest loans from governments and green investors to support the infrastructure development in advance of the Stewardship scheme operation.

4.5.7 Innovation Support

A wide range of innovation and investment in both carpet design and manufacture will be required to meet the objectives of a truly circular carpet sector and respond to the eco-design incentives noted above. Innovation support and grant/low-interest loan schemes, such as those provided in parts of Europe, can all play a helpful role in accelerating change. Ideally this should be supported through an element of the Stewardship fees. This innovation support could be combined with other business tax incentives for CE carpet companies.

4.5.8 Education and Outreach

Education and outreach activities, including clear guidance and awareness raising around the mandatory and voluntary aspects of any state bill, should be provided on an ongoing and reasonably regular basis for private consumers, public sector procurers and users and businesses including manufacturers, importers/brand owners, retailers and commercial building owners. This activity should be detailed as part of the Stewardship Plan for approval by the state authorities and should include:

- Awareness raising, including state-wide public communication campaigns, around the need to reuse and recycle carpet where possible and the means available in the state to do that.
- Awareness raising, including state-wide public communication campaigns, around selecting more sustainable carpet and the appropriate use of the Green Carpet Mark.
- Outreach, for example written guidance and webinars, with public procurement professionals, including guidance around the use of the GCM and GPP in leasing and purchasing carpet.
- Outreach, for example written guidance and webinars, with business stakeholders, including producers and users of carpet.

The full communications program should be set out in the Stewardship Plan and an evaluation undertaken on an annual basis to assess and report on the effectiveness of the education and outreach activities and to refine the program in subsequent years.

4.5.9 Enforcement and Fines

Strong enforcement provisions are key. As communicated by CalRecycle in a recent [document on the Carpet Stewardship Program](#) in CA, the threat of fines for non-compliance should be explicit and the fines substantial. For example, the recently passed pharmaceutical and sharps EPR law in CA, SB 212, included fines of \$50,000 per each day for non-compliance in order to provide enough incentive for producers to comply.

APPENDICES

A.1.0 Current Carpet Circularity Issues

A.1.1 The US Carpet Market

The US carpet market is the biggest in the world. The United States imported carpet valued at \$600 million from Europe in 2016, mainly from Turkey (valued at \$267M) and Belgium (\$95M).

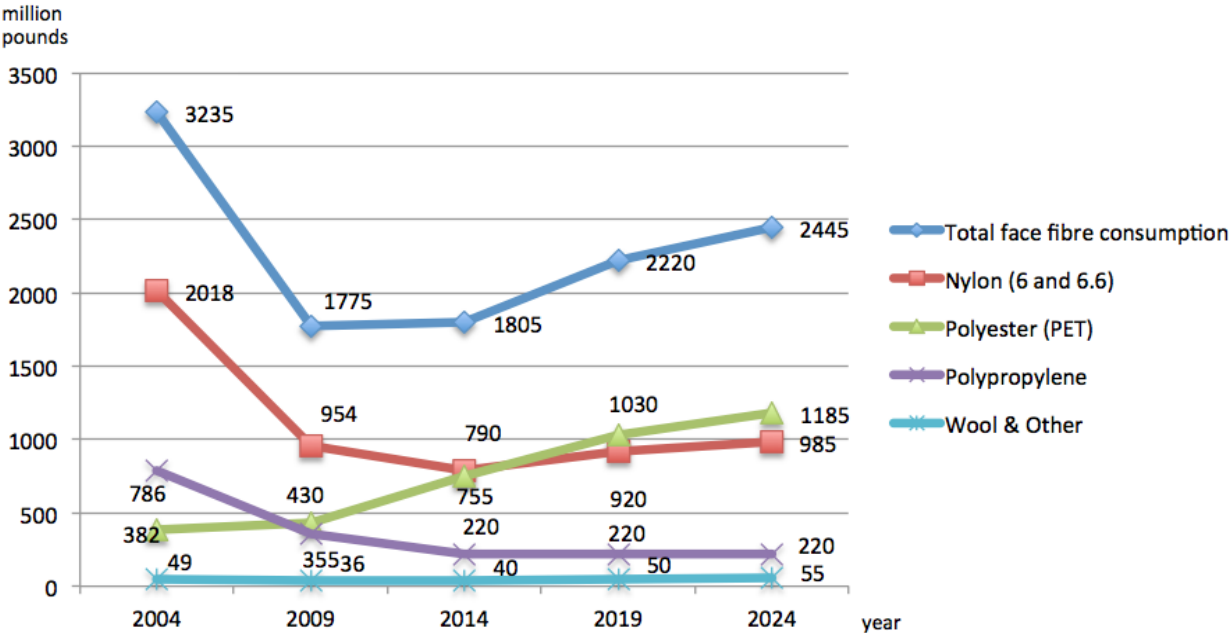
Carpets come in a wide range of different types. Roughly these product types can be split into 3 main groups: loose laid rugs, wall-to-wall floor coverings (residential and commercial, including events) and non-flooring applications (e.g. automotive, outdoor sport fields and landscaping). The study focus is on the second one of these, which represents textile floor coverings. Every type of face fiber has different quality characteristics and is hence used to satisfy different preferences or to meet different performance requirements (wear resistance, inflammability, softness; vehicles, hotel rooms, offices, living rooms etc.). Sometimes different fibers are mixed in order to create specific properties for the carpet.

Carpets can be produced in various ways but primarily woven on a loom, 'tufted' through a primary backing or made using a needle felting (fiber entanglement) approach. In addition, they can be made in the form of broadloom (i.e. a wide carpet), carpet tiles and vehicle carpet (often molded to shape). Most carpets are tufted (around 80%) and the share of carpet tiles is constantly on the rise (Checalier 2016). Tufted pile yarns can be made from wool, nylon, polyester or polypropylene and are usually made with a polypropylene primary backing and then locked in place using a synthetic rubber-based latex adhesive. Chalk is also added to the backing to provide weight and stability. In some cases, it is thought that fly-ash has also been added as a filler material¹².

The fibers used are mainly polymer based, i.e. plastic. The demand for face fiber (for carpets and rugs) in the US is predicted to develop as shown in the figure below.

¹² In the US at least - <https://healthybuilding.net/uploads/files/eliminating-toxics-in-carpet-lessons-for-the-future-of-recycling.pdf>

Figure A-1: Development of US face fiber demand for carpets and rugs from 2004-2024 (The Freedonia Group, Inc. 2015b)



Nylon carpet fibers, while less expensive than wool, are the most expensive fibers compared to other artificial fibers like polypropylene (PP – more widely used in the EU) and polyester (PET – widely used in the US). In comparison to polyester (PET) fibers, nylon can be three times as costly. Nylon is durable and can easily withstand wear and tear and although hygroscopic it is less absorbent than wool. Nylon fibers can be dyed after production in almost any color. These preferable characteristics, however, still make it a well-used fiber despite the cost. In the US it accounted for 43.8% of the fiber consumption in 2014, followed by PET fibers (41.8%) (The Freedonia Group, Inc. 2015b).

The majority of polyester carpet face fibers are made from PET, which are the second most used fiber in the US and will soon overtake the share of nylon. This is more true for the US than for Europe (Vankann 2016). Because PET face fiber is mostly made from recycled bottles, PET carpets are seen as environmentally friendly, although it is not clear if it is better or worse from an LCA perspective to recycle bottle to bottle rather than bottle to carpet. The latter could be regarded as downcycling. In the US it is expected that PET fibers will continue to be less expensive than PP fibers whilst offering good performance and aesthetic properties, leading to a further decrease of the PP market

share in the US (The Freedonia Group, Inc. 2015b). The EU market, however, remains dominated by PP and nylon use¹³.

Polyester carpet fibers can also be formulated from polytrimethylene terephthalate (PTT). These fibers are often presented as environmentally friendly materials, as they contain plant-based material and are suggested as having a lower carbon footprint, although this is sometimes disputed depending on what is taken into account. Dow Sorona® EP contains 20% to 37% renewable material from non-food biomass, and has performance similar to conventional PBT plastics according to Dow. PTT fibers are generally also stain resistant and have consistent colorfastness properties. However, PTT fibers can cause problems in recycling systems set up to deal with mainstream polymers and hence are likely to be down-cycled (The Freedonia Group, Inc. 2015b). Caprolactam, which is used as a monomer in PA6 (nylon), can also be produced from biomass¹⁴.

A.1.2 Main recycling processes

A.1.2.1 Mechanical Recycling

Mechanical recycling includes a range of techniques including dry systems that essentially aim to shred and hammer materials to separate fibers from the adhesives and release filler materials. This results in low grade mixed material for equestrian surfaces, carpet underlay and secondary backing etc. Dry/wet systems start with a dry stage (as described above) and then have a wet stage to help to separate different polymers to high levels of purity (95% pure nylon face fiber from PP backing is reported for example). This is still a capital intensive solution although one employed in the US and possibly the EU. It seems that Northcoast Fibers in the US are working on more affordable means for recycling PET and PP carpets, although the technology is not known at present. The recovered polymer fibers can then be processed further by plastics processors who will wash and extrude to make new plastic pellets and yarn.

In terms of carpet tiles, bitumen backing, as still used in some cases, creates specific problems for recycling as the bitumen melts during reprocessing. However bespoke recovery processes by carpet tile manufacturers, such as Desso Refinity®, have been developed to recover nylon pile yarns as well as the bitumen content.

¹³ Carpet Recycling UK Conference 2016

¹⁴ <http://www.chemengonline.com/bio-based-caprolactam-joint-development-project-now-underway/?printmode=1>

A.1.2.2 Shearing Systems

Shearing systems cut the face fiber off the backing material in a machine. The purity of the material is consequently very high (around 99%) where there is only one face fiber being used. The equipment is relatively cheap and unsophisticated and can be deployed locally. The down side is that the material yield is only 30% to 40% by weight, leaving the backing material as a carcass that can only be used for down-cycling or landfill. Much of this weight is actually chalk filler (calcium carbonate) and latex.

A.1.2.3 Chemical Depolymerisation

Depolymerization (chemical recycling) is used for the general decomposition of mixed used plastics and is used for the depolymerization of nylon 6 carpet to allow new nylon 6 to be made from the resulting pure monomers, as in virgin nylon processing. This approach is very capital intensive and uses large amounts of energy and chemicals and of course results in some residues, but produces pure nylon 6 that has a relatively high value compared to other processing techniques. The Aquafil plant in Slovenia is now perhaps the largest global facility (the US Evergreen site in Augusta having closed) and cost €25m in 2011.

A.1.2.4 Chemical Washing

It is important to also note the potential of chemical cleaning as a stage before chemical recycling. In the food industry, the cleaning with critical CO₂ has been well established (over 80 yrs) and ING-PUM (www.ing-pum.de) holds a patent in the same technique for synthetic polymers. This method can handle mixtures (i.e. 96% PA6 + 3% PA 6.6. + 1% unknown) and can remove additives and even color (pigment). Ioniqa (<http://www.ioniqa.com/>) applies a different method (ion-exchange) to clean PET (they can only process PET at this point).

From an energy efficiency point of view, it may be helpful to clean polymer streams and resell them at this point rather than breaking them down to the monomer level and subsequently putting them back together as a polymer. ING-PUM is already operational, as is Ioniqa, though not yet applied to harvest secondary raw material from end-of-life carpets. A current Horizon2020 project is scaling an industrial pilot for the chemical recycling of PET (see <https://www.demeto.eu/project>).

A.1.2.5 Dyeing

It is worth noting also that PP fibers must be dyed during fiber production (when the polymer is still in its molten state) unlike nylon fibers, which can be dyed after fiber production. Similarly, recycled PET is also not free of color and PET face fiber carpets cannot be printed on. The fiber, therefore, needs to be colored prior to the carpet production. Compared to Nylon, which can be recolored quite easily, recycled PP and

PET fibers cannot and, since color sorting of fibers is technically challenging, are less useable as mixed colour fibres.

A.1.3 Barriers to Circularity

Several key barriers have been identified with regard to carpet circularity:

- Key area 1: A lack of design drivers to facilitate reuse, refurbishment or recycling of carpets. Simple single polymer and more readily-separated designs are necessary to keep recycling costs down and increase material yields. While some manufacturers do have recyclable designs, these products represent a small market share and concrete and enforceable product requirements are still lacking at the national level.
- Key area 2: Economic barriers and uncertainty. Recovery of plastics, even in the down-cycling sense, from carpets is a complex process that can be very costly. Closed loop recycling requires very high levels of investment and yet the value of the resulting material may be less than the cost of the reprocessing, especially when the oil price is low. Clearly reflecting the environmental externalities in the price of virgin material would be helpful in this sense.
- Key area 3: A lack of cost effective collection, sorting and reprocessing methods. Better methods are required that maintain product integrity (e.g. not being bonded to a floor), segregation, minimise contamination and maximise yield recovery at a reasonable operational cost.
- Key area 4: Traceability and toxicity. Carpets can contain a wide range of materials and legacy chemicals (potentially from decades ago) that would be prohibited under REACH in many products today. Not knowing what materials are present, for example in terms of fibre types and chemicals, limits the potential to recycle or even down-cycle the fibres and other materials.
- Key area 5: Lack of producer responsibility for carpets and resulting waste streams. An EPR system would mandate carpet recycling and drive better design to reduce toxicity and recycling costs.

A.1.4 Hazardous Substance Issues

The recent Anthesis report¹⁵ for Changing Markets has identified a list of 59+ toxic substances used in carpets sold on the EU market. Healthy Building Network (HBN) has also identified similar issues in the US¹⁶. The list of substances includes phthalates,

¹⁵ Toxics in Carpets in the European Union, Anthesis, March 2018

¹⁶ Eliminating Toxics in Carpet: Lessons for the Future of Recycling. Healthy Buildings Network, October 2017

perfluorinated compounds (PFASs), azo dyes, isocyanates, flame retardants, anti-microbials and toxic heavy metals. Based on the research, it appears that many of the chemicals found in carpets may volatilize and/or migrate from carpets through typical use and abrasion of carpet as well as adhere to dust – making dermal, inhalation, and ingestion exposure to their toxic effects all possible. Some of the toxic effects of the chemicals of concern identified in this report include carcinogenicity, mutagenicity, reproductive toxicity, and endocrine disruption just to name a few.

Moreover, children are particularly vulnerable to these toxic chemicals, particularly during critical stages in their physical and cognitive development. Of the 59 substances identified in the report, 37 are not restricted or banned for their use in carpet or carpet materials. Additionally, many of the certifications that monitor chemicals in carpets do not currently ban or restrict the chemicals of concern in this report either. For example, the GUT label only bans or restricts 13 out of the 59 identified chemicals of concern.

There are ‘hidden costs’ associated with the use and exposure to chemicals of identified in this report. Health care costs and lost earnings linked to the exposure to endocrine disruptors is estimated to be €163 billion each year in the EU¹⁷. There are also hidden costs associated with environmental contamination such as necessary infrastructure for clean-up. Industry is therefore often not responsive to the true costs associated with toxic chemicals and/or the products they create and these costs typically are passed onto tax payers.

A.1.5 What Constitutes Good Eco-Design?

What can be considered ‘good’ eco-design is to a degree subjective with various trade-offs to consider in life cycle impact terms. The following sections, however, set out what can generally be regarded as good practice in most circumstances in terms of reducing overall environmental and health impacts. This understanding is important in terms of setting eco-design criteria and modulating EPR fees.

A.1.5.1 Sustainable materials and low toxicity

Low toxicity and use of sustainable/low-impact materials is an important part of eco-design and essentially includes consideration of:

- Zero known hazardous substances and substances of very high concern (SVHCs)
- Natural low-impact materials – e.g. wool, jute and sisal – where hazardous chemicals have not be used in treatments

¹⁷ Andrology. 2016 July ; 4(4): 565–572. doi:10.1111/andr.12178

Burden of disease and costs of exposure to endocrine disrupting chemicals in the European Union: an updated analysis

- Recycled plastic content (where legacy toxins can be eliminated); and potentially
- Bio-based materials (although this is debatable – see below)

A.1.5.2 Hazardous substances

The hazardous substances remain of great concern as noted in Section 5, and the 59 chemicals of concern identified in the Anthesis report should be restricted and/or banned to ensure consumer safety, environmental protection and facilitate the circular economy. One approach would be to ban all SVHCs on the REACH Candidate List, or to move only to chemicals that are not on the more extensive SIN List: <http://chemsec.org/business-tool/sin-list/>. The SIN List has been devised by chemists to help speed up the process of identifying SVHCs before they are classified as such and placed on the Candidate List. Substitution of chemicals is a complex task and it would be helpful for member states to start driving the development of solutions ahead of EU legislation under REACH.

It is worth noting that nylon does not need an anti-stain coating, being inherently quite easy to clean, which may help reduce the use of chemicals overall. Plastic carpets also don't need moth-proofing. Conversely, wool doesn't need a flame retardant (being naturally flame resistant) but does need stain protection and moth-proofing but to process wool (and remove grease) some chemical treatment are also used. There is therefore no simple answer in terms of which materials may be preferable in hazardous substance terms.

It is also worth noting that less hazardous flame retardants have already been developed and are in use. For example, the Healthy Building Network report¹⁸ notes that . “Most of the carpet industry has successfully flame retarded their carpets with alumina trihydrate or other non-hazardous options. “Germany’s Blue Angel ecolabel for carpets identifies many low hazard options: “To the extent as required by fire protection regulations inorganic ammonium phosphates (diammonium phosphate, ammonium polyphosphate etc.), other dehydrating minerals (aluminum hydrate or the like) or expandable graphite may be used as flame retardants. Antimony oxides shall not be used as flame retardants.”

A.1.5.3 Recycled and bio-based materials

It is worth noting that several companies are already making use of recycled content (not necessarily closed loop, carpet to carpet), including Interface, Desso, Balta and other brands that use the Econyl recycled content from Aquafil. Desso, for example, produces

¹⁸ Eliminating Toxics in Carpet: Lessons for the Future of Recycling. Healthy Buildings Network, Oct 2017

the Refinity closed loop tile and Ecobase tiles, while Forbo Flooring in the UK also uses recycled content in tiles.

In terms of bio-based materials, Jabro SmartStrand uses 37% Dow bio-polymers (PTT), Balta also has the Amaize product-line, made from corn using DuPont Sorona (<https://www.amaize.eu/en/amazingly/sustainable>) and although they claim reduced carbon footprint for the material inputs, the presence of this mixed with synthetic polymers will seriously inhibit end-of-life recycling. Bio-based materials are also no guarantee of non-toxicity as they can equally become toxic due to the use of hazardous additives.

A.1.5.4 A Life Cycle Analysis perspective on fibers

There is no specific Life Cycle Analysis (LCA) benchmark for carpet materials per se but it is perhaps useful to consider LCA analysis for fibers where used in another application, textiles. The Made-By Index for textile fibers is one guide¹⁹, using LCA to identify fiber categories, A (best) to E (worst). Green House Gas emissions, Eco Toxicity and Human Toxicity are allocated a weight of 20% while the remaining parameters are given a weight of 13.33% - Energy, Water and Land Use. The benchmark takes into account the production process of natural fibers and man-made fibers but not the later processing stages or indeed end of life impacts.

In this analysis materials with high recycled content (mechanically and chemically recycled nylon and polyester/PET) score highly (A or B class) as do materials made of organic materials as may be expected, although it is important to note that the potential of hazardous legacy chemicals is not considered in terms of the former. Natural materials such as conventional virgin wool and cotton do not come out well in this analysis, although the durability of wool is not taken into account. One problem with natural fibers is that they are difficult to recycle, since the fibers break down and get shorter and shorter with each cycle. This is why typically wool can only be recycled into felt.

A.1.5.5 Durability

Circularity essentially requires life extension of materials and is therefore about durability as well as reuse and recycling. The general life span of a carpet is about 5 to 15

¹⁹ Made-By is an independent not for profit organisation working in the fashion industry: <http://www.made-by.org/consultancy/tools/environmental/>

years²⁰; depending on the material, the density of pile, carpet design and use intensity, excluding factors like damage, change of taste or change of the facility's owner or usage.

In terms of construction, woven carpets can be very strong and hardwearing, hence their use in airports, hotels and cruise ships worldwide. Loop pile (where the fiber shows as a loop on top) is more hard-wearing than cut pile (where the loop is cut and tuft end exposed). Twist pile, where two fibers of the same or different colors are twisted together also offers greater durability (but complicates recycling where different fiber types are used). Dark and mixed color carpets and those with random patterns are less likely to be ruined by small stains, also extending life.

Carpets also need to be as color fast and stain resistant as possible and are often treated with a UV resistant and stain preventative treatment. Clearly this can result in legacy chemical impacts as discussed previously (see 4.0). Regarding color fastness and stain resistance, technologies are being developed with nano-materials and the possible health impacts of these are not known (nano-particles being able to pass through a human cell membrane – see <http://www.centi.pt/>).

Wool and nylon carpets are the most hard-wearing carpets (they can be used for 15 years or more with regular cleaning) but also the most expensive. Polypropylene fiber (PP), offers end users qualities like low weight, colorfastness and resistance to moisture and staining. While quite hard-wearing, PP fibers are not as durable as nylon or polyester fibers, which makes them unsuitable for certain applications, such as extreme heavy-traffic commercial settings. Pure PP is often used in low wear areas such as bedrooms but would be less suitable for hallways which get more wear. Here a wool / PP blend may be used, typically 80% wool and 20% PP or other synthetic fiber, although this type of mixture is likely to inhibit recycling.

Pure wool and pure nylon tend only to be used in luxury and commercial applications in the EU. Sisal or Sea grass are also used for high quality carpets. Commercial carpets are, however, nearly always made of nylon and typically designed to last at least 7 years.

A.1.5.6 Reuse

Carpet reuse can eliminate the environmental impacts associated with new carpet manufacture, but reuse at scale is restricted due to the fact that broadloom carpet is generally fitted to a particular size and shape of room and hence any reuse requires fitting to a room of a smaller dimension. While reuse of broadloom carpet is therefore problematic to organize on a large scale, reuse of carpet tiles is far simpler as they can

²⁰ The UK Tenancy Deposit Scheme A guide to product lifespans, August 2017, suggests - Low quality – two to four years Medium quality – five to eight years Top quality – eight to fifteen years.

be more flexibly re-deployed. There are a wide range of case studies²¹²²²³²⁴²⁵²⁶ in the UK and elsewhere, Interface being one of the best-known examples. There are also good reuse opportunities in events carpeting although reuse appears to be rare.

The Interface TacTile no-glue installation carpet tile is an important contributor to allowing reuse since carpet tiles are not stuck to the floor and hence are not damaged in removing them. It's interesting to note that the company's "Evergreen Lease" program (for business), where Interface retained ownership of its carpet in customers' facilities, maintaining and reclaiming the tiles as necessary, was not a great success. This is reportedly the result, in part, of having to get customers to move floorcoverings over from capital (i.e. procurement) to operating budgets – which are generally different budget holders. The company still offers a free take back program however.

A.1.5.7 Recyclability

The recyclability largely comes down to the design of the carpet to maximize the technical feasibility of fiber recovery at minimum cost and to produce fibers that are clean and have a strong secondary market so that the economics add-up overall. This in turn means:

- Single polymer design – face fibers and backing
- Easily separable face fibers and primary backing (the woven matrix) from secondary backing (the adhesive and filler part)
- Use of materials for which closed loop recycling is possible
- Information on the composition (materials and additives)
- Elimination of hazardous substances
- Easy installation and removal methods (without the use of permanent adhesives)

Through the use of single polymers and/or more easily separable primary and secondary backing, and the elimination of hazardous chemicals, closed-loop recycling would become far more feasible (e.g. face fiber to face fiber or other high-value material). Due

²¹ http://www.wrap.org.uk/sites/files/wrap/Non-clothing%20textiles%20report%20summary_0.pdf

²² http://www.carpetrecyclinguk.com/downloads/Anglo_Social_Carpet_Tile_Reuse_Case_Study.pdf

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http://www.carpetrecyclinguk.com/downloads/Carpet_Tile_Recycling_Carpet_Tile_Reuse_Case_Study.pdf

²⁴ http://www.carpetrecyclinguk.com/downloads/Greenstream_Flooring_CIC_Carpet_Tile_Reuse_Case_Study.pdf

²⁵ http://www.carpetrecyclinguk.com/downloads/Spruce_Carpets_Carpet_Tile_Reuse_Case_Study.pdf

²⁶ <http://www.wrap.org.uk/sites/files/wrap/Collection%20of%20carpet%20tiles%20from%20businesses%20by%20reprocessor.pdf>

to the long-life span of carpets, the decisions made today influence the recyclability of textile flooring in 5 to 15 years. In order to enhance the recyclability of carpets it is important to change the design and production standards now and to identify this new generation of carpets through use of appropriate tagging and information provision. A mandatory Product Information System (e.g. with an RFID-chip+Blockchain encryption) would allow 100% traceability of the materials present to assist recyclers.

Some single polymer carpets already exist. Reeds Carpets (UK)²⁷ make 100% PP carpets for trade events and exhibitions without a secondary backing and take this back and recycle it, although they are not thought to reuse the carpets. Other event carpets are mostly disposed of to landfill or incineration after a very short use-phase (they are effectively disposable). Reed's single polymer approach allows fiber recycling. More generally, Niaga Mono is single polymer (<https://www.dsm-niaga.com/carpet/technology.html>), the Mohawk Everstrand Carpet claims to be engineered from one type of recycled PET (and can also be recycled²⁸) while the Mohawk Air.O, an entirely PET-based carpet, is also latex and VOC free, with a built in cushioning, and claimed to be fully recyclable²⁹.

Another major issue is that the backing is not made only of pure materials but is mixed with fillers. The backing and fillers are not meant to be separable and are generally bonded with latex. Some companies, including DSM – Niaga are now looking at means of reversible (heat-based) separation of the primary from the secondary backing (this may be through the use of a reversible heat melt as the adhesive.)

Carpet tile backings in the UK are still often bitumen based, with a minority being PVC and manufacturers are developing new types of tile backings to improve recyclability. Examples of this include Desso Ecobase[®], which uses a non-PVC, non-bitumen polymeric backing to increase recyclability³⁰.

²⁷ <http://www.reeds-carpets.co.uk/services/recycling/>

²⁸ <https://www.mohawkflooring.com/carpet/brand/everstrand>

²⁹ <http://www.floordaily.net/floorfocus/mohawk-introduces-airo-100-recyclable-easy-to-install-floorcovering-jan-2017>

³⁰ Guidance on re-use and recycling of used carpets and environmental considerations for specifying new carpet