Technical Tools and Approaches in the Design of Sustainable Plastics
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**FOREWORD**

This report was prepared as a background document for the “Global Forum on Environment focusing on Plastics in the Circular Economy – Sustainable Design of Plastics from a Chemicals Perspective” that took place on 29-31 May 2018 in Copenhagen, Denmark.

The workshop was organised in co-operation between the OECD Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology (Joint Meeting) and Working Party on Resource Productivity and Waste (WPRPW), and was hosted by the Danish Government, with funding from the European Commission, Nordic Council of Ministers, Austria (Federal Ministry for Sustainability and Tourism), Germany (Federal Ministry of Environment, Nature Conservation and Nuclear Safety) and Belgium (Public Waste Management Agency of Flanders).

An expert group was formed from delegates nominated by the Joint Meeting and the WPRPW to inform the organising of the workshop in collaboration with the OECD secretariat and representatives within the Danish Government.

The document was drafted by ABT Associates and was revised following the feedback received at the Global Forum and from Delegates after the workshop. Eeva Leinala and Peter Börkey of the OECD Secretariat provided substantive inputs and guidance. The report is published under the responsibility of the Joint Meeting of the Chemicals Committee and the Working Party on Chemicals, Pesticides and Biotechnology of the OECD.
EXECUTIVE SUMMARY

The goal of this report is to identify and evaluate technical tools and approaches that support sustainable plastics design and identify key gaps that need to be addressed. By considering the importance of sound chemical management and the life-cycle during the design stage, plastic manufacturers can develop sustainable products that influence the overall environmental and health impacts from chemicals at various stages including the material resourcing, product manufacture, product use, and end-of-life. In order to address the challenges of chemical selection and substituting alternatives, several organizations have developed technical tools and approaches to assist in designing sustainable plastics.

Tools and approaches that are related to polymer and chemical selection at the design stage of the plastic product were identified for analysis. A common set of ten attributes were developed that provide users with a quick understanding of the tool or approach’s capabilities, what stage(s) of the product life cycle is addressed, and potential weaknesses or gaps among the tools and approaches.

The eighteen tools and approaches identified were grouped into three categories: Reports, Guides & Certifications, Interactive Tools, and Initiatives and Consultations. The report summarizes the tools and approaches based on the selected attributes. The resulting analysis and summary tables are included in Section 3 of this report.

In addition, the report identifies and briefly summarizes tools that were not specifically designed to address sustainable plastics design but may be useful in conjunction with other approaches. These tools include life-cycle analysis (LCA), eco-profiles, industry-developed materials selection software, authoritative lists, and eco-labels.

Based on the results of the analysis, a gap analysis of the eighteen tools was conducted (Section 4). The following gaps were identified among the eighteen tools and approaches: frequency of updates, stage of the life cycle addressed, access to interactive tools, lack of references to other tools, and variety of plastic product categories described in tools.

The final section of this report (Section 5) includes recommendations for ways that OECD can address these gaps in an effort to advance the field. These included: identifying plastic product categories not currently addressed by tools that may benefit from specific sustainability guidance; further analysing the tools through alignment with criteria for sustainable plastics design; developing an online centralized repository or “toolbox” of tools and resources related to the design of sustainable plastics; and, building upon the summaries of tools and approaches in this report by conducting more in-depth evaluations that can inform specific areas of tool development.
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TECHNICAL TOOLS AND APPROACHES IN THE DESIGN OF SUSTAINABLE PLASTICS
1. BACKGROUND

Sustainable chemistry is the scientific practice of increasing the efficiency with which natural resources are used in development of chemical products and services. Sustainable chemistry encourages manufacturers to make design choices that, for example, reduce waste, increase energy efficiency, and are safer for users and the environment (OECD, 2018b). An important factor of sustainable chemistry is the practice of “green chemistry.” The 12 principles of green chemistry, developed by Paul Anastas and John Warner, include prevention, atom economy, designing safer chemicals, design for energy efficiency, and design for degradation (Anastas & Warner, 1998).

Sustainable plastic design is often considered in the context of the life-cycle or circular economy. Life-cycle thinking takes into account hazard, exposure, and energy use at all points of the product’s life-cycle: raw material extraction, product manufacturing, product use, and end-of-life management. The circular economy is a similar concept in product design that aims to maximize the value of raw materials and extend product use.

The plastics industry provides significant opportunity for sustainability chemistry given the ubiquity of plastics in everyday life. From a chemicals perspective, there is increasing awareness of the potential impact of chemical components of plastic (both polymers and additives) on human health and the environment. Humans can be exposed to plastic additives through dust, in toys, or through food contact materials. In addition, there is concern that plastics may cause long-term environmental contamination due to bioaccumulation and persistence.

By considering the importance of sound chemical management and the life-cycle during the design stage, plastic manufacturers can develop sustainable products that influence the overall environmental and health impacts from chemicals at various stages including the material resourcing, product manufacture, product use, and end-of-life. However, because of the complex nature of plastics, there are several challenges with sustainable design. In particular, at the end-of-life stage, as the level of complexity of the plastic product increases (e.g., different material types, additives, and multi-layer materials), the recyclability decreases due to the difficulty to efficiently separate material streams. The presence of certain hazardous chemicals can also limit the types of products for which recycled plastic material can be used. Considering plastic product design, especially assessing the chemicals used in production, can minimize environmental and health impacts of chemicals throughout the entire life cycle.

In order to address the challenges of chemical selection and substituting alternatives, several organizations have developed technical tools and approaches to assist in designing sustainable plastics.
2. METHODOLOGY

This report identifies and summarizes tools and approaches that are related to polymer and chemical selection at the design stage of plastic products. Two main criteria were used in identifying tools: (1) the tools must contain at least a section or module specific to plastics and address sustainable design, and (2) the tools must either address polymer and chemical selection at the design phase or non-chemical design choices that can increase length of use or recyclability.

Potential tools were identified through literature searches, web searches, and stakeholder recommendations. Tools meeting the criteria described above were included in this report. This report does not aim to comprehensively capture all relevant tools, nor rate or rank the tools in terms of their usefulness or design. The tools included in this report likely only represent a sample of what is available. This report is intended as a starting point in capturing relevant tools and resources that can assist practitioners in designing sustainable plastics, as well as identifying areas that would benefit from further tool development.

This report divides each of the tools into three categories: Reports, Guides & Certificates (Section 3.1), Interactive Tools (Section 3.2), and Initiatives and Consultations (Section 3.3).

In order to better understand the tools and approaches, their capabilities, and the resulting gaps among available tools, each tool was summarized using a common set of attributes. The selected attributes aim to provide users with a quick understanding of the tool’s capabilities, what stage of the life cycle is addressed, and potential gaps among the tools. Each attribute is assessed using publicly available information, such as methodology documentation, reports, and online tool descriptions. The analysis provided in this report is not based on using or applying the tools in the context of plastics design, nor an in-depth assessment of the tool’s usability and functionality.

In some cases with limited available information, especially for tools requiring paid subscriptions, the tool’s attributes are summarized to the extent possible with publicly accessible information.

The following attributes were analyzed for each identified tool and approach:

- Type of tool: Is the tool a technical on-line resource, a guide, a consultation, or another type?
- Tool purpose/goal: What is the primary problem that the tool attempts to resolve?
- Description of tool: What additional information or methodology does the tool incorporate?
- User input/output (for interactive tools only): For tools that evaluate chemicals or polymers based on data, what are the inputs? What does the tool output?
- Data transparency: Is the tool’s methodology documented and available to the public? Does the tool provide the data inputs or sources used? How are data gaps addressed?
- Tool update frequency: When was this tool initially published or released? How frequently are the data and methods associated with the tool updated?
- Level of expertise needed to use tool: What is the target audience for the tool, and what level of experience does a plastic designer need?
- Stage(s) of life cycle addressed by tool/approach: How does the tool address the life cycle, including raw material extraction, materials processing, product design, product manufacturing, product use, and end-of-life.
- Product design capabilities: does the tool include a material selection guide, and if so, what factors are considered (cost, technical performance, human health and environmental hazards, other sustainability endpoints)? Does the tool assist in considering alternative or new polymers and additives?
- Accessibility: Is this tool free to use, or does it require a subscription? Alternatively, is the tool only available to a certain group of users?

The report also identifies tools that may be useful in sustainable plastics design but do not have a specific focus on plastics. Section 3.4 includes examples of tools developed by businesses and industry associations that can assist in plastics material selection, and Section 3.5 includes examples of LCA software, eco-profiles, eco-labels, and hazardous chemical lists that are relevant to sustainable design. These tools are not evaluated based on the set of attributes but several examples are included with short summaries.

After summarizing tools in Section 3, the report identifies potential gaps that exist among the tools (Section 4) and recommends possible activities that the OECD could develop to move this field forward (Section 5).
3. SUMMARY OF TECHNICAL TOOLS AND APPROACHES

This section contains a systematic categorization and summary of tools and approaches. All tools and approaches are specific to sustainable design for plastics and aim to support product designers in their decision making about the selection of substances, material composition, and other design choices.

3.1. Reports, Guides & Certifications

This category of tools includes reports, guides, certifications and other documents that can assist in sustainable plastics design. These resources include material assessments based on hazard or other factors such as recyclability, guidance for sustainable plastics design, and design standards. These tools often provide methodologies for sustainable plastics design, including chemical rankings and other material assessment strategies.
### Table 3.1. Plastics Scorecard: Report Tool

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Clean Production Action (United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The Plastics Scorecard was designed to help purchasers choose safer plastics and help manufacturers reduce chemicals of concern.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>The report includes appendices with chemical hazards, health hazard ratings and GreenScreen® assessments that are used in scoring the chemical inputs.</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>Version 1.0 of the Plastics Scorecard was published in 2014. There is no announced date for Version 2.0.</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>The Plastics Scorecard is designed for anyone interested in identifying and selecting plastics that are inherently less hazardous, thus requiring a low level of expertise. The tool’s criteria for evaluating plastics can be valuable for more knowledgeable users, such as product designers.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>The Plastics Scorecard evaluates and categorizes plastic products based on environmental benchmarks for 1) feedstock production, 2) chemical and plastics manufacturing, 3) use and 4) end of life.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>In addition to evaluating scoring plastics based on manufacturing inputs and product footprint, the Plastics Scorecard presents a strategy for reducing chemical footprint through a 5-step program: ask if a plastic is necessary, find safer additives, use safer polymers, close the loop and use post-consumer recycling content, and redesign products.</td>
</tr>
<tr>
<td><strong>Url for more information</strong></td>
<td><a href="http://www.bizngo.org/resources/entry/plastics-scorecard-resource">http://www.bizngo.org/resources/entry/plastics-scorecard-resource</a></td>
</tr>
</tbody>
</table>

**Note:** The Plastics Scorecard scores plastics by Manufacturing Score and Product Footprint and presents a 5-step program for companies that want to reduce chemical footprint of their plastics. The Plastics Scorecard determines a score based on chemical inputs of the manufacturing process (primary chemicals, intermediate chemicals, and monomers) and scores each stage of the manufacturing process based on hazards of the input chemicals. The resulting aggregate score ranges from 0 (most hazards) to 100 (most benign).
Table 3.2. ISO/TC 61 - Standards Related to Plastics

<table>
<thead>
<tr>
<th>Standards Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organization (Country)</td>
</tr>
<tr>
<td>Tool purpose/goal</td>
</tr>
<tr>
<td>Data transparency</td>
</tr>
<tr>
<td>Tool update frequency</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
</tr>
<tr>
<td>Product design capabilities</td>
</tr>
<tr>
<td>Accessibility</td>
</tr>
<tr>
<td>Url for more information</td>
</tr>
</tbody>
</table>

Note: ISO/TC 61/SC 14 includes standards related to plastics and the environment. The ISO/TC 61/SC 14 is a technical subcommittee that develops standards focused on plastics and the environment. The standards vary from testing methods to biodegradability standards to specifications for compostable plastics. ISO/TC 61/SC 1 includes standards related to terminology and symbols for plastics. These standards provide a framework for the transfer of information along the value chain, particularly end-of-life stage operations.
### Table 3.3. Environmental and Health Hazard Ranking and Assessment of Plastic Polymers Based on Chemical Composition

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Lithner, D.; Larsson, A.; Goran, D.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>This article aims to identify and compile the environmental and health hazards of chemicals used in plastic polymers, to make a hazard ranking of the polymers based on monomer classifications, and to make assessments of polymers.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>The hazard classifications, hazard scores, and ranking of chemicals are included in the supplementary materials for the journal article.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>This article was published in 2011, and the co-authors have not published a more recent article building upon the original methodology.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>A low level of expertise is needed. The ranking can be used as a tool to quickly identify less hazardous plastic polymers.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>The hazard rankings are for chemicals that may be used or released during the production, use, and disposal of the plastic product.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>By using the hazard ranking to select plastic polymers for production, this tool enables product designers to choose plastics that are inherently less hazardous to human health and the environment.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Article available for purchase.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="https://doi.org/10.1016/j.scitotenv.2011.04.038">https://doi.org/10.1016/j.scitotenv.2011.04.038</a></td>
</tr>
</tbody>
</table>

**Note:** This model inputs hazard classification data, primarily, from the Annex VI in the EU CLP regulation. A hazard score is then calculated. For polymers, a sum of hazard scores for all monomers is calculated as well. Note that, unlike other tools summarized in the report, the methodology ranks polymers based on monomers.
Table 3.4. Comprehensive Procurement Guideline (CPG) Program

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>U.S. EPA (United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The CPG program’s purpose is to promote a systematic approach to reducing materials use and environmental impact of a wide range of product types. Central to the CPG program is EPA’s list of designated products and the accompanying recommendations for recovered content, both post-consumer material content and/or total recovered material content.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>The criteria for designating products are available and involve product research, workgroup review, and public comment.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>Products are frequently added to the CPG Supplier Directory if they meet the product specifications outlined by the CPG program. However, EPA does not have plans at this time to add additional CPG-designated products.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>A low level of expertise is needed to use the CPG program for product selection.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>This tool addresses the end-of-life stage of the life cycle by encouraging purchase of products that are manufactured with recycled materials.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>The CPG program does not help in product design, but rather highlights products with lower impact.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Free to access.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program">https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program</a></td>
</tr>
</tbody>
</table>

Note: The CPG program designates products that are made with recovered materials and recommends buying those products. Procuring agencies (federal agencies and contractors) must purchase products with the highest recovered material content level practical. There are eight categories of products in the CPG program, some of which include plastic products (e.g. Nonpaper Office Products).
### Table 3.5. Circular Design Guide

Product Design Guide Tool

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Collaboration between the Ellen MacArthur Foundation and IDEO (United Kingdom and United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The purpose of the Circular Design Guide is to encourage a new business model that helps innovators find creative solutions based on the “circular economy.” Designed with input from businesses, students, and circular economy experts, the Guide is designed for varying levels of experience, and for any stage in the innovation process.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>N/A</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>Unknown</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>A user with any level of expertise can benefit this tool.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>The Circular Design Guide addresses all stages of the life cycle, based on the idea that waste of one product can become the input to another.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>The approaches and resources outlined in the guide can be used in product design to select more sustainable raw materials, decrease waste, and design for recyclability.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>This tool is free and accessible to the public.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="https://www.circulardesignguide.com/">https://www.circulardesignguide.com/</a></td>
</tr>
</tbody>
</table>

*Note: The Circular Design Guide provides a series of tools, such as worksheets, modules, videos, and case studies, which emphasize innovation and sustainability in design. Note that this tool is not specific to plastics but contains methods that are applicable across many products.*
### Table 3.6. APR Design® Guide for Plastics Recyclability

**Guidance Tool**

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>The Association of Plastics Recyclers (United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The purpose of this tool is to provide a comprehensive resource outlining the up-to-date plastics recycling industry’s recommendations for plastic packaging.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>The definition and methodology used in producing this guide is outlined on the APR Design Guide website.</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>This tool is updated regularly.</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>The intended audience of this tool is a package design engineer with a high level of expertise in recyclability and design.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>The APR Design Guide primarily addresses the post-consumer use of a product’s life cycle – recyclability.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>This tool provides resources for product designers. For example, certain polymers are labeled as “preferred” for use in design because when used, the majority of the industry is capable of recycling the product with the potential of producing a high quality material.</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>This resource is free and available to the public.</td>
</tr>
<tr>
<td><strong>Url for more information</strong></td>
<td><a href="https://www.plasticsrecycling.org/apr-design-guide/apr-design-guide-home">https://www.plasticsrecycling.org/apr-design-guide/apr-design-guide-home</a></td>
</tr>
</tbody>
</table>

*Note:* This guide covers plastic items entering the postconsumer collection and recycling systems most widely used in industry today. Collection methods include single stream and dual stream MRF’s, deposit container systems, mixed waste facilities, and grocery store rigid plastic and film collection systems. The impact of package design on automated sortation process steps employed in a single stream MRF, as well as high volume recycling processes is of primary consideration.
### Table 3.7. Test to Assess and Prevent the Emission of Primary Synthetic Microparticles (Primary Microplastics)

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Federal Public Service of Health, Food Chain Safety and Environment (Belgium)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The purpose of this tool is to outline a self-test that evaluates and reduces the emissions of microplastics in the aquatic environment.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>This manual was published in November, 2015.</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>This tool is intended for companies that work with polymer granulate. The user should be an employee who is familiar with product design.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>This tool addresses product manufacture by evaluating microparticles that are emitted during production process.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>This tool can be used to identify alternatives at the design stage to avoid emissions.</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>This manual is free to use and available in English. The introductory text on the website is available in four languages.</td>
</tr>
</tbody>
</table>

*Note:* The self-test outlined in this tool focuses on primary synthetic microplastics. The tool then describes a series of questions and ways to evaluate primary synthetic microplastics, including the size and density of microparticles. Then, the tester identifies sources of emission and ways to avoid emissions. This tool also includes a list of non-soluble synthetic polymers that can occur as synthetic microparticles and possible alternatives.
Table 3.8. Eco Design of Plastics Packaging
Guidelines, Checklist, and Toolbox

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>German Industrial Association for Plastic Packaging (Germany)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The goal of the tool and associated Round Table is to promote the Eco Design of plastic packaging, principally by preparing guidelines and recommendations for the players in the value chain.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>N/A</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>The Round Table was launched in 2014 and the guidelines and tools are continuously updated.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>This tool is for plastic packaging designers.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>The guidelines and resources provided by this tool address all stages of the life cycle while focusing on product manufacture.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>Product designers can use the guidelines provided by this tool to design packaging with lower environmental impact.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>The tools, checklists, and guidelines are posted for public availability. Many are only in German.</td>
</tr>
</tbody>
</table>

*Note:* The Round Table’s Management Guidelines for the Eco Design of Plastic Packaging aim to highlight and implement management procedures, strategies and methods for the development of packaging design in line with the required corporate or brand owners environmental policies. As such, the guidelines assist top managers, product managers, marketing directors, packaging developers and designers in the development of appropriate plastic packaging for finished goods.
3.2. Interactive Tools

Interactive tools rely on user inputs or selections and then provide an output in the form of an assessment, ranking, or interactive report. The tools in this section assist users in improving their materials selection, end-of-life management including recyclability, and address other stages of the life cycle. These interactive tools are either web-based or a software.
Table 3.9. PET Bottle Categorisation Tool
Interactive categorisation tool

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>WRAP (United Kingdom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The purpose of this tool is to calculate company performance against the recyclability of PET bottles in order to help companies improve recyclability.</td>
</tr>
<tr>
<td>User input/output</td>
<td>User inputs PET bottle attributes and sales data. The tool outputs a report that assesses PET bottle design as A (ideal), B (not ideal/not detrimental) or C (detrimental) based on recyclability matrix and provides industry benchmarks based on inputted sales data.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>The tool makes available the matrix used in determining recyclability. Sales data and company information used to product industry benchmarks is not shared.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>Unknown</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>Users must have available PET bottle attributes in order to classify recyclability (e.g. colourants).</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>This tool addresses the post-consumer use of product life cycle – recyclability.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>This tool suggests improvements to PET bottle design by specifically highlighting elements that companies can target to increase recyclability including bottle dimensions, closure liners and seals, adhesives, and labels.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>This tool is free to use online. Organizations must register to utilize the full tool, including the industry benchmarks. Users that do not register can use the tool for basic PET bottle classification.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="http://www.wrap.org.uk/content/pet-bottle-categorisation-tool">http://www.wrap.org.uk/content/pet-bottle-categorisation-tool</a></td>
</tr>
</tbody>
</table>

Note: This tool includes a recyclability matrix that assesses recyclability based on several categories, which can be used to determine the recyclability of PET bottles. In addition, the ability to input sales data allows users to benchmark their performance and suggests bottle design alternations to improve recyclability.
Table 3.10. Systematic Assessment for Flame Retardants (SAFR®)

**Assessment Tool**

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>ICL-IP (Israel)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The Systematic Assessment for Flame Retardants (SAFR) is a framework that provides a rigorous evaluation of specific flame retardants in their applications, thus enabling users to choose the most sustainable flame retardants for the intended use in products, which include plastics.</td>
</tr>
<tr>
<td><strong>User input/output</strong></td>
<td>The tool inputs hazard data for health and environmental endpoints, based on GHS for classification and labeling, as well as data on frequency of contact and potential emissions. The output is an assessment of the flame retardant which shows uses that are recommended, acceptable or not recommended.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>The tool is proprietary and the data inputs and modeling approach are not available to the public.</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>A low level of expertise is needed. Users input flame retardants and receive recommendations on usage.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>This tool addresses hazard and exposure potential of flame retardants during the product use stage.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>This tool can be used to select more sustainable flame retardants for plastic production.</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>SAFR is a proprietary tool available for purchase.</td>
</tr>
<tr>
<td><strong>Url for more information</strong></td>
<td><a href="https://www.safrworks.com/">https://www.safrworks.com/</a></td>
</tr>
</tbody>
</table>

*Note: SAFR develops a sustainability profile for flame retardants by defining the health hazards, assessing exposure, and providing recommendations.*
**Table 3.11. RecyClass**

Plastics packaging assessment tool

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Plastics Recyclers Europe (Belgium)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The goal of RecyClass is to achieve more recycling by encouraging product designers and manufacturers to pay attention to recyclability when designing a package.</td>
</tr>
<tr>
<td><strong>User input/output</strong></td>
<td>User inputs a questionnaire related to their packaging, and RecyClass outputs an energy efficiency rating from A to F.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>The data and methods used to determine the rating are not available.</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>A low level of expertise about recycling is sufficient, as RecyClass helps users to answer the questionnaire with explanations.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>This tool addresses the post-consumer use of product life cycle – recyclability.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>This tool is helpful to product designers who wish to improve their recyclability through design specifications.</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>RecyClass is free for registered users.</td>
</tr>
</tbody>
</table>

*Note:* RecyClass consists of an online tool where users fill out a questionnaire that determines the extent a certain package is suitable for recycling. The tool identifies any adjustments that can improve the recyclability rating. An optional certification is available after the initial rating.
### Table 3.12. COMPASS® (Comparative Packaging Assessment)

**Design-phase web application**

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>Sustainable Packaging Coalition (SPC) (United States)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>COMPASS provides comparative environmental profiles of packaging alternatives based on life-cycle assessment metrics and design attributes. COMPASS helps packaging designers make more informed material selections and design decisions early in the development process.</td>
</tr>
<tr>
<td>User input/output</td>
<td>The user inputs data on primary, secondary and tertiary components of packaging. The model outputs an environmental impact assessment as well as attributes related to the packaging.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>Version 1.0 was released in 2009 based on metrics developed in 2007. The tool has since undergone updates but no significant change has been made to the methodology.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>The data sources and methodology are outlined in the FAQ.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>COMPASS was developed for brand owners, packaging designers and engineers and requires a high level of expertise.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>COMPASS takes into account raw material extraction, packaging material manufacture, distribution, and end-of-life treatment. (The use phase is not modeled.)</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>COMPASS provides guidance to packaging designers who want to take into account consumption and emissions when selecting plastic packaging.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Licenses are available for purchase, but a one-week free trial is offered.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="http://design-compass.org/">http://design-compass.org/</a></td>
</tr>
</tbody>
</table>

*Note: COMPASS is a design guidance tool that provides information about the environmental profile of a packaging that can inform decisions that are aligned with a company’s overall sustainability goals. The life-cycle approach accounts for environmental impacts associated with the materials and processes used to bring packaging to market, and allow decision makers to incorporate environmental parameters alongside economic factors. COMPASS should be used as part of the design phase to help designers make more informed decisions prior to taking a new package to market. Several materials are included in COMPASS, including plastic polymers.*
Table 3.13. CES Selector
Material Selection Tool

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>GRANTA Material Intelligence (United Kingdom)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The purpose of this tool is to provide product designers with data, graphical analysis and evaluation of material properties to identify solutions and reduce material and costs.</td>
</tr>
<tr>
<td>User input/output</td>
<td>CES Selector inputs a database containing physical, cost, mechanical, thermal, electrical, optical, durability, environmental data on engineering materials and processes. The output includes data and graphical representations on cost, performance, and environmental impact.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>The underlying database is available within the CES Selector software.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>The latest release is the 2018 version.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>This tool is targeted at high expertise users who are involved in plastics design.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>This tool addresses materials processing and product manufacturing, transport, use, and disposal.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>CES Selector has many applications for product design, especially material selection. The database takes into account cost, performance and impact.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>This tool is proprietary and licenses are available for purchase.</td>
</tr>
</tbody>
</table>

*Note:* CES Selector is an interactive tool that plots and analyzes material properties, compares materials, and helps with substitution. In addition, the tool contains data on environmental properties and restricted substance risk to guide early-stage product design.
Table 3.14. SOLIDWORKS Sustainability
Design Performance Simulation

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>SOLIDWORKS (France)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>SOLIDWORKS Simulation is a CAD-embedded software tool that enables designers and engineers to simulate and analyze design performance.</td>
</tr>
<tr>
<td>User input/output</td>
<td>User-inputted parameters include transportation mode and distance, assembly energy, and use-phase energy consumption, recycled content level and end-of-life scenarios. The software outputs environmental impacts and costs. In addition, the material optimization module inputs material characteristics and engineering parameters and compares environmental impacts.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>This is a proprietary tool. The data inputs and methodology are not accessible.</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>The most recent version was released in 2017.</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>This tool requires a high understanding of product design in order to optimize using the LCA tool.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>This tool performs an LCA and takes into account transportation mode and distance, assembly energy, and use-phase energy consumption, recycled content level and end-of-life scenarios.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>SOLIDWORKS Sustainability has many applications for product design, especially material selection. The tool takes into account cost and performance.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>This tool is proprietary and licenses are available for purchase.</td>
</tr>
</tbody>
</table>

Note: SOLIDWORKS Sustainability, one of the packages of the software, enables users to perform an LCA of the environmental impacts. In addition, SOLIDWORKS Plastics is an additional package that can be used for plastics simulation.
3.3. Initiatives and Consultations

This category of tools includes initiatives and consultations that assist manufacturers and product designers in identifying opportunities for sustainable design. These approaches include consultations among stakeholders and technical evaluations done by experts. Also included are extended producer responsibility (EPR) schemes, which encourage sustainable design and reduce environmental impact through end-of-life management. Multiple countries have implemented EPR schemes; France’s and Italy’s EPR schemes are included in this report as examples.
Table 3.15. European PET Bottle Platform (EPBP)

| Organization (Country)                                                                 | EPBP was formed by the European Association of Plastics Recycling and Recovery Organisations (EPRO), the European Plastics Recyclers (EuPR), PET Containers Recycling Europe (Petcore), the Union of European Beverages Association (UNESDA) and the European Federation of Bottled Water (EFBW) |
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### Table 3.16. ABC-X Assessment

Material assessment consultation

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>EPEA Nederland (Netherlands)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Tool purpose/goal</strong></td>
<td>The purpose of the ABC-X Assessment is to determine whether plastic materials are suitable for development of a Cradle to Cradle® product.</td>
</tr>
<tr>
<td><strong>Data transparency</strong></td>
<td>The data used are not available to the public.</td>
</tr>
<tr>
<td><strong>Tool update frequency</strong></td>
<td>Unknown</td>
</tr>
<tr>
<td><strong>Level of expertise needed to use tool</strong></td>
<td>Low expertise needed – this is a service provided by EPEA.</td>
</tr>
<tr>
<td><strong>Stage(s) of life cycle addressed by tool/approach</strong></td>
<td>Since this assessment is related to Cradle to Cradle® certification, designing products that qualify would address all aspects of the life cycle.</td>
</tr>
<tr>
<td><strong>Product design capabilities</strong></td>
<td>The ABC-X Assessment aids product designers and manufacturers in selecting materials that are deemed more sustainable.</td>
</tr>
<tr>
<td><strong>Accessibility</strong></td>
<td>The general methodology developed for the ABC-X Assessment is available, but the assessments and chemical data used are proprietary.</td>
</tr>
<tr>
<td><strong>Url for more information</strong></td>
<td><a href="http://www.epea.nl/abc-x-assessment/">http://www.epea.nl/abc-x-assessment/</a> (website in Dutch)</td>
</tr>
</tbody>
</table>

**Note:** The Cradle to Cradle® certification is available for sustainable products that are rated on five categories: material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness. For manufacturers seeking Cradle to Cradle® certification, the ABC-X Assessment classifies materials and chemicals used as well as the materials’ risk and toxicological profile. The ABC-X Assessment also provides recommendations for safe application of materials. The assessment uses physical, ecological and toxicological properties from research and scientific literature, contained in EPEA’s internal database. EPEA outputs a material assessment based on the ABC-X classification scale. A is “Ideal C2C material” and X is “Highly problematic properties, must phase out.”
Table 3.17. CITEO
EPR Scheme in France

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>CITEO (France)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>The purpose of an EPR scheme is to provide incentives for manufacturers to design sustainable products and to ensure effective end-of-life management though reuse and recycling. France’s CITEO is the collective EPR scheme for household packaging waste in France.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>N/A</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>N/A</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>None. Companies that participate in an EPR scheme contribute funds for the collective organization (CITEO) to manage waste activities.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>The EPR program primarily addresses end-of-life waste management, but also encourages product eco-design that decreases waste, uses less-toxic materials, and improves recyclability.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>Collective organizations (CITEO) provide tools to companies to use in eco-design, such as guides, trainings, and environmental assessments.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>The EPR program is open to all manufacturers and importers in France, and includes various stakeholders.</td>
</tr>
</tbody>
</table>

Note: France’s Extended Producer Responsibility (EPR) program requires manufactures and importers to assume responsibility for product waste. There are 15 different product schemes, including plastic packaging. Manufacturers can use a Producer Responsibility Organization (PRO) which is an inclusive governance model that is made up of various stakeholders, including producers, municipalities, waste management operators, NGOs, consumer organizations, and the public. The PRO is a legal entity that consults multiple stakeholders, collects fees, encourages eco-design of products, and implements mechanisms for handling waste. France’s EPR scheme uses fee modulation to incentivize encourage eco-design by rewarding innovation in product design through lower fees.
Table 3.18. CONAI, the National Packaging Consortium
EPR Scheme in Italy

<table>
<thead>
<tr>
<th>Organization (Country)</th>
<th>CONAI (Italy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tool purpose/goal</td>
<td>CONAI is a system forming the response from private companies to a problem of collective interest, i.e. the environment, in accordance with the guidelines and objectives set by the political system. The purpose is to transition from landfills to a system based on prevention, recovery and recycling of six materials, which include plastics.</td>
</tr>
<tr>
<td>Data transparency</td>
<td>N/A</td>
</tr>
<tr>
<td>Tool update frequency</td>
<td>N/A</td>
</tr>
<tr>
<td>Level of expertise needed to use tool</td>
<td>None. Companies that participate fund activities that are directed by CONAI.</td>
</tr>
<tr>
<td>Stage(s) of life cycle addressed by tool/approach</td>
<td>EPR systems including CONAI are tools that address the end-of-life stage for plastic packaging. CONAI also addresses additional stages of the life cycle by supporting product design that considers raw materials, transportation, and production processes.</td>
</tr>
<tr>
<td>Product design capabilities</td>
<td>CONAI cooperates with companies and municipalities to prevent waste. These guidelines and cooperation are used for eco-sustainable packaging design.</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Any manufacturing or user company that is responsible under Italian legislation for proper and effective environmental management of packaging may join CONAI. 900,000 companies have joined the National Packaging Consortium.</td>
</tr>
<tr>
<td>Url for more information</td>
<td><a href="http://www.conai.org/en/">http://www.conai.org/en/</a></td>
</tr>
</tbody>
</table>

Note: CONAI collaborates with Municipalities according to specific agreements governed by the ANCI-CONAI National Framework Agreement and serves as a guarantee to citizens that any materials from separate waste collections are fully used through proper recovery and recycling processes. Any companies that join the Consortium pay a compulsory Contribution which serves as a form of financing allowing CONAI to support separate waste collection and packaging waste recycling.
3.4. Industry-Developed Tools

In some cases, businesses or industry groups develop tools and guides for plastics material selection. These tools typically focus on performance and engineering considerations. Nevertheless, they may include physical data, performance, and other materials information that could be helpful in designing more sustainable plastics. Most tools are subscription-based or available to customers.

Some examples of industry-developed tools include:

- **Curbell Plastics Research Materials** – The research materials developed by Curbell contain properties and product comparisons for use in plastic material selection.
- **LANXESS Design Guide** – This design guide is a plastics material selection guide for engineers and product designers that explains tests used to compare and evaluate engineering plastics.
- **Eck Plastic Arts Material Selection Guide** – This guide is intended to provide physical data that can be used when selecting material for plastics.
- **BASF Material Selection Tools** – This collection of online tools provides BASF’s customers with a comparison of their materials. For example, a downloadable database allows customers to search for data on resin products.

3.5. LCAs and Other Tools

There are many tools that don’t explicitly address polymer and chemical selection at the design stage, but may be helpful to product designers when used in conjunction with other tools. For example, LCA tools allow a user to assess the environmental impacts associated with all stages of the product’s life, from raw material extraction, to manufacture, distribution, use, and end-of-life (or “cradle to grave”). Eco-profiles similarly analyze the environmental impact of a product but from resource extraction to the factory gate (i.e., before the product is transported to the consumer) – often referred to as “cradle to gate” assessments or partial LCAs. There are many tools available that perform or facilitate LCAs, and the below list represents examples of these tools.

- **SimaPro** – One of the most widely used LCA software packages, SimaPro allows users to calculate the environmental impact of their product or process. Add-ons may be available for assessment of plastics.
- **GaBi** – GaBi is another widely used LCA software package. GaBi sells an extension database that models processes related to plastics.
- **OpenLCA** – openLCA is an open source and free-to-use software for conducting LCAs.
- **ProScale** – ProScale is a new LCA approach to describe relative potential toxicological performances of products and allow for comparisons with other products.
- **IdematLightLCA** – This LCA extension of the Ideamat App enables full LCA calculations and shows the advantage of the circular economy.
- **Eco-Cost Value Ratio model** – This model developed by Deft University of Technology provides data on eco-costs to enable fast track LCA calculations.

- **PlasticsEurope Eco-Profiles Programme** – PlasticsEurope is an industry organization that publishes eco-profile reports that provide environmental data on industrial processes associated with plastic manufacturing that are used in LCAs.

Chemical hazard assessment tools that are not specific to plastics may also be useful to product designers in identifying, comparing, and selecting safer alternatives to replace more hazardous chemicals. The OECD Substitution and Alternatives Assessment Toolbox (SAATTToolbox) contains a compilation of resources relevant to chemical substitution and alternatives assessment (OECD, 2018a[1]). Examples are included below.

- **GreenScreen® for Safer Chemicals** – GreenScreen® is a hazard screening tool developed by Clean Production Action that allows users to evaluate chemicals based on hazards and assess safer alternatives. This tool can be used by plastic product designers to identify priority chemicals for substitution or assess chemical hazards.

- **Column Model** – The Column Model was developed by the Institute for Occupational Safety and Health (IFA) of the German Social Accident Insurance as a tool for industry for identifying alternative substances. The Column Model assesses alternative chemicals or materials/mixtures and minor process changes.

In addition, “authoritative lists” of hazardous chemicals published by government agencies and NGOs are not specific to plastics, but offer a resource for easily identifying polymers and chemicals with known toxicity concerns. Below are some examples of chemical lists.

- **Substances of Very High Concern (SVHC)** - The European Chemicals Agency (ECHA) identifies substances of very high concern based on several hazard criteria with the aim to replace these substances with less dangerous substances or technologies where technically and economically feasible alternatives are available.

- **EC Annex VI CMR Substances** – ECHA also maintains this list of substances or groups of substances that classified as carcinogenic, mutagenic, or toxic for reproduction (CMR substances).

- **SIN List** – The SIN List, developed by ChemSec, identifies and predicts chemicals that are likely to be banned or restricted in the future based on hazard characteristics. This list may be used by product designers to identify chemicals for substitution in plastics.

- **PROP 65** – PROP 65 is a list of chemicals maintained by the State of California that are known to cause cancer, birth defects, or other reproductive harm.

- **IRIS** – The U.S. EPA’s Integrated Risk Information System is a program that develops assessments that characterize a chemical or mixture’s environmental health hazards.
While not providing resources or tools for plastic product design, eco-labels, certifications, and other product rating databases provide incentives for companies to take into account sustainability or hazard criteria when designing products. Some examples of eco-labels and certifications are listed below.

- **EPEAT** – EPEAT, a program of Green Electronics Label, is an environmental product rating program for electronics that aims to help purchasers select high-performance electronics that meet IT and sustainability goals. EPEAT-registered electronics are rated based on environmental criteria that address the entire life cycle, from design to end-of-life management and packaging. Note that EPEAT is not a plastics-specific tool, but the electronic products incorporate plastics in manufacturing.

- **EU Ecolabel** – The EU Ecolabel, a program implemented by the European Commission, is another example of an ecolabel issued to products based on criteria that evaluates environmental impact over the entire life cycle. Like EPEAT, this ecolabel is not specifically for plastics but some electronics products incorporate plastics in manufacturing.

- **Cradle to Cradle** – This program is an independent product certification that assesses products based on five categories: material health, material reutilization, renewable energy and carbon management, water stewardship, and social fairness. Many product categories include plastics.

- **Nordic Swan** – Nordic Swan is an ecolabel in the Nordic countries with sixty different product groups, including plastics (e.g. disposable bags). This ecolabel evaluates products on all phases of the life cycle and sets strict requirements for chemicals used in products.

Finally, there are many available chemical databases and other data sources that, while not focused on plastics, may be useful in obtaining hazard and other information for chemicals used in plastics. Some examples are included below. For additional examples, see the OECD SAATT Toolbox.

- **ChemView** – This database, developed by the U.S. EPA, contains chemical health and safety data as well as information on EPA’s assessments and regulatory actions for chemicals under the Toxic Substances Control Act (TSCA).

- **eChemPortal** – This searchable database, the development of which is coordinated by the OECD, can be used to obtain physio-chemical properties and other toxicity information, as well as exposure and use information, on chemicals.

### 3.6. Summary of Tools and Approaches

Key attributes of the 18 tools and approaches summarized in this report are shown in Table 3.1 below. Figure 1 shows the life-cycle stages addressed by each tool and approach.
### Table 3.19. Summary of Tools and Approaches for the Design of Sustainable Plastics

<table>
<thead>
<tr>
<th>Name of Tool (Organization)</th>
<th>Type of Tool</th>
<th>Purpose of Tool</th>
<th>Data Input</th>
<th>Data Output</th>
<th>Stage(s) of Life cycle Addressed</th>
<th>Tool Update Frequency</th>
<th>Open Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plastics Scorecard (Green Production Action)</td>
<td>Report</td>
<td>Designed to help purchasers choose safer plastics and help manufacturers reduce chemicals of concern</td>
<td>N/A</td>
<td>N/A</td>
<td>Throughout</td>
<td>No updates</td>
<td>Yes</td>
</tr>
<tr>
<td>ISO/TC 61 - Standards Related to Plastics (ISO)</td>
<td>Standard</td>
<td>Provide standardization relating to biodegradability, biobased plastics, carbon and environmental footprint, microplastics and ocean/terrestrial environments, recycling, waste management, and circular economy</td>
<td>N/A</td>
<td>N/A</td>
<td>Product manufacture and end-of-life</td>
<td>Reviewed every five years</td>
<td>No</td>
</tr>
<tr>
<td>Environmental and health hazard ranking and assessment of plastic polymers based on chemical composition (Lithner, D.; Larsson, A.; Goran, D.)</td>
<td>Journal article</td>
<td>Develop a hazard ranking of plastic polymers based on monomer classifications</td>
<td>N/A</td>
<td>N/A</td>
<td>Production, use, and end-of-life</td>
<td>No updates</td>
<td>No</td>
</tr>
<tr>
<td>Comprehensive Procurement Guideline (CPG) Program (U.S. EPA)</td>
<td>Product list</td>
<td>Promote a systematic approach to reducing materials use and environmental impact over the entire life cycle by program recommending sustainable products</td>
<td>N/A</td>
<td>N/A</td>
<td>End-of-life</td>
<td>Ongoing</td>
<td>Yes</td>
</tr>
<tr>
<td>Circular Design Guide (Ellen MacArthur Foundation and IDEO)</td>
<td>Product design guide</td>
<td>Encourage a new business model that helps innovators find creative solutions based on the “circular economy”</td>
<td>N/A</td>
<td>N/A</td>
<td>Throughout</td>
<td>Unknown</td>
<td>Yes</td>
</tr>
<tr>
<td>Tool Description</td>
<td>Type</td>
<td>Description</td>
<td>Aspects of existing PET bottle</td>
<td>Bottle classification</td>
<td>End-of-life (post-consumer use)</td>
<td>Ongoing Status</td>
<td>Electronic Access</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>APR Design® Guide for Plastics Recyclability (Association of Plastic Recyclers)</td>
<td>Guide</td>
<td>Provide a comprehensive resource outlining the up-to-date plastics recycling industry’s recommendations for plastic packaging</td>
<td>N/A</td>
<td>N/A</td>
<td>End-of-life (post-consumer use)</td>
<td>Ongoing</td>
<td>Yes</td>
</tr>
<tr>
<td>Test to assess and prevent the emission of primary synthetic microparticles (primary microplastics) (Federal Public Service of Health, Food Chain Safety and Environment)</td>
<td>Manual</td>
<td>Outline a self-test that evaluates and reduces the emissions of microplastics in the aquatic environment</td>
<td>N/A</td>
<td>N/A</td>
<td>Product manufacture</td>
<td>Unknown</td>
<td>Yes</td>
</tr>
<tr>
<td>Eco Design of Plastics Packaging (German Industrial Association for Plastic Packaging)</td>
<td>Guide, checklist, toolbox</td>
<td>Promote the Eco Design of plastic packaging, principally by preparing guidelines and recommendations for the players in the value chain</td>
<td>N/A</td>
<td>N/A</td>
<td>Throughout, focusing on product manufacture</td>
<td>Ongoing</td>
<td>Yes</td>
</tr>
<tr>
<td>Interactive Tools</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PET Bottle Categorization Tool (WRAP)</td>
<td>Web-based tool</td>
<td>Evaluate current performance of a plastic product against Wrap’s recyclability categories</td>
<td>Aspects of existing PET bottle</td>
<td>Bottle classification</td>
<td>End-of-life (post-consumer use)</td>
<td>Unknown</td>
<td>Yes</td>
</tr>
<tr>
<td>Systematic Assessment for Flame Retardants (ICL-IP)</td>
<td>Web-based tool</td>
<td>Provide a rigorous evaluation of specific flame retardants in their applications, thus enabling users to choose the most sustainable product for the intended use</td>
<td>Hazard data, frequency of contact</td>
<td>Flame retardant assessment</td>
<td>Product use</td>
<td>Unknown</td>
<td>No</td>
</tr>
<tr>
<td>RecyClass (Plastics Recyclers Europe)</td>
<td>Web-based tool</td>
<td>Achieve more recycling by encouraging product designers and manufacturers to pay attention to recyclability when designing a package</td>
<td>Packaging information</td>
<td>Energy efficiency rating</td>
<td>End-of-life (post-consumer use)</td>
<td>Unknown</td>
<td>Yes, for register ed users</td>
</tr>
<tr>
<td>COMPASS® (Sustainable Packaging Coalition)</td>
<td>Web-based tool</td>
<td>Provides comparative environmental profiles of packaging alternatives based on life cycle assessment metrics and design</td>
<td>Packaging information</td>
<td>Environmental impact</td>
<td>Raw material extraction, packaging material manufacture</td>
<td>Ongoing minor functionality updates</td>
<td>No</td>
</tr>
</tbody>
</table>
attributes. And helps packaging designers make more informed material selections and design decisions early in the development process.

<table>
<thead>
<tr>
<th>Initiative and Consultations</th>
<th>CES Selector (GRANTA Material Intelligence)</th>
<th>SOLIDWORKS Sustainability (SOLIDWORKS)</th>
<th>CES Selector (GRANTA Material Intelligence)</th>
<th>SOLIDWORKS Sustainability (SOLIDWORKS)</th>
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<tr>
<td>Software</td>
<td>CES Selector (GRANTA Material Intelligence)</td>
<td>SOLIDWORKS Sustainability (SOLIDWORKS)</td>
<td>CES Selector (GRANTA Material Intelligence)</td>
<td>SOLIDWORKS Sustainability (SOLIDWORKS)</td>
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<tr>
<td>Attributes</td>
<td>Material data</td>
<td>Parameters including assembly energy, recycled content, and end-of-life scenarios</td>
<td>Material data</td>
<td>Parameters including assembly energy, recycled content, and end-of-life scenarios</td>
</tr>
<tr>
<td>Description</td>
<td>Cost, performance, environmental impact.</td>
<td>Costs, environmental impact</td>
<td>Description</td>
<td>Costs, environmental impact</td>
</tr>
<tr>
<td>Cost</td>
<td>Throughout</td>
<td>Throughout</td>
<td>Cost</td>
<td>Throughout</td>
</tr>
<tr>
<td>Distribution</td>
<td>2018 is current version</td>
<td>2017 is current version</td>
<td>Distribution</td>
<td>2018 is current version</td>
</tr>
<tr>
<td>End-of-life treatment</td>
<td>No</td>
<td>No</td>
<td>End-of-life treatment</td>
<td>No</td>
</tr>
<tr>
<td>Note(s): 1This column highlights the primary stage(s) of the life cycle addressed.</td>
<td>Note(s): 1This column highlights the primary stage(s) of the life cycle addressed.</td>
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<td>Note(s): 1This column highlights the primary stage(s) of the life cycle addressed.</td>
</tr>
</tbody>
</table>
Figure 3.1. Stages of Life Cycle Addressed by Each Tool

These tools address the entire life cycle:
- Plastics Scorecard
- Circular Design Guide
- Eco Design of Plastics Packaging
- Lithner et al
- COMPASS
- CES Selector
- SOLIDWORKS and other LCAs
- ABC-X Assessment

Raw Materials

ISO Standards
Test to access microparticles

Product Manufacture

Systematic Assessment for Flame Retardants

Use Phase

- CPG Program
- APR Design Guide
- PET Bottle Categorization
- RecyClass
- EPBP
- EPR Schemes
- ISO Standards

End of Life
4. GAP ANALYSIS

There are several gaps associated with identified tools and approaches, as shown in Table 3-1. In particular, there are gaps in frequency of data updates, accessibility, plastic product categories highlighted, and stage of the life cycle addressed. Identified gaps are based on the key attributes summarized from publicly available tool methodology and documentation. Additional gaps may become apparent upon more in-depth evaluations of each tool.

Frequency of Updates:

- Nine of the tools either have an unknown frequency of updates or have never been updated.
- It is likely that some of these nine tools are outdated and don’t reflect the current state of the science.

Interactive Tools:

- Interactive tools are particularly useful because they allow users to receive custom recommendations based on their criteria and inputs.
- Only six interactive tools were identified, and four are proprietary/fee-based tools.

Stages of Life Cycle:

- The majority of tools focus on end-of-life, particularly recyclability.
- Some tools address the entire life cycle through LCA and other environmental criteria calculations.
- The most underrepresented life-cycle stages are raw material extraction and processing, as many tools focus on the product life cycle from manufacturer to end-of-life.
- Only two interactive tools address the product manufacturing stage of the life cycle.

Lack of References to Other Tools:

- Most tools do not link to or reference other tools or resources that could be used in tandem. This makes searching for and identifying applicable tools time consuming and difficult.
- The Circular Design Guide and Eco Design of Plastics Packaging both link to other tools.

Types of Plastic Products:

- Many tools are applicable to plastics at large.
- Seven tools are applicable to specific plastic product categories:
  - Two tools are specific to PET bottles.
  - Five tools are specific to plastic packaging.
There are potentially additional plastic products that would benefit from a tool tailored to that product category.
5. RECOMMENDATIONS

As shown in this report, tools exist that can support the design of sustainable plastic products by incorporating circular design and assessing all stages of the life cycle. In addition, tools are available that focus on specific aspects of the life cycle. In particular, recyclability is a common area of focus among the tools summarized for this report.

The following next-steps could be taken in order to begin addressing the gaps identified in this report and to assess the full extent of the tools available to the plastics industry:

- Identify plastic product categories not currently addressed by tools that may benefit from specific sustainability guidance.
- Align the tools identified and summarized in this report with the steps to sustainable plastics design and continual improvement described in the OECD report, *Considerations and Criteria for Sustainable Plastics from a Chemicals Perspective* (OECD, 2018c). This alignment would provide practical information to designers and other interested users on which tools are applicable for a given step of the design process.
- Use the information compiled in this report to develop an online centralized repository or “toolbox” of tools and resources related to the design of sustainable plastics. Such a repository would be updated as new tools and resources become available. The design and functionality of the repository could be modeled on the OECD SAATTToolbox (see here: http://www.oecdsaattoolbox.org/). For example, an interactive tool selector that provides users that ability to filter tools based on their needs could be included, as well as case studies that capture ‘real-life’ application of the tools. The repository could also include the alignment of tools and sustainable design steps as described above.
- Build upon the summaries of tools and approaches in this report by conducting more in-depth evaluations that can inform specific areas of tool development. This could be done by systematically evaluating each tool against one or more design scenarios or sets of questions to capture in greater detail each tool’s capabilities and relative strengths and weaknesses. These in-depth evaluations could be used for the purposes of developing the online repository of tools (described above) and/or for the development of a white paper describing concrete areas of tool development needed.
References


