Review

How Do LCA Studies Support CE? A Systematic Case Study Review

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Abstract

This study explores the integration of Circular Economy (CE) principles within the framework of Life Cycle Assessment (LCA), a foundational methodology in industrial ecology aimed at enhancing product sustainability. With CE offering a roadmap towards ecological sustainability within economic systems, the research examines the extent to which conventional LCA studies align with CE principles across diverse industries classified by the International Standard Industrial Classification (ISIC). Analyzing 282 LCA studies, the investigation identifies a limited incorporation of CE concepts. Most studies inadequately address CE in their goal and scope, lack CE-specific data in inventories, predominantly focus on basic recycling strategies, overlook CE-specific indicators, neglect CE considerations in sensitivity analyses, and omit CE-related recommendations in conclusions. These findings underscore the necessity for a more robust integration of CE principles within LCA methodologies, emphasizing CE measures as pivotal drivers for enhancing product environmental performance across industries.

Keywords: Life Cycle Assessment · Circular Economy · Literature Review

1. INTRODUCTION

Life Cycle Assessment (LCA) and Circular Economy (CE) are two rapidly evolving and growing fields within industrial ecology and environmental economics. The focus of LCA is to analyze the whole life cycle of systems or products covering a broad range of environmental impacts for which it attempts to perform a quantitative assessment. While product refers to a specific item or good that is manufactured and consumed, systems denote more complex or interconnected sets of products, processes, and services. Hauschild et al. (2018) explain that although it observes mainly environmental impacts, it can include both social and economic impacts as well. From an industrial ecology perspective, LCA examines how industrial systems – integrated set of processes and entities – interact with the biosphere, aiming to align them with natural ecosystems (Erkman, 1997). In the perspective of environmental economics, LCA support, for example, the design of policies and regulations by quantifying environmental impacts and establishing limits to be followed in the economy (Erkman, 1997).

In reference to CE, Kirchherr et al. (2023) states it has already evolved into a distinct field of study with a coherent set of shared concepts and practical tools. Succinctly, it aims to accomplish sustainable development by decoupling resource use and environmental impacts from economic prosperity and well-being (Pruhs et al., 2024). Among the various existing CE definitions, the one considered most eminent belongs to Ellen MacArthur Foundation (Kirchherr et al., 2017): "CE is an industrial system that is restorative or regenerative by intention and design. It replaces the 'end-of-life' concept with restoration, shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models." Fostering product sustainability requires innovative solutions towards reducing the environmental footprint, as well as critical assessment towards avoiding

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negative trade-offs. The vision of a CE serves as a creative toolbox in order to identify potentials for further improvement, as the objective is to minimize resource input and waste, emissions, and energy leakages by slowing, closing and narrowing material and energy loops (Bocken et al., 2016).

The need to conserve and reuse all vital resources was already a core theme of the earliest works of industrial ecology and ecological economics. Indeed, Boulding (1966) essay "The economics of the coming spaceship earth" summarizes many of the basic ideas of CE. As stated by Lowe & Evans (1995), CE is an essential objective in industrial ecology, aimed at transitioning the product system, i.e., all the processes required to deliver the function of the product (Hauschild et al., 2018), from a linear to a closed-loop model. Simultaneously, CE is a pivotal focus point within environmental economics. Andersen (2007) asserts that environmental economics examines the economic justifications for CE, offering an analytical approach to identify which material streams and circular strategy options, i.e., strategies to achieve CE, provide the greatest returns.

The increasing significance of CE has consequently resulted in its extensive integration within the LCA research domain. CE has been widely used in the LCA research landscape for some time. For example, the use of LCA in the context of CE has been the subject of an LCA Discussion Forum (Haupt & Zschokke, 2017), a position paper by UNEP's Life Cycle Initiative (Peña et al., 2021), and numerous related contributions at scientific conferences such as the Life Cycle Management Conferences (Life Cycle Management Conference, 2021, 2023).

Within this framework, the LCA tool is very useful to evaluate changes in production systems towards circularity. According to Haupt & Zschokke (2017), "LCA should be used to quantify the environmental impacts of the implementation of a circular system". Therefore, LCA can be used to evaluate several options for CE solutions to ensure a positive balance of efforts and benefits in both new product designs and end-of-life treatments. In this regard, CE solutions illustrate how each CE strategy can be implemented, including numerous practical solutions such as upcycling, cascading, or servitisation (Gallego-Schmid et al., 2020).

Although the two concepts share a common goal, which is to foster sustainable development, sometimes they do not necessarily work hand-in-hand, which is mainly based on different perspectives for system optimization. From an LCA perspective, not every activity on closure products material and energy flows results in advantages for the total life cycle balance. Thus, burden-shifting and negative trade-offs can arise by implementing CE strategies, for example, if more energy has to be used for recovery of recycled material than for virgin materials (Schäfer, 2021). Other studies on LCA have also indicated that closed loops may not always be the best option for the environment (Laner & Rechberger, 2007; Humbert et al., 2009; Geyer et al., 2016).

From a CE perspective, LCA studies often derive no or only very simplified recommendations for further CE improvements across the entire life cycle. This is for example the case, if the conclusion of an LCA study is that the EoL stage has no or only very low significance for results. In consequence, little attention is paid to closing loops, i.e., the further use cases of products, components and materials after their first life has expired. Hence, the use of non-circular data in LCA may indicate a systemic limitation to support increased circularity. CE strategies adopting LCA for CE loops raise questions about the appropriate definition of the system boundary and how to allocate flows and impacts. Saidani et al. (2022) note that "modeling and evaluating the end-of-life and/or CE-related pathways (and their associated impacts) is still challenging."

LCA and CE can benefit from each other in the sense of a mutual interest for sustainability, i.e., both are "complementary" to help for "more sustainable decision" (Cilleruelo Palomero et al., 2024). CE fundamentally serves as a pathway towards enhanced ecological and economic sustainability. By incorporating CE principles into LCA and life cycle costing, the prioritization of sustainability is emphasized. Improvement measures can be compared in terms of their circularity, but should be prioritized according to their respective contribution to sustainability. LCA comparisons might arrive at clear recommendations for favorable alternatives, even if the related circularity assessments are questionable due to inconsistent or impractical CE metrics. As described by Saidani et al. (2022), LCA can be employed to evaluate the effects of circularity by assessing impacts throughout the product's life cycle, which includes the impacts of the subsequent 2nd, 3rd, and further life stages. In this sense, LCA facilitates the analysis of the relationship between circularity and sustainability performance, highlighting how sustainability impacts can either strengthen or undermine the case for circular approaches (Corona et al., 2019; Dieterle & Viere, 2022; Saidani et al., 2022).

Hence, this research aims to investigate the coverage and support of CE in LCA studies throughout industries. It is focusing on product-related studies as the most common form of LCA with direct implications in industries

(Peña et al., 2021). Corona et al. (2019) argue that the use of LCA at the product level to evaluate circularity is a proper approach due to its considerable potential for addressing all CE goals. In contrast, at other higher levels, such as for cities and countries, alternative methodologies, such as Material Flow Analysis, may be more appropriate. Thus, the application of LCA within product systems reinforces the link between CE and sustainable development (Lei et al., 2021). The industries analyzed were classified according to the International Standard Industrial Classification of All Economic Activities (United Nations. Statistical Division., 2008). The macro-level subdivides the spectrum of productive activities into broad groups, specifically into major activities such as manufacturing. The micro-level corresponds to secondary activities, which are subdivisions of the primary activity, as exemplified by the manufacture of lifting and handling equipment.

Therefore, the current research focuses on the following research question: How do LCA studies support CE assessments at a product level? To answer this question, the study assesses the current status of CE integration within a large sample of LCA studies with particular focus on the ways in which LCA studies address the topic of CE within their goal-setting, scope, inventory process, and subsequent stages of analysis and conclusions. 282 LCA studies from various industries published in academic literature from 2015-2022 were reviewed concerning their inclusion of CE-related measures and activities.

Even though the number of studies involving LCA and CE has increased more recently, it is worth mentioning the existence of a few earlier scientific publications exploring their interplay. For example, Mayers et al. (2005) has used LCA to investigate the possible environmental effects of different end-of-life scenarios, circular or not, based on an example of printer in the United Kingdom. In another example, Mattila et al. (2012) proposed LCA as a general framework for quantifying the environmental performance of by-product exchange in industrial symbiosis.

2. RESEARCH DESIGN & METHODOLOGY

To answer this paper's research question empirically, a literature research for product LCA studies was conducted using Web of Science and including all publications in English language across all available categories in this research platform. The research was conducted for the period from 2015 to 2022, with the year 2015 being identified by Teixeira (2020) as a turning point in the publication of studies addressing the intersection of CE and LCA. The closing year of the research in 2022 was chosen considering it as the last year preceding the bibliographic research, which was conducted in 2023.

In a first step all papers were selected for which the following search string matched the publication's title: [*"lca OR "life cycle assessment" OR "carbon footprint" OR "environmental footprint" OR "environmental impact" OR "circular*" OR "recycl*"*]. To ensure that the identified publications cover a whole environmental product life cycle from raw material extraction to end-of-life, the following search strings were applied to the papers' abstracts: [*"cradle to grave" OR "cradle to cradle" OR "full life cycle" OR "entire life cycle" OR "all life cycle stages"*].

The initial search led to a sample of 564 publications throughout several macro and micro industries. The abstract of those publications was scanned for papers that did cover only few stages of a product life cycle, e.g. excluded use and end-of-life stages, and for papers that were of rather conceptual or theoretical nature instead of covering actual LCA applications. These two types of papers were excluded to ensure that the sample includes full life cycle-oriented actual case studies only. The exclusion process was conducted by two independent researchers who each analyzed titles and abstracts of all 564 publications and the full manuscript in cases of uncertainty. Studies that were classified as 'relevant' by only one of two researchers were then analyzed jointly and classified as 'relevant' or 'irrelevant'. A total of 284 (50.4%) out of 564 studies were considered 'relevant'.

A final (detailed) examination was carried out on the 284 chosen articles from various industries, focusing on the product system and its system boundaries. The aim was to identify any disparities between the information provided in the abstract and the content presented in the main body of the articles. When such disparities were observed, particularly when the system boundary described in the abstract (typically 'cradle-to-grave') did not align with that presented in the full paper (usually 'only' cradle-to-gate), the decision was made to exclude these studies from the selected set. In summary, these studies were deemed 'out-of-scope'. As a final result, 239 'valid' articles were ultimately chosen for inclusion in the proposed study, out of which two studies had to be excluded due to unavailability of their full texts. The complete list of the 237 articles selected for the study can be found in Appendix A.

Each full text within the final sample of 237 studies was analyzed by at least two of the authors according to eight criteria illustrated in Figure 1. The criteria consider the four main phases of an LCA (goal & scope, inventory, impact assessment, interpretation of results). Criterion I examines whether CE activities are mentioned and explained in goal & scope. Here, CE activities encompass fundamental process characteristics 9R's strategies from Potting et al. (2017), such as recycling or refurbishment.

Criterion II reviews if CE related data is reported and documented in the study's life cycle inventory. The goal is to identify whether typical activities of CE are included and compiled in the inventory of elementary flows.

Criterion III checks whether CE-specific indicators, i.e., materials flow data in the end-of-life and/or CE-related pathways, are used within life cycle impact assessment. Saidani et al. (2022) elucidate the process of environmental impact assessment within the context of circularity, which encompasses evaluating the life cycle impact of subsequent iterations (2nd, 3rd, etc.) of products and materials. Criteria IV to VI all concern the interpretation of results and break down this phase into several categories. Criterion IV assesses whether the results include any statement of the overall relevance of CE activities. Within the obtained results, considerations are drawn regarding the significance of CE cycles for enhancing the environmental performance of the system under investigation. Criterion V, in turn, checks if CE activities are considered in sensitivity and scenario assessments. Criterion VI considers the availability of CE-specific conclusions and recommendations, providing an authentic depiction of the advantages and shortfalls CE strategies in comparison to linear production systems.

Criteria VII and VIII concern all LCA phases. In a CE context, the distinction of different LCA stages such as raw material acquisition, manufacturing, distribution, use, or end-of-life is particular importance, e.g. to understand the impacts of recycling and respective credits for secondary materials or the effects of sharing or reuse strategies within the use phase on the demand for all other phases. Criterion VII therefore checks whether a LCA study clearly differentiates different LCA stages in inventory, impact assessment and results. Finally, criterion VIII asks for the study's relevant CE strategies following the ten "R-strategies" according to Reike et al. (2018) and UNEP (2019).

All criteria were assessed for each study and classified on scales. In essence, an analysis of the diverse studies revealed disparate classification scales corresponding to each criterion, including yes/no-answers (criterion III and VII), graduated scales like no/brief/comprehensive (criterion I, similarly II, IV, V, VI), and simple selection lists (criterion VIII). All details concerning the literature survey including reference of all studies and assessments of all criteria are provided in the electronic supplementary material (ESM) based on MS Excel.

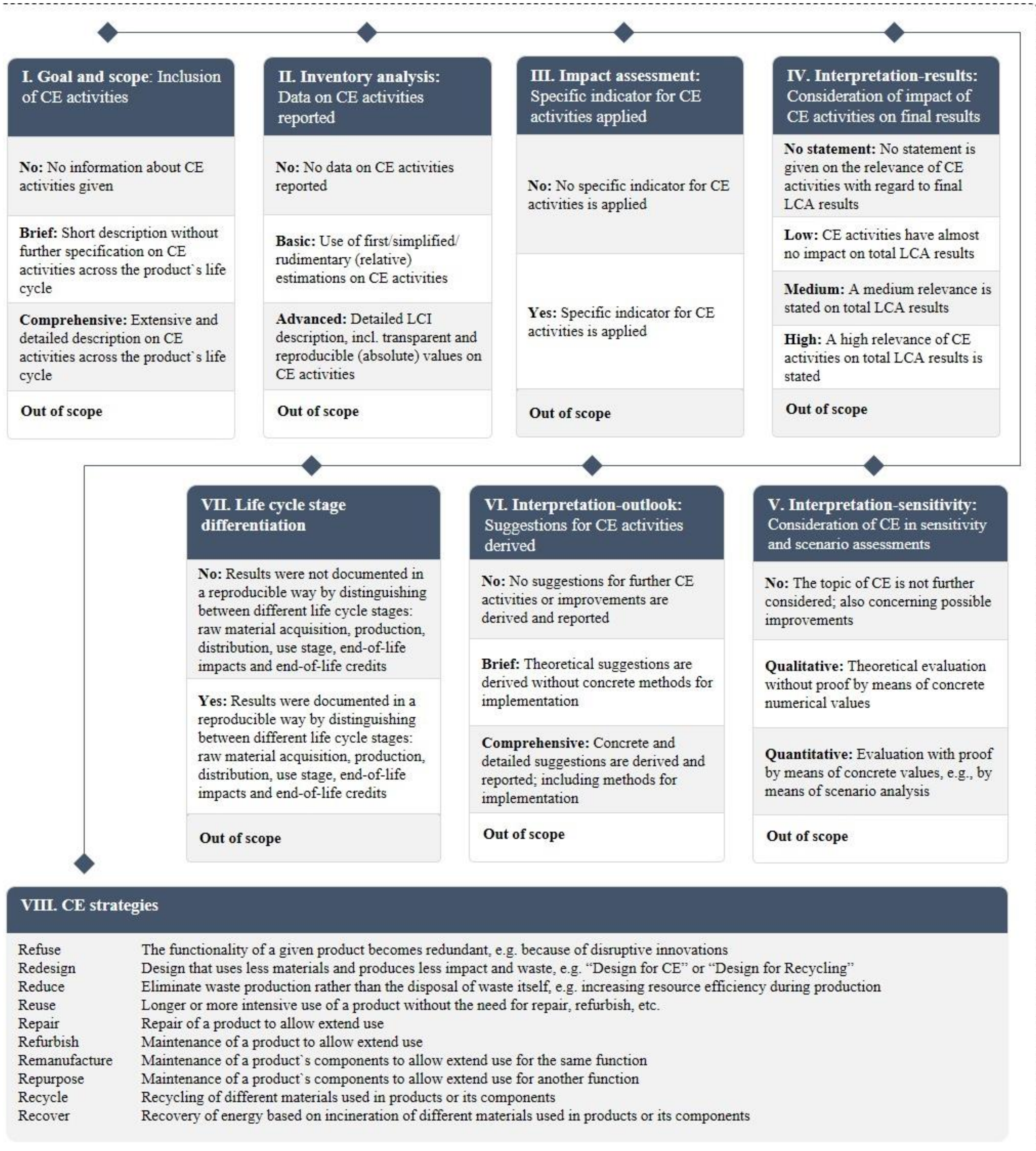

Figure 1. CE Review Criteria for Final Sample of LCA Studies (N=237)

3. RESULTS

To comprehend the economic context of all studies, the studies were categorized according to their macro and micro industries following the United Nations' International Standard Industrial Classification (ISIC) taxonomy (United Nations. Statistical Division., 2008). The 237 LCA case studies considered in this analysis cover different industries, predominantly manufacturing (150 cases), construction (44 cases), electricity/gas/steam/air conditioning supply (31 cases), agriculture/forestry/fishing (6 cases), water supply/sewerage/waste management/remediation activities (4 cases), human health/social work activities (1 case) and administrative and support service (1 case). The smallest three categories are summarized as "Others" in the following. The macro industries can be further broken down to a micro industry view, where within manufacturing electrical equipment, dairy products, motor vehicles, rubber and plastics products, beverages, and machinery and equipment are the largest groups. Figure 2 provides an overview of industries covered in the given studies.

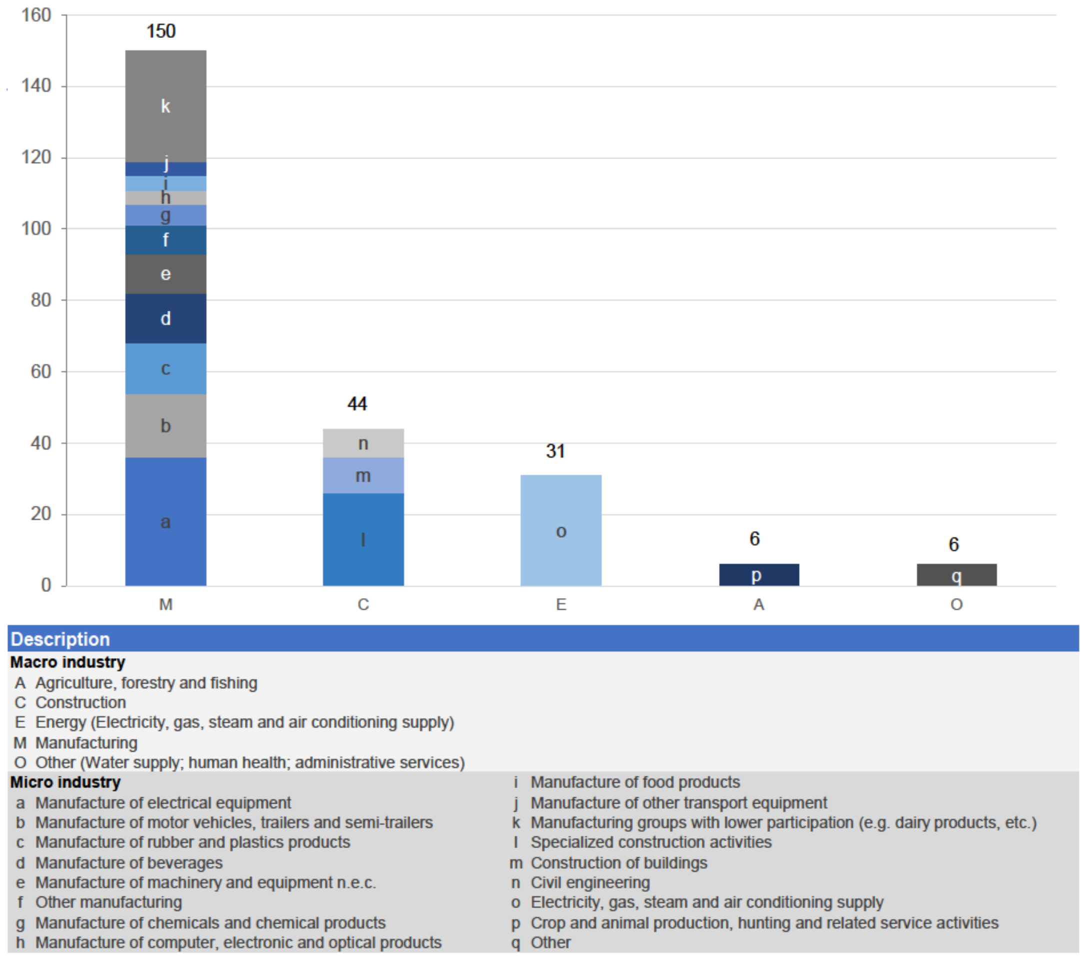

Figure 2. Studies Distribution by Macro and Micro Industry Breakdown

A summary of all results for the different criteria is provided in Figure 3 and further explained discussed below. In Figure 4, an additional method employed to analyze the outcomes is rooted in the assessment of the relative involvement of macro-industrial sectors concerning instances where the articles classification attained the highest possible rating for each criterion analyzed, indicative of the most exemplary CE approach inside LCA available. Figure 4 presents both the categories` values for all industries and the respective averages.

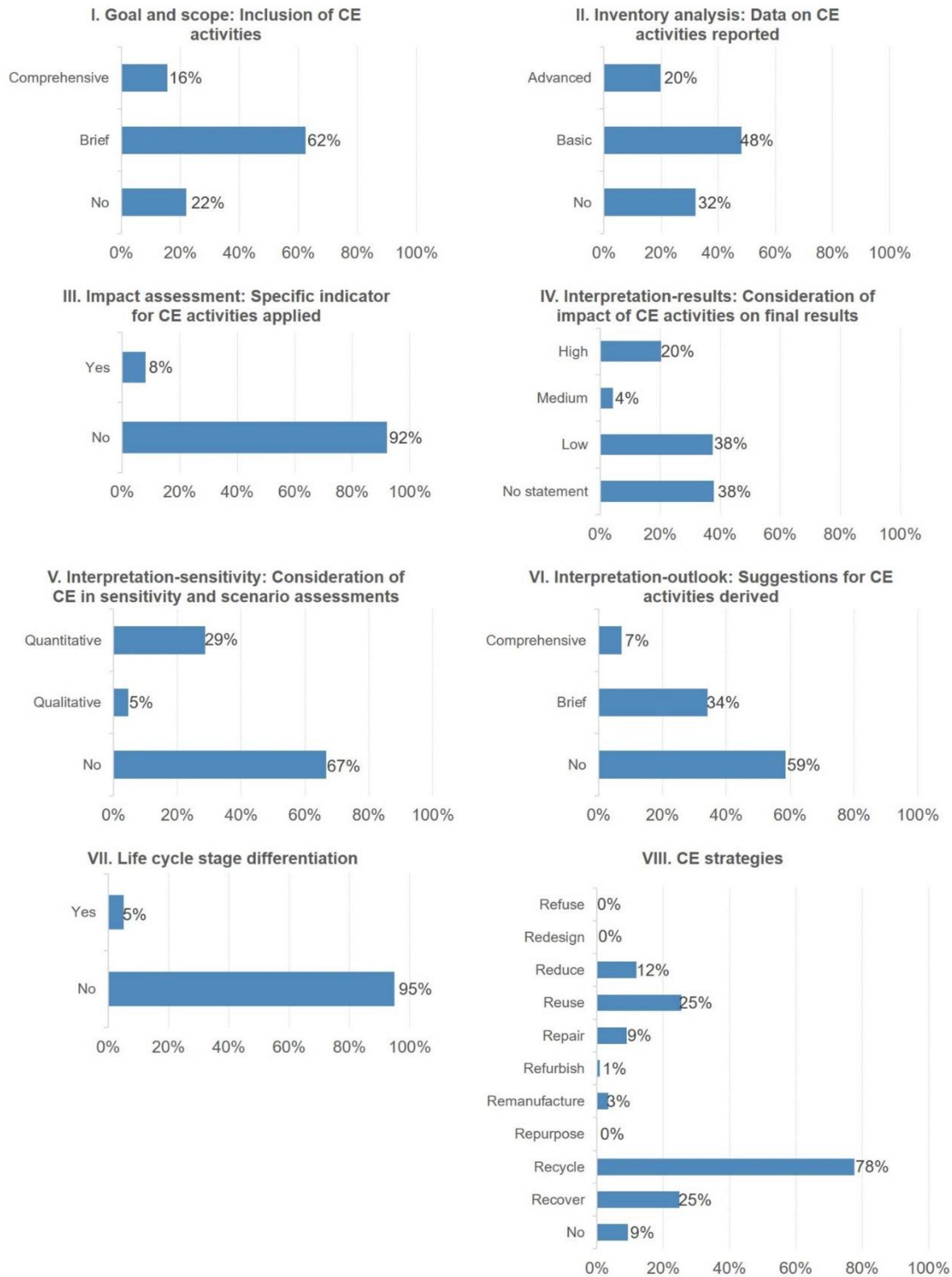

Figure 3. Analysis Results: Coverage and Support of CE in LCA Studies

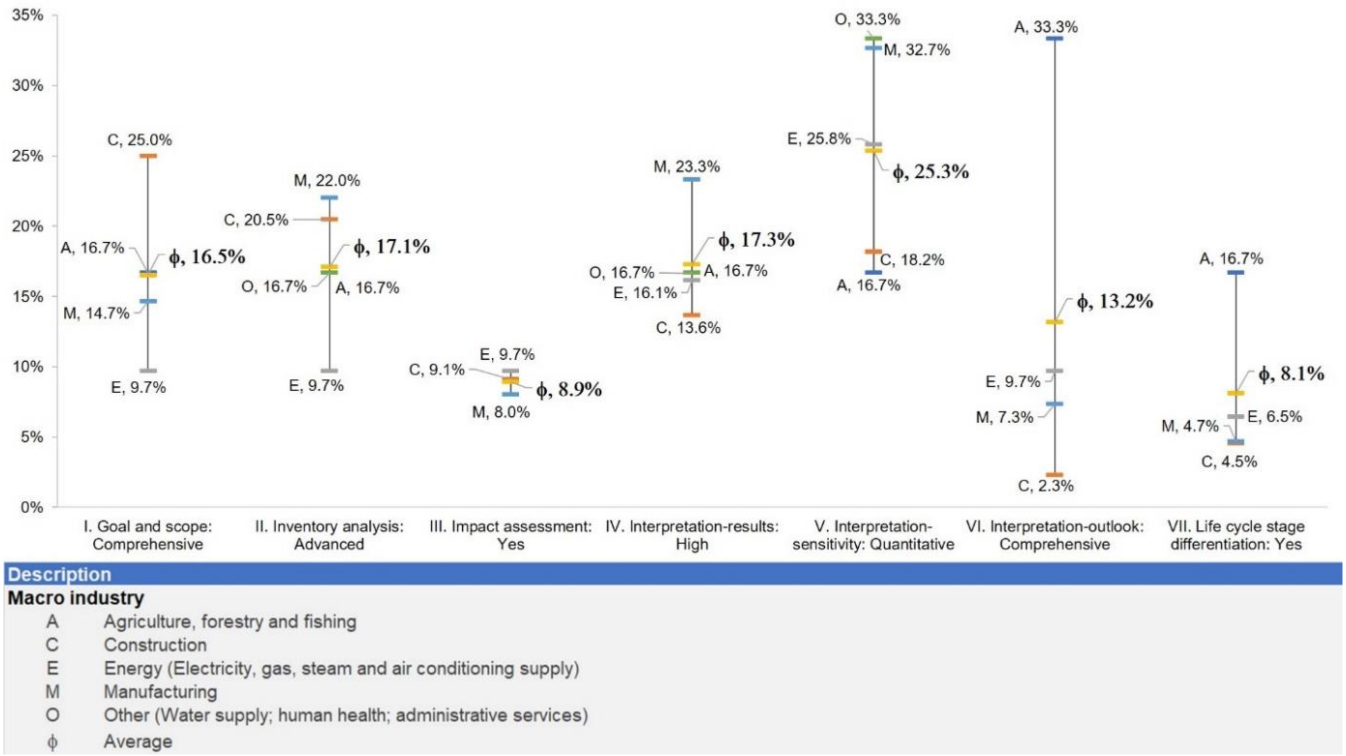

Figure 4. Studies With Most Advanced CE Coverage With Breakdown by Industry

3.1 CE Activities in Goal and Scope (Criterion I)

The results (see Figure 3) reveal that 84% (200 out of 237) of the LCA studies provide no or only brief information on CE activities within goal and scope. In their study, on beverage bottle, for instance, Benavides et al. (2018) has not fully considered recycling or reuse activities inside the scope, focusing only into the production stage and not including activities for CE looping at the end-of-life. The study considered data on secondary materials, but not the recycling process itself.

In opposition, 16% (37 out of 237) of all LCA studies provide a comprehensive view of CE in goal and scope. For example, Horowitz et al. (2018), in another study on beverage bottles, provide a comprehensive description of CE activities within the goal and scope. The aim of this study is to evaluate three different options for environmentally-friendly beverage bottles. The study considered resource circularity activities throughout the entire life cycle, including the recycling processes and their outcomes. In another example, more specifically concerning the product life cycle of wool carpet, Sim & Prabhu (2018) included a detailed description of the product's remanufacturing activity within the goal and scope phase of the LCA.

In industry relative terms (see Figure 4), the sector exhibiting the most substantial share of cases achieving a comprehensive view of CE in goal and scope is the construction industry with 25%, while the energy sector (electricity, gas steam and air conditioning supply) shows the lowest contribution (10%). Considering all economic macro sectors, the average among them remained at 16,5%. Evaluating the sectors against the obtained average, it is possible to see that only the agricultural (Agriculture, Forestry, and Fishing) and construction sectors achieved a final result above the overall average, indicating a higher prevalence of CE activities in the goal and scope of these respective sectors.

3.2 CE Data in Life Cycle Inventory (Criterion II)

Only 20% of the analyzed studies provide advanced documentation of LCI data in terms of CE (47 out of 237 studies, see Figure 3). Advanced documentation means that exists detailed LCI description, including transparent and reproducible (absolute) values on CE activities. A good example for such advanced documentation is provided by Khan et al. (2021), who incorporated the numbers related to the inventory for all CE activities (Reuse, Repair, Recycle, Recover) defined within the scope of a specific study on composite pallets. The final inventory results, containing the numbers for CE activities, were made available in a file, along with the study, for consultation. On the contrary, the majority of studies (80%, 190 out of 237) features only basic or no documentation.

In terms of industry representation, the manufacturing (22%) and construction (21%) sectors exhibit above average values (17%) for advanced documentation, with the energy sector (10%) featuring lowest contribution again.

3.3 CE In Life Cycle Impact Assessment (Criterion III)

The results in Figure 3 indicate that only 8% of all studies (19 out of 237) use specific CE indicators, i.e., metrics designed to evaluate various aspects of circularity (see e.g. ISO 59020), in their final assessment. One example would be the study from Meyer & Katz (2016), who conducts an LCA analysis for bamboo-based laptops enclosure using different base materials options, aluminum, polycarbonate-acrylonitrile butadiene styrene (PC-ABS), or polylactic acid (PLA), and considered landfilling, recycling, or energy production during end-of-life. In this case, the impacts of the different CE activities were quantified and examined through mid-point impact calculation, such as global warming. Another evidenced is provided by Lee et al. (2021) in their comparative study of single-use surgical and embedded filtration layer (EFL) reusable face masks. During the LCA, the authors assessed the environmental impacts associated with the reuse stage, i.e., the washing process of the mask.

There is no significant variance across the different industries (see Figure 4). The average of studies with specific CE indicators remained at 9%, which is relatively low compared to other categories. No positive cases were identified for the agricultural and other sectors (Utilities, Human Health, Administrative Services).

3.4 CE in Life Cycle Interpretation (Criterion IV to VI)

3.4.1 *Interpretation-Results (Criterion IV)*

According to the category IV in Figure 4, only 20% (48 out of 237 reviewed studies) state a high relevance on CE activities within final interpretation stage of the reviewed LCA studies. Among these studies, there is Liu et al. (2021), who conducted an LCA on power batteries used in electric bicycles in China. In this study, results included relevant statements about end-of-life activities for CE, specifically recycling rates and recycling technologies. These considerations were important for identifying promising opportunities to reduce the environmental impacts of different investigated batteries.

In another study, this time by Lee et al. (2021), the significance of CE in the LCA outcomes is evidenced by the emphasis placed on the lesser impacts incurred through the reuse process of EFL masks compared to single-use masks. There is a discernible concern in demonstrating the benefits of environmental impact reduction.

Still within category IV, the manufacturing sector exhibits the highest incidence of favorable cases, accounting for 15% (35 out of 237) in absolute terms. In terms of relative industry performance, it also demonstrates the most robust performance, encompassing 23% of all studies within its sector. The construction sector exhibits the least robust performance (14%), while the industry-wide average stands at 17%. The manufacturing sector was the only one to remain above the average obtained across all sectors.

3.4.2 *Interpretation-Sensitivity (Criterion V)*

Following to the category V on interpretation, it shows that approximately three out of ten LCA studies (around 29%) did a quantitative sensitivity analysis on CE activities (68 out of 237 studies). Consulting again the work from Liu et al. (2021), it provides, for instance, a scenario analysis on the “promotion of battery recycling”, displaying the changes in LCA results under low and high recycling rates scenarios. In the work by Lee et al. (2021), a quantitative sensitivity analysis was conducted for the two surgical mask options under study, considering the CE strategy reuse.

The manufacturing sector leads in terms of cases demonstrating superior performance, constituting 21% (49 out of 237) in absolute terms, whereas the sector others has supremacy in relative terms by industry (33%). The cross-industry average stays at 25%, concurrently with the agricultural sector displaying the weakest performance (17%). Three sectors exhibited relatively superior performance compared to the sector average, namely manufacturing, energy, and other sectors.

3.4.3 *Interpretation-Outlook (Criterion VI)*

With respect to the outlook category VI, only around 7% of the reviewed studies (17 out of 237) derive comprehensive recommendations for further action in terms of CE. In this case, “comprehensive recommendations” comprise specific and detailed suggestions for improving CE, including methods for implementation. For example, Meyer & Katz (2016) provides comprehensive insights within the context of CE while assisting in the selection of renewable and circular materials for laptop enclosures, such as the use of bio-based plastics. The authors draw attention to the tangible environmental benefits obtained through the utilization of materials containing higher levels of post-consumer recycled content.

The manufacturing sector exhibits the most favorable performance at 5% (11 out of 237), albeit modest in absolute terms. In the relative industry analysis, the agricultural sector attains the most substantial share with 33%. The average for "comprehensive" results within the category amounts to 13%. Only the agricultural sector achieved results above the average among the other sectors, potentially indicating a greater emphasis on applicable solutions in support of CE. The construction sector records the poorest performance among all industries, registering a mere 2%.

3.5 CE Across All Stages of the LCA

3.5.1 *Life Cycle Stage Differentiation (Criterion VII)*

In almost all studies, reproducibility and transparency (category VII) in terms of documenting LCA results is lacking, as credits within end-of-life were not documented separately from environmental impacts for treatment within end-of-life, as it is for example recommended by the Product Environmental Footprint (PEF-Initiative of the European Commission). The LCA conducted by Shu et al. (2021), focused on the analysis of two common alternatives for car batteries, is an example where the LCA results are categorized and quantified according to the product life cycle stages, namely the production phase, the use phase, the recycling phase, and the transportation phase.

The manufacturing sector obtained a final value of only 3% (7 out of 237) in absolute terms. Concerning the relative industry performance, the agricultural sector exhibited superior results, encompassing 17% of sector studies. The sector with the lowest performance is the construction sector, which attained a mere 5%, whereas the industry-wide average stood at 8%. Once again, only the agricultural sector achieved a result above the average among the other sectors.

3.5.2 *CE Strategies (Criterion VIII)*

According to the research, 91% of the reviewed articles are related to one or more of the CE strategies. Recycling is the most widely used CE strategy, mentioned in over 78% (184 out of 237) of the studies, followed by "Recover" and "Reuse", each mentioned in approximately 25% of the studies. The “Reduce” is mentioned in 28 times, or 12% of the studies. Following, there is the strategy “Repair”, that accounts for 9% of the studies (21 out of 237). Results for remanufacturing and refurbishing strategies are negligible in absolute terms (8 and 2 cases, out of 237).

In the context of recycling, manufacturing takes the lead with 64% (117 out of 237), followed by construction at 16% and energy at 10%. The subsequent strategy, reuse, exhibits manufacturing as the most proficient sector, constituting 17% of cases. The recover option appears more notably in the manufacturing sector with 17% of the cases, followed by construction and energy with 3% each. In terms of repair, both manufacturing (6%) and construction (3%) emerge as leaders, albeit with limited success. Lastly, the reduce strategy prominently figures in the manufacturing sector, representing 8% of cases.

In relative terms within each industry, the recycling strategy is most prominently featured within the construction sector, accounting for 84% of the studies, followed by manufacturing (78%) and energy (74%). In the context of the recovery strategy, the agricultural and other sector holds a significant lead, representing 33% of the cases. Moving to the remanufacturing strategy, the construction sector exhibits the most favorable results at 7%, despite generally modest scores across all sectors. Negligible results were observed for the refurbishing strategy, with no sector achieving noticeable outcomes. Regarding the repair strategy, construction leads the way with 16% of the studies referencing this approach. The reuse strategy yields more substantial results, with the manufacturing and construction sector accounting for 27% of cases. Finally, the last strategy, reduce, is more prominently mentioned within the manufacturing and other sector, comprising approximately 13 % of references.

4. DISCUSSION

There is a leadership of the manufacturing sector in terms of the number of LCA studies involving CE activities. This leadership may indicate a higher penetration of the CE theme in this sector, with a stronger focus on the electronics, automotive, and plastics industries. Two other sectors with a higher number of publications involving CE would be the construction sector and the energy sector. Besides potentially indicating a greater penetration of the CE theme in these sectors, the results may also be a consequence of a higher production of LCA studies for these sectors. This opinion is supported by the work of Moutik et al. (2023), who conducted a bibliometric analysis of LCA studies from 1991 to 2022.

Considering the evolution of the quantity of LCA studies focusing on CE over time, an increase in the number of studies has been identified. Between 2015 and 2018, 87 studies were published, while between 2019 and 2022, 148 studies were published, representing a 70% increase over time. This growing interest in integrating the topic of CE into LCA studies indicates a trend for the future as well, given that CE is progressively gaining more significance in business, governmental, and academic spheres as a driver for sustainable development.

Results within both categories I and II (introduction/goal and scope, inventory analysis) exhibited a notable degree of similarity, characterized by closely calculated averages (16.5% and 17.1%, respectively) and relatively similar ranking of industries. This observation suggests an enhanced propensity for the availability of LCI data for CE activities when their definitions are comprehensively elaborated upon during the study's preliminary phase. Among the most commonly encountered secondary and tertiary activities in the articles, recycling and recovery stand out, jointly holding a supremacy over the others, followed by reuse. One reason for the absence of greater diversity in circular strategies within LCA studies likely stems from the more linear nature of the data used and the present absence of more precise methods and standards to incorporate additional cycles of CE into LCA studies. This view is shared by Cilleruelo Palomero et al. (2024), who argue about the current existence of LCA databases mostly tailored for linear systems.

Although a low presence of CE indicators in LCA studies (category III) was observed (8%), activities related to CE and their impact are indirectly addressed in the various analyzed studies by means of the statement of relevance (category IV), with high intensity (20 %), medium (4%), or low (38%). The existence of statements of relevance for CE activities in LCAs, in a higher proportion than those with specific CE indicators, demonstrates a potential future for the increasing incorporation of new CE indicators. The work by Saidani et al. (2022) also addresses this trend of greater inclusion of typical CE indicators in LCA studies, although it is yet unclear which metrics or methods are appropriate to evaluate circularity.

Additionally, there were a predominance of recycling (78%) and recovery (25%) over other more interesting options from a product integrity and consequent added value preservation perspective. The supremacy of recycling and recovery strategies demonstrates a potential disconnect between LCA studies and cutting-edge circularity initiatives.

Although the social aspects were not considered in the study, it is recognized that the implementation of CE strategies and circular business models inevitably will produce social implications (Padilla-Rivera et al., 2020). For instance, certain sectors, countries, and professions (e.g. related to raw material extraction or waste disposal) might lose revenues and employment. At the same time, the social acceptance and social norms and values will have a large effect on the actual success of circular solutions and determine the use phase of respective LCA studies. Future research might further include these considerations and integrate social LCA consideration into integrative CE and LCA approaches.

Regeneration is an important aspect and strategy of CE. Certain LCA studies evaluate regenerative strategies, contributing to restoring, renewing, or revitalizing natural resources and system. For instance, Seghetta et al. (2016)used LCA to verify the feasibility of a biorefinery that utilizes offshore cultivated seaweed to provide regeneration services. In this case, LCA results has shown the system was able to contribute to climate change mitigation by substitution of gasoline and soybean proteins, while returning excess atmospheric and marine carbon (HCO3). While this study subordinated regenerative CE strategies to the logic of the (ten) R-strategies, future studies could pay particular attention to regenerative strategies and biological cycles in the interplay between CE and LCA.

5. CONCLUSION & OUTLOOK

The results of this study reveal that CE activities are generally not regarded as a hot spot in product LCA studies, with only 20 % of the reviewed studies attributing a high relevance to CE activities across all industries considered. Secondly, it highlights the inadequate attention afforded to CE within the different stages of an LCA. Inside goal and scope definition more than 70 % of the reviewed studies provide little to no information on CE; in the inventory analysis only 7 % of the reviewed LCA studies provide advanced documentation of LCI data pertaining to CE activities; within impact assessment, specific CE indicators were scarcely encountered; and merely 14 % of the reviewed studies conducted a sensitivity analysis on CE in the interpretation phase. Building upon these results, this review exposes a notable deficiency in the extent of coverage and support for CE within contemporary LCA studies.

According to the results of this review study, different recommendations for further action can be derived for all industries considered. First of all, activities to foster CE need to be described in more detail in goal and scope as well as in inventory analysis. During impact assessment, specific CE indicators should be considered, e.g. by applying concepts such as Material Circularity Indicator (EMF, 2019), Circular Performance Indicator (Huysman et al., 2017), Circular Economy Index (Di Maio & Rem, 2015) or the identification of Life Cycle Gaps (Dieterle et al., 2018). As part of the interpretation stage, different perspectives need to be considered and sensitivity analysis of different CE scenarios is recommended.

The findings of this study reinforce and encourage research on the interplay of CE and LCA, concerning, for instance, the integration and proper representation of secondary, tertiary and further CE cycles into LCA studies. Furthermore, it would be worth finding out whether the comprehensive consideration of CE within LCA studies would significantly change the results and recommendations of existing LCA studies - such as those considered in this study. It should be emphasized and reiterated that CE is an important component for achieving ecological and economic sustainability of products and companies and that a comprehensive and systematic consideration and classification of CE in the LCA methodology is of vital importance for practice and research alike.

AUTHOR CONTRIBUTIONS

Juliano Bezerra de Araujo: Writing – original draft, developing of graphs and figures, drawing conclusions.
Michael Dieterle: Conception and design of study, writing – original draft, reviewing literature, drawing conclusions, validation of the study.
Luis Schell: Reviewing literature.
Tayla Herrmann: Reviewing literature.
Marina Haug: Reviewing literature.
Tobias Viere: Conception and design of study, writing – original draft & reviewing, drawing conclusions, validation of the study.

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DECLARATIONS

Competing interests The authors declare no competing interests.

APPENDIX A

Further detailed information on the review of the identified LCA studies can be found in the attached electronic supplementary material (ESM). To find a full-size table click here.

Paper	**Author(s)**	**Year**	**Title**	**DOI**	**(End-)Product**	**Industrie Macro**	**Industrie Meso**	**System boundaries**	**Functional unit**	**Introduction/ Goal and Scope:** Activites on CE described	**Inventory analysis:** Data on CE activities reported	**CE activities:** R-Principles	**Impact assessment:** Specific indicator for CE activities applied	**Results:** Statement on relevance of CE activities with regard to final LCA results	**Interpretation:** Sensitivity on CE analyzed	**Outlook:** Suggestions for further CE activities derived	**Reproducibility:** Final LCA results were documented in a reproducible way by distinguishing between several life cycle stages
1	Abd Rashid, AF; Idris, J; Yusoff, S	2017	Environmental Impact Analysis on Residential Building in Malaysia Using Life Cycle Assessment	http://dx.doi.org/10.3390/su9030329	House	Construction	Construction of buildings	cradle-to-grave	1 m^2 of gross floor area	Brief	Basic	Recycle	No	No statement	No	No	No
2	Abouhamad, M; Abu-Hamd, M	2021	Life Cycle Assessment Framework for Embodied Environmental Impacts of Building Construction Systems	http://dx.doi.org/10.3390/su13020461	University building	Construction	Construction of buildings	cradle-to-grave	n.d.	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
3	Accardo, A; Dotelli, G; Musa, ML; Spessa, E	2021	Life Cycle Assessment of an NMC Battery for Application to Electric Light-Duty Commercial Vehicles and Comparison with a Sodium-Nickel-Chloride Battery	http://dx.doi.org/10.3390/app11031160	NMC battery for electric vehicle	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of Nominal energy capacity of the battery pack	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
4	Adsal, KA; Uctug, FG; Arikan, OA	2020	Environmental life cycle assessment of utilizing stem waste for banana production in greenhouses in Turkey	http://dx.doi.org/10.1016/j.spc.2020.02.009	Banana	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	2 tons of bananas produced	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
5	Ahamed, A; Vallam, P; Iyer, NS; Veksha, A; Bobacka, J; Lisak, G	2021	Life cycle assessment of plastic grocery bags and their alternatives in cities with con fi ned waste management structure: A Singapore case study	http://dx.doi.org/10.1016/j.jclepro.2020.123956	grocery bags	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	820 million bag equivalents	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
6	Al-Behadili, SH; El-Osta, WB	2015	Life Cycle Assessment of Dernah (Libya) wind farm	http://dx.doi.org/10.1016/j.renene.2015.05.041	Wind farm	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	the kWh electricity produced	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
7	Alberola-Borras, JA; Vidal, R; Juarez-Perez, EJ; Mas-Marza, E; Guerrero, A; Mora-Sero, I	2018	Relative impacts of methylammonium lead triiodide perovskite solar cells based on life cycle assessment	http://dx.doi.org/10.1016/j.solmat.2017.11.008	Perovskite solar cells	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 cm^2 of active surface area	Comprehensive	Basic	Reuse, Recycle	No	Low	No	No	No
8	Alejandre, C; Akizu-Gardoki, O; Lizundia, E	2022	Optimum operational lifespan of household appliances considering manufacturing and use stage improvements via life cycle assessment	http://dx.doi.org/10.1016/j.spc.2022.04.007	washing machine, microwave, dishwasher	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	operating lifespan of each electric appliance	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
9	Alhazmi, H; Alduwais, AK; Tabbakh, T; Aljamlani, S; Alkahlan, B; Kurdi, A	2021	Environmental Performance of Residential Buildings: A Life Cycle Assessment Study in Saudi Arabia	http://dx.doi.org/10.3390/su13063542	house (villa)	Construction	Construction of buildings	cradle-to-grave	villa with a total gross floor area (GFA) of 387 m^2 and a lifespan of 50 years	No	No	No	No	No statement	No	No	No
10	Al-Khori, K; Al-Ghamdi, SG; Boulfrad, S; Koc, M	2021	Life Cycle Assessment for Integration of Solid Oxide Fuel Cells into Gas Processing Operations	http://dx.doi.org/10.3390/en14154668	fuel cell	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 MW electricity output	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope

11	Allan, K; Phillips, AR	2021	Comparative Cradle-to-Grave Life Cycle Assessment of Low and Mid-Rise Mass Timber Buildings with Equivalent Structural Steel Alternatives	http://dx.doi.org/10.3390/su13063401	5- and 12-story building	Construction	Construction of buildings	cradle-to-grave	n.d.	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
12	Almutairi, K; Thoma, G; Burek, J; Algarni, S; Nutter, D	2015	Life cycle assessment and ecoNomic analysis of residential air conditioning in Saudi Arabia	http://dx.doi.org/10.1016/j.enbuild.2015.06.004	air conditioning	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	climate control of 1 m^2 of living area	Brief	Basic	Recycle	No	Low	No	No	No
13	Alvarez-del-Castillo, MD; Garrido-Soriano, N; Casadesus, M; Macanas, J; Molins-Duran, G; Carrillo-Navarrete, F	2022	Environmental Impact of Chicken Feathers Based Polypropylene Composites Developed for Automotive and Stationary Applications and Comparison with Glass-Fibre Analogues	http://dx.doi.org/10.1007/s12649-022-01810-0	automotive/stationary applications (panels)	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	1. equivalent mass necessary to make all the internal panels of an average car; 2. equivalent mass to manufacture fat Non-structural panels	Brief	Basic	Recover	No	No statement	No	No	No
14	Anil, SK; Ma, JF; Kremer, GE; Ray, CD; Shahidi, SM	2020	Life cycle assessment comparison of wooden and plastic pallets in the grocery industry	http://dx.doi.org/10.1111/jiec.12974	wodden and plastic pallets	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	required number of wooden or plastic pallets for a certain number of trips	Brief	Basic	Reuse, Repair, Recycle, Recover	No	Low	Quantitative	Brief	No
15	Apolonia, M; Simas, T	2021	Life Cycle Assessment of an Oscillating Wave Surge Energy Converter	http://dx.doi.org/10.3390/jmse9020206	wave energy converter	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh electricity delivered to the Portuguese electricity network	Brief	Basic	Recycle	No	High	Quantitative	Brief	No
16	Asadi, S; Babaizadeh, H; Foster, N; Broun, R	2016	Environmental and ecoNomic life cycle assessment of PEX and copper plumbing systems: A case study	http://dx.doi.org/10.1016/j.jclepro.2016.08.006	PEX and copper pipes	Manufacturing	Manufacture of fabricated metal products, except machinery and equipment	cradle-to-grave	required amount of piping for each alternative for the under study building	Brief	No	Recycle	No	No statement	No	No	No
17	Ata-Ali, N; Penades-Pla, V; Martinez-Munoz, D; Yepes, V	2021	Recycled versus Non-recycled insulation alternatives: LCA analysis for different climatic conditions in Spain	http://dx.doi.org/10.1016/j.resconrec.2021.105838	ventilated facedes	Construction	Specialized construction activities	cradle-to-grave	1 m^2	Brief	No	Recycle	No	No statement	No	No	No
18	Auer, J; Meincke, A	2018	Comparative life cycle assessment of electric motors with different efficiency classes: a deep dive into the trade-offs between the life cycle stages in ecodesign context	http://dx.doi.org/10.1007/s11367-017-1378-8	electric motors	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	provision of mechanical power in an applied usage scenario	Brief	Basic	Recycle, Recover	No	Low	No	Comprehensive	No
19	Ayagapin, L; Praene, JP	2020	Environmental Overcost of Single Family Houses in Insular Context: A Comparative LCA Study of Reunion Island and France	http://dx.doi.org/10.3390/su12218937	single family houses	Construction	Construction of buildings	cradle-to-grave	1 m^2 of constructed area floor	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
20	Babaizadeh, H; Haghighi, N; Asadi, S; Broun, R; Riley, D	2015	Life cycle assessment of exterior window shadings in residential buildings in different climate zones	http://dx.doi.org/10.1016/j.buildenv.2015.03.038	exterior shades	Construction	Specialized construction activities	cradle-to-grave	1 unit of shading	Brief	Basic	Recycle	No	No statement	No	No	No
21	Balasbaneh, AT; Ramli, MZ	2020	A comparative life cycle assessment (LCA) of concrete and steel-prefabricated prefinished volumetric construction structures in Malaysia	http://dx.doi.org/10.1007/s11356-020-10141-3	steel and concrete prefinished volumetric construction	Construction	Specialized construction activities	cradle-to-grave	1 m^2 of a wall component	Brief	Basic	Reuse, Recycle	No	High	No	No	No
22	Bandekar, PA; Putman, B; Thoma, G; Matlock, M	2022	Cradle-to-grave life cycle assessment of production and consumption of pulses in the United States	http://dx.doi.org/10.1016/j.jenvman.2021.114062	pulses	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	60 g of pulses	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
23	Baydar, G; Ciliz, N; Mammadov, A	2015	Life cycle assessment of cotton textile products in Turkey	http://dx.doi.org/10.1016/j.resconrec.2015.08.007	T-Shirt	Manufacturing	Manufacture of textiles	cradle-to-grave	1000 items of knitted and dyed cotton T-shirt	No	No	No	No	No statement	No	No	No
24	Benavides, PT; Dunn, JB; Han, J; Biddy, M; Markharn, J	2018	Exploring Comparative Energy and Environmental Benefits of Virgin, Recycled, and Bio-Derived PET Bottles	http://dx.doi.org/10.1021/acssuschemeng.8b00750	PET Bottle	Manufacturing	Manufacture of beverages	cradle-to-grave	one 26 g, 500 ml PET bottle	Brief	Basic	Recycle	No	Low	No	Brief	No

25	Benveniste, G; Pucciarelli, M; Torrell, M; Kendall, M; Tarancon, A	2017	Life Cycle Assessment of microtubular solid oxide fuel cell based auxiliary power unit systems for recreational vehicles	http://dx.doi.org/10.1016/j.jclepro.2017.07.130	auxiliary power unit systems	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	450 MJ of energy produced	Brief	Basic	Reduce, Recycle	No	No statement	Quantitative	No	No
26	Besseau, R; Sacchi, R; Blanc, I; Perez-Lopez, P	2019	Past, present and future environmental footprint of the Danish wind turbine fleet with LCA_WIND_DK, an online interactive platform	http://dx.doi.org/10.1016/j.rser.2019.03.030	wind turbine fleet	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply			Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
27	Bhatt, A; Bradford, A; Abbassi, BE	2019	Cradle-to-grave life cycle assessment (LCA) of low-impact-development (LID) techNologies in southern Ontario	http://dx.doi.org/10.1016/j.jenvman.2018.10.033	low-impact-development (LID) parking lot	Construction	Civil engineering	cradle-to-grave	1 m^2 of impervious area treated by the system	Brief	Basic	Reuse, Recycle	No	No statement	No	No	No
28	Bicer, Y; Khalid, F	2020	Life cycle environmental impact comparison of solid oxide fuel cells fueled by natural gas, hydrogen, ammonia and methaNol for combined heat and power generation	http://dx.doi.org/10.1016/j.ijhydene.2018.11.122		Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply			Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
29	Bonamente, E; Cotana, F	2015	Carbon and Energy Footprints of Prefabricated Industrial Buildings: A Systematic Life Cycle Assessment Analysis	http://dx.doi.org/10.3390/en81112333	prefabricated industrial buildings	Construction	Construction of buildings	cradle-to-grave	1 m^3 of prefabricated building	Brief	No	Recycle	No	No statement	No	No	No
30	Bonamente, E; Pelliccia, L; Merico, MC; Rinaldi, S; Petrozzi, A	2015	The Multifunctional Environmental Energy Tower: Carbon Footprint and Land Use Analysis of an Integrated Renewable Energy Plant	http://dx.doi.org/10.3390/su71013564	stand-alone renewable energy plant	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of produced energy	Brief	Basic	Recycle	No	Low	Quantitative	No	No
31	Bonamente, E; Scrucca, F; Rinaldi, S; Merico, MC; Asdrubali, F; Lamastra, L	2016	Environmental impact of an Italian wine bottle: Carbon and water footprint assessment	http://dx.doi.org/10.1016/j.scitotenv.2016.04.026	wine bottle	Manufacturing	Manufacture of beverages	cradle-to-grave	0,75 l wine bottle	No	Basic	Recycle	No	No statement	No	No	No
33	Botejara-Antunez, M; Gonzalez-Dominguez, J; Garcia-Sanz-Calcedo, J	2022	Comparative analysis of flat roof systems using life cycle assessment methodology: Application to healthcare buildings	http://dx.doi.org/10.1016/j.cscm.2022.e01212	flat roof	Construction	Specialized construction activities	cradle-to-grave	1 m^2 of roof area	No	No	No	No	No statement	No	No	No
34	Boutros, M; Saba, S; Manneh, R	2021	Life cycle assessment of two packaging materials for carbonated beverages (polyethylene terephthalate vs. glass): Case study for the lebanese context and importance of the end-of-life scenarios	http://dx.doi.org/10.1016/j.jclepro.2021.128289	bottles	Manufacturing	Manufacture of beverages	cradle-to-grave	hold 50 ml of a carbonated beverage	Brief	Basic	Reuse, recycle	No	High	Quantitative	No	No
35	Buccino, C; Ferrara, C; Malvano, C; De Feo, G	2019	LCA of an ice cream cup of polyethylene coated paper: how does the choice of the end-of-life affect the results?	http://dx.doi.org/10.1080/09593330.2017.1397771	ice cream cup	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	one ice cream cup	No	No	Recover	No	No statement	No	No	No
36	Burchart-Korol, D; Jursova, S; Folega, P; Korol, J; Pustejovska, P; Blaut, A	2018	Environmental life cycle assessment of electric vehicles in Poland and the Czech Republic	http://dx.doi.org/10.1016/j.jclepro.2018.08.145	electric vehicle	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	150.000 km	No	No	No	No	No statement	No	No	No
37	Burchart-Korol, D; Zawartka, P	2019	Environmental life cycle assessment of septic tanks in urban wastewater system - a case study for Poland	http://dx.doi.org/10.24425/aep.2019.130243	septic tanks	Water supply; sewerage, waste management and remediation activities	Sewerage	cradle-to-grave	1 population-equivalent	Brief	Basic	Recycle	No	Low	No	No	No
38	Buyle, M; Galle, W; Debacker, W; Audenaert, A	2019	Sustainability assessment of circular building alternatives: Consequential LCA and LCC for internal wall assemblies as a case study in a Belgian context	http://dx.doi.org/10.1016/j.jclepro.2019.01.306	wall	Construction	Specialized construction activities	cradle-to-grave	one 1m^2 space dividing wall	Comprehensive	Basic	Reuse, Recycle	No	High	Qualitative	Brief	No
40	Calado, EA; Leite, M; Silva, A	2019	Integrating life cycle assessment (LCA) and life cycle costing (LCC) in the early phases of aircraft structural design: an elevator case study	http://dx.doi.org/10.1007/s11367-019-01632-8	aircraft elevator	Manufacturing	Manufacture of other transport equipment	cradle-to-grave	one medium size cargo aircraft elevator	Brief	Basic	Recycle, Recover	No	Low	No	No	No
41	Cappucci, GM; Ruffini, V; Barbieri, V; Siligardi, C; Ferrari, AM	2022	Life cycle assessment of wheat husk based agro-concrete block	http://dx.doi.org/10.1016/j.jclepro.2022.131437	wall	Construction	Specialized construction activities	cradle-to-grave	1 m^2 of wall	Brief	Basic	Recycle	No	Low	Quantitative	Brief	No
42	Carvalho, ML; Temporelli, A; Girardi,	2021	Life Cycle Assessment of Stationary Storage Systems within the Italian Electric Network	http://dx.doi.org/10.3390/en14082047	battery	Manufacturing	Manufacture of	cradle-to-grave	1 kWh of energy released	Brief	Basic	Recycle, Recover	No	Low	No	No	No

	P						electrical equipment										
43	Casamayor, JL; Su, D; Ren, Z	2018	Comparative life cycle assessment of LED lighting products	http://dx.doi.org/10.1177/1477153517708597	table lamp	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	the production of 948 lm of light	Brief	Basic	Reduce, Recycle	No	No statement	Quantitative	No	No
44	Cascione, V; Roberts, M; Allen, S; Dams, B; Maskell, D; Shea, A; Walker, P; Emmitt, S	2022	Integration of life cycle assessments (LCA) in circular bio-based wall panel design	http://dx.doi.org/10.1016/j.jclepro.2022.130938	wall	Construction	Specialized construction activities	cradle-to-cradle	1 m^2	Brief	No	Reuse, Remanufacture, Recycle, Recover	No	Low	No	No	No
45	Casson, A; Beghi, R; Giovenzana, V; Fiorindo, I; Tugnolo, A; Guidetti, R	2019	Visible Near Infrared Spectroscopy as a Green TechNology: An Environmental Impact Comparative Study on Olive Oil Analyses	http://dx.doi.org/10.3390/su11092611	olive oil	Manufacturing	Manufacture of vegetable and animal oils and fats	cradle-to-grave	the pool of analyses necessary to obtain the three parameters	No	No	No	No	No statement	No	No	No
46	Cecchel, S; Chindamo, D; Collotta, M; Cornacchia, G; Panvini, A; Tomasoni, G; Gadola, M	2018	Lightweighting in light commercial vehicles: cradle-to-grave life cycle assessment of a safety-relevant component	http://dx.doi.org/10.1007/s11367-017-1433-5	vehicle	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	350000 km driven	Brief	Basic	Recycle	No	Low	Quantitative	No	No
47	Chen, YS; Ding, ZS; Liu, JH	2019	Life Cycle Assessment of Environmental Emissions and Scenario Simulation of an Automotive Power Seat Considering Scrap Recycling	http://dx.doi.org/10.1089/ees.2018.0507	automotive power seats	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	usage of seats for 15 years	Brief	Basic	Reuse, Remanufacture, Recycle	No	Low	No	No	No
48	Chen, YS; Hu, X; Liu, JH	2019	Life Cycle Assessment of Fuel Cell Vehicles Considering the Detailed Vehicle Components: Comparison and Scenario Analysis in China Based on Different Hydrogen Production Schemes	http://dx.doi.org/10.3390/en12153031	fuel cell vehicle (Toyota Mirai)	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	250000 km driven	Brief	Basic	Recycle	No	High	No	No	No
49	Chen, ZJ; Gu, HM; Bergman, RD; Liang, SB	2020	Comparative Life-Cycle Assessment of a High-Rise Mass Timber Building with an Equivalent Reinforced Concrete Alternative Using the Athena Impact Estimator for Buildings	http://dx.doi.org/10.3390/su12114708	building	Construction	Construction of buildings	cradle-to-grave	n.d.	Brief	No	Reuse, Recycle	No	Low	No	No	No
50	Cibelli, M; Cimini, A; Cerchiara, G; Moresi, M	2021	Carbon footprint of different methods of coffee preparation	http://dx.doi.org/10.1016/j.spc.2021.04.004	Coffee	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	one 40 ml cup of coffee	Brief	Basic	Recycle	No	Low	No	No	No
51	Cimini, A; Moresi, M	2018	Effect of Brewery Size on the Main Process Parameters and Cradle-to-Grave Carbon Footprint of Lager Beer	http://dx.doi.org/10.1111/jiec.12642	beer	Manufacturing	Manufacture of beverages	cradle-to-grave	1 hL of lager beer packed in 66-cL (glass or PET) bottles	Comprehensive	Basic	Reuse, Repair, Recycle	No	Low	Quantitative	Brief	No
52	Cimini, A; Moresi, M	2018	Mitigation measures to minimize the cradle-to-grave beer carbon footprint as related to the brewery size and primary packaging materials	http://dx.doi.org/10.1016/j.jfoodeng.2018.05.001	beer	Manufacturing	Manufacture of beverages	cradle-to-grave	1 hL of lager beer packed in 66-cL glass (GB) or PET (PB) bottles	Brief	Basic	Reduce, Recycle, Recover	No	Low	No	No	No
53	Cobut, A; Blanchet, P; Beauregard, R	2015	The environmental footprint of interior wood doors in Non-residential buildings - part 1: life cycle assessment	http://dx.doi.org/10.1016/j.jclepro.2015.04.079	door	Manufacturing	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	cradle-to-grave	closure + separation of 2 rooms with communicating surface of 2.1 by 0.9 m	No	No	No	No	No statement	No	Brief	No
54	Comodi, G; Bevilacqua, M; Caresana, F; Paciarotti, C; Pelagalli, L; Venella, P	2016	Life cycle assessment and energy-CO2-ecoNomic payback analyses of renewable domestic hot water systems with unglazed and glazed solar thermal panels	http://dx.doi.org/10.1016/j.apenergy.2015.08.036	domestic hot water system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	entire equipment able to satisfy the hot water energy demand of a 4-occupants apartment	Brief	No	Recycle	No	No statement	No	No	No
55	Cordella, M; Bauer, I; Lehmann, A; Schulz, M; Wolf, O	2015	Evolution of disposable baby diapers in Europe: life cycle assessment of environmental impacts and identification of key areas of improvement	http://dx.doi.org/10.1016/j.jclepro.2015.02.040	disposable baby diapers	Manufacturing	Manufacture of wearing apparel	cradle-to-grave	production and consumption of one unit of product	Brief	No	Recycle, Recover	No	Low	No	Brief	No

56	Corradini, G; Pierobon, F; Zanetti, M	2019	Product environmental footprint of a cross-laminated timber system: a case study in Italy	http://dx.doi.org/10.1007/s11367-018-1541-x	MHM (Massiv-Holz-Mauer) wall element	Construction	Specialized construction activities	cradle-to-grave	1 m^2 of wall element	Brief	No	Reduce, Recycle	No	No statement	No	Brief	No
57	Cossutta, M; Vretenar, V; Centeno, TA; Kotrusz, P; McKechnie, J; Pickering, SJ	2020	A comparative life cycle assessment of graphene and activated carbon in a supercapacitor application	http://dx.doi.org/10.1016/j.jclepro.2019.118468	supercapacitor application	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 supercapacitor rack of 5 supercapacitors with capacitance of 5 F	Comprehensive	Basic	Reuse, Recycle	No	High	No	Brief	No
58	Cucinotta, F; Raffaele, M; Salmeri, F; Sfravara, F	2021	A comparative Life Cycle Assessment of two sister cruise ferries with Diesel and Liquefied Natural Gas machinery systems	http://dx.doi.org/10.1016/j.apor.2021.102705	ship	Manufacturing	Manufacture of other transport equipment	cradle-to-grave	1 ship during its lifetime	Brief	Basic	Recycle	No	No statement	No	No	No
59	Cusenza, MA; Guarino, F; Longo, S; Cellura, M	2022	An integrated energy simulation and life cycle assessment to measure the operational and embodied energy of a Mediterranean net zero energy building	http://dx.doi.org/10.1016/j.enbuild.2021.111558	Net zero energy building	Construction	Specialized construction activities	cradle-to-grave	1 m^2 conditioned area during one year	Comprehensive	Advanced	Recycle, Recover	No	Low	No	No	No
60	Dalla Riva, A; Burek, J; Kim, D; Thoma, G; Cassandro, M; De Marchri, M	2017	Environmental life cycle assessment of Italian mozzarella cheese: Hotspots and improvement opportunities	http://dx.doi.org/10.3168/jds.2016-12396	High moisture mozzarella cheese	Manufacturing	Manufacture of dairy products	cradle-to-grave	1 kg of HM mozzarella cheese	Brief	Basic	Recycle	No	No statement	No	No	No
61	D'Ammaro, D; Capri, E; Valentino, F; Grillo, S; Fiorini, E; Lamastra, L	2021	Benchmarking of carbon footprint data from the Italian wine sector: A comprehensive and extended analysis	http://dx.doi.org/10.1016/j.scitotenv.2021.146416	wine	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	1 bottle of 0.75 L of wine	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
62	Dani, AA; Roy, K; Masood, R; Fang, ZY; Lim, JBP	2022	A Comparative Study on the Life Cycle Assessment of New Zealand Residential Buildings	http://dx.doi.org/10.3390/buildings12010050	residential building	Construction	Construction of buildings	cradle-to-cradle	annual carbon emissions per gross floor area (GFA)	Brief	Basic	Reuse, Recycle, Recover	No	No statement	No	No	No
63	David, G; Vega, GC; Sohn, J; Nilsson, AE; Helias, A; Gontard, N; Angellier-Coussy, H	2021	Using life cycle assessment to quantify the environmental benefit of upcycling vine shoots as fillers in biocomposite packaging materials	http://dx.doi.org/10.1007/s11367-020-01824-7	rigid tray	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1 tray of standard model (176 × 162 × 40 mm, GN 1/6 type), 25 cm3 in volume, for single-use packaging	Brief	No	Recycle	No	No statement	No	Brief	No
64	De Marco, I; Riemma, S; Lannone, R	2018	Uncertainty of input parameters and sensitivity analysis in life cycle assessment: An Italian processed tomato product	http://dx.doi.org/10.1016/j.jclepro.2017.12.258	mashed tomatos	Manufacturing	Processing and preserving of fruit and vegetables	cradle-to-grave	500 g of mashed tomato produced and packaged in Tetra Pak®	Brief	Basic	Recycle, Recover	No	No statement	No	Brief	No
65	de Otazu, RLDD; Akizu-Gardoki, O; de Ulibarri, B; Iturrondobeitia, M; Minguez, R; Lizundia, E	2022	Ecodesign coupled with Life Cycle Assessment to reduce the environmental impacts of an industrial enzymatic cleaner	http://dx.doi.org/10.1016/j.spc.2021.11.016	industrial enzymatic multipurpose cleaner	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	1 kg of detergent in its container	Brief	Basic	Reduce, Reuse, Recycle	No	Low	Quantitative	Brief	No
66	Delgado, MAS; Usai, L; Pan, QY; Stromman, AH	2019	Comparative Life Cycle Assessment of a Novel Al-Ion and a Li-Ion Battery for Stationary Applications	http://dx.doi.org/10.3390/ma12193270	Al-ion battery	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	(1) per cell manfactured, (2) per Wh of storage capacity	Comprehensive	Advanced	Recycle	No	Low	No	No	No
67	Deng, YL; Paraskevas, D; Tian, YJ; Van Acker, K; Dewulf, W; Duflou, JR	2016	Life cycle assessment of flax-fibre reinforced epoxidized linseed oil composite with a flame retardant for electronic applications	http://dx.doi.org/10.1016/j.jclepro.2016.05.172	biobased PCB substrate	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 m^2 of PCB substrate with a thickness of 1.6 mm	Comprehensive	Advanced	Recycle, Recover	No	Low	No	No	No
68	Diaz-Basteris, J; Rivero, JCS; Menendez, B	2022	Life cycle assessment of restoration mortars and binders	http://dx.doi.org/10.1016/j.conbuildmat.2022.126863	mortar	Manufacturing	Manufacture of other non-metallic mineral products	cradle-to-grave	1 t mortar	Brief	No	Recycle	No	Low	No	Brief	No
69	Donahue, LM; Hilton, S; Bell, SG; Williams, BC; Keoleian, GA	2020	A comparative carbon footprint analysis of disposable and reusable vaginal specula	http://dx.doi.org/10.1016/j.ajog.2020.02.007	vaginal specula	Manufacturing	Other manufacturing	cradle-to-grave	completion of 20 gynecologic examinations	Brief	No	Reuse	Yes	High	Quantitative	Brief	No
70	Eranki, PL; Landis, AE	2019	Pathway to domestic natural rubber production: a cradle-to-grave life cycle assessment of the first guayule automobile tire manufactured in the United States	http://dx.doi.org/10.1007/s11367-018-1572-3	guayule tire	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	(1) 1 kg of natural rubber, (2) 1 tire	Brief	Basic	Recover	No	No statement	No	No	No

71	Erkayaoglu, M; Demirel, N	2016	A comparative life cycle assessment of material handling systems for sustainable mining	http://dx.doi.org/10.1016/j.jenvman.2016.03.011	off-highway trucks and belt conveyors	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-operation		Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
72	Evangelista, PPA; Kiperstok, A; Torres, EA; Goncalves, JP	2018	Environmental performance analysis of residential buildings in Brazil using life cycle assessment (LCA)	http://dx.doi.org/10.1016/j.conbuildmat.2018.02.045	residential building	Construction	Construction of buildings	cradle-to-grave	square meters of total built-up area of the building per year (m^2/year)	No	No	No	No	No statement	No	No	No
73	Evangelisti, S; Tagliaferri, C; Brett, DJL; Lettieri, P	2017	Life cycle assessment of a polymer electrolyte membrane fuel cell system for passenger vehicles	http://dx.doi.org/10.1016/j.jclepro.2016.11.159	fuel cell vehicle	Manufacturing	Manufacture of computer, electronic and optical products	cradle-to-grave	1 km driven by one vehicle (car)	Brief	Basic	Recycle, Recover	No	Low	No	No	No
74	Faludi, J; Bayley, C; Bhogal, S; Iribarne, M	2015	Comparing environmental impacts of additive manufacturing vs traditional machining via life-cycle assessment	http://dx.doi.org/10.1108/RPJ-07-2013-0067	additive manufacturing machines	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	manufacturing of two specific parts in acrylonitrile butadiene styrene (ABS) plastic or similar polymer	Brief	No	Recycle, Recover	No	Low	Qualitative	No	No
75	Famiglietti, J; Toppi, T; Pistocchini, L; Scoccia, R; Motta, M	2021	A comparative environmental life cycle assessment between a condensing boiler and a gas driven absorption heat pump	http://dx.doi.org/10.1016/j.scitotenv.2020.144392	gas heat pump	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	1 kWh of thermal energy	Brief	Advanced	Recycle	No	No statement	No	No	No
76	Fu, YY; Liu, X; Yuan, ZW	2015	Life-cycle assessment of multi-crystalline photovoltaic (PV) systems in China	http://dx.doi.org/10.1016/j.jclepro.2014.07.057		Manufacturing	Manufacture of electrical equipment			Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
77	Fulford, B; Mezzi, K; Whiting, A; Aumonier, S	2021	Life-Cycle Assessment of the Breezhaler(R) Breath-Actuated Dry Powder Inhaler	http://dx.doi.org/10.3390/su13126657	inhaler	Manufacturing	Other manufacturing	cradle-to-grave	an inhaler device, excluding active pharmaceutical ingredients (APIs)	Brief	No	Recycle	No	No statement	No	No	No
78	Gabriel, NR; Martin, KK; Haslam, SJ; Faile, JC; Kamens, RM; Gheewala, SH	2021	A comparative life cycle assessment of electric, compressed natural gas, and diesel buses in Thailand	http://dx.doi.org/10.1016/j.jclepro.2021.128013	diesel/electric bus	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	to transport 46 people, 170 km every day for 15 years	Brief	No	Recycle	No	Low	No	Brief	No
79	Gagliardi, F; Rosa, ADL; Filice, L; Ambrogio, G	2021	Environmental impact of material selection in a car body component-The side door intrusion beam	http://dx.doi.org/10.1016/j.jclepro.2021.128528	side-door intrusion beams	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	absorb the fixed energy of 17,7 kJ	Brief	Basic	Recycle	No	Low	No	No	No
80	Gallucci, T; Lagioia, G; Piccinno, P; Lacalamita, A; Pontrandolfo, A; Paiano, A	2021	Environmental performance scenarios in the production of hollow glass containers for food packaging: an LCA approach	http://dx.doi.org/10.1007/s11367-020-01797-7	glass container	Manufacturing	Manufacture of other non-metallic mineral products	cradle-to-grave	1 kg of finished hollow glass	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
81	Galve, JE; Elduque, D; Pina, C; Javierre, C	2022	Life Cycle Assessment of a Plastic Part Injected with Recycled Polypropylene: A Comparison with Alternative Virgin Materials	http://dx.doi.org/10.1007/s40684-021-00363-2	plastic component present in the induction cooktops	Manufacturing	Manufacture of rubber and plastics products		1 injected part delivered to the costumer	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
82	Gamboa, CJO; Ruiz, PAC; Kaloush, KE; Linares, JPL	2021	Life cycle assessment including traffic Noise: conventional vs. rubberized asphalt	http://dx.doi.org/10.1007/s11367-021-01992-0	rubberized asphalt	Manufacturing	Manufacture of other non-metallic mineral products			Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
83	Gasia, J; Fabiani, C; Chafer, M; Pisello, AL; Manni, A; Ascani, M; Cabeza, LF	2021	Life cycle assessment and life cycle costing of an inNovative component for refrigeration units	http://dx.doi.org/10.1016/j.jclepro.2021.126442	optimisation kit (the Turboalgor kit®) in a refrigeration	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	the whole Turboalgor kit®	Brief	Advanced	Recycle	No	Low	No	Brief	No
84	Gaudreault, C; Loehle, C; Prisley, S; Solarik, KA; Verschuyl, JP	2020	Are the factors recommended by UNEP-SETAC for evaluating biodiversity in LCA achieving their promises: a case study of corrugated boxes produced in the US	http://dx.doi.org/10.1007/s11367-020-01765-1	corrugated box	Manufacturing	Manufacture of paper and paper products	cradle-to-grave	The domestic use of 1 kg of an average corrugated product produced in the US	Brief	No	Recover	No	No statement	No	No	No

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85	Gawron, JH; Keoleian, GA; De Kleine, RD; Wallington, TJ; Kim, HC	2018	Life Cycle Assessment of Connected and Automated Vehicles: Sensing and Computing Subsystem and Vehicle Level Effects	http://dx.doi.org/10.1021/acs.est.7b04576	connected and automated vehicles (CAVs) subsystems	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	a passenger car with a service life of 160,000 miles traveled over 12 years	No	No	No	No	No statement	No	No	No
86	Gislason, S; Bruhn, S; Breseghello, L; Sen, B; Liu, G; Naboni, R		Porous 3D printed concrete beams show an environmental promise: a cradle-to-grave comparative life cycle assessment	http://dx.doi.org/10.1007/s10098-022-02343-9	load-bearing beam	Manufacturing	Other manufacturing	cradle-to-grave	Beams of 3 m in length with a span of 2.76 m in a simply supported beam setup, tested in three-point bending with a failure of 43.7 kN and an estimated lifetime of 50 years	Brief	Basic	Reuse, Recycle	No	Low	Quantitative	Brief	No
87	Gomes, R; Silvestre, JD; de Brito, J	2019	Environmental Life Cycle Assessment of Thermal Insulation Tiles for Flat Roofs	http://dx.doi.org/10.3390/ma12162595	thermal insulation tiles	Manufacturing	Manufacture of other non-metallic mineral products	cradle-to-grave	one finished and packed thermal insulation tile	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
88	Gouveia, JR; Silva, E; Mata, TM; Mendes, A; Caetano, NS; Martins, AA	2020	Life cycle assessment of a renewable energy generation system with a vanadium redox flow battery in a NZEB household A joint organization of University of Aveiro (UA), School of Engineering of the Polytechnic of Porto (ISEP) and SCIence and Engineering Institute (SCIEI)	http://dx.doi.org/10.1016/j.egyr.2019.08.024	Vanadium Reddox Flow Battery	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh supplied to the household	Brief	No	Recycle, Recover	No	Low	No	Brief	No
89	Grimmond, TR; Bright, A; Cadman, J; Dixon, J; Ludditt, S; Robinson, C; Topping, C	2021	Before/after intervention study to determine impact on life-cycle carbon footprint of converting from single-use to reusable sharps containers in 40 UK NHS trusts	http://dx.doi.org/10.1136/bmjopen-2020-046200	sharps container	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	total fill line litres (FLL) of sharps containers needed to dispose sharps over the respective study years across the 40 trusts	Brief	Basic	Reduce, Recycle	No	High	Qualitative	Brief	No
90	Gul, H; Uctug, FG; Gungormusler, M		Environmental life cycle assessment of industrially produced pickled and roasted vegetables	http://dx.doi.org/10.1007/s13762-021-03740-1	pickled cucumbers, roasted capia peppers	Manufacturing	Manufacture of food products	cradle-to-grave	one 1-kg jar (gross-weight) consumed by the household	Brief	Basic	Recycle	No	No statement	No	No	No
91	Gursel, IV; Moretti, C; Hamelin, L; Jakobsen, LG; Steingrimsdottir, MM; Junginger, M; Hoibye, L; Shen, L	2021	Comparative cradle-to-grave life cycle assessment of bio-based and petrochemical PET bottles	http://dx.doi.org/10.1016/j.scitotenv.2021.148642	polyethylene terephthalate (PET) bottles	Manufacturing	Manufacture of beverages	cradle-to-grave	packaging water in one hundred 0,5l bottles providing a shelf life of at least 9 months	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
92	Hahnel, G; Whyte, A; Biswas, WK	2021	A comparative life cycle assessment of structural flooring systems in Western Australia	http://dx.doi.org/10.1016/j.jobe.2020.102109	structural flooring systems	Construction	Specialized construction activities	cradle-to-cradle	floor area of 25 m^2	Comprehensive	Advanced	Reduce, Recycle, Recover	No	Low	No	Brief	No
93	Hampo, CC; Ya, HH; Abd Majid, MA; Mokhtar, AA; Rasangika, AHDK; Muhammed, M	2021	Life Cycle Assessment of a Vapor Compression Cooling System Integrated within a District Cooling Plant	http://dx.doi.org/10.3390/su132111940	vapor compression system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	he VCC systems used to charge the TES tank in a DC plant	Brief	Basic	Reduce, Recycle, Recover	No	No statement	No	No	No
94	Han, BL; Wang, RS; Yao, L; Liu, HX; Wang, ZG	2015	Life cycle assessment of ceramic facade material and its comparative analysis with three other common facade materials	http://dx.doi.org/10.1016/j.jclepro.2015.03.032	ceramic façade panels	Construction	Specialized construction activities	cradle-to-grave	1 m^2 CFP	Comprehensive	Advanced	Reduce, Reuse, Recycle	No	Low	No	Brief	No
95	Hasik, V; Escott, E; Bates, R; Carlisle, S; Faircloth, B; Bilec, MM	2019	Comparative whole-building life cycle assessment of reNovation and new construction	http://dx.doi.org/10.1016/j.buildenv.2019.106218	building	Construction	Construction of buildings	cradle-to-grave	1 building	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
96	Hayek, J; El Bachawati, M; Manneh, R	2021	Life cycle assessment and water footprint scarcity of yogurt	http://dx.doi.org/10.1007/s10668-021-01445-6	yogurt	Manufacturing	Manufacture of dairy products	cradle-to-grave	1 kg of yogurt in a transportable container	Brief	Basic	Reuse	No	Low	No	Brief	No

97	He, MB; Zong, SX; Li, YC; Ma, MM; Ma, X; Li, K; Han, X; Zhao, MY; Guo, LP; Xu, YL	2022	Carbon footprint and carbon neutrality pathway of green tea in China	http://dx.doi.org/10.1016/j.accre.2022.04.001	green tea	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	n.d.	Brief	Basic	Reduce, Recover	No	High	No	Comprehensive	No
98	Helmers, E; Dietz, J; Weiss, M	2020	Sensitivity Analysis in the Life-Cycle Assessment of Electric vs. Combustion Engine Cars under Approximate Real-World Conditions	http://dx.doi.org/10.3390/su12031241	car	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	impact equivalents/km	Brief	Basic	Reduce, Reuse	No	Low	No	Brief	No
99	Herrando, M; Elduque, D; Javierre, C; Fueyo, N	2022	Life Cycle Assessment of solar energy systems for the provision of heating, cooling and electricity in buildings: A comparative analysis	http://dx.doi.org/10.1016/j.enconman.2022.115402	solar energy system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	building energy system able to provide the energy demand of the building	No	No	No	No	No statement	No	No	No
100	Hicks, AL; Halvorsen, H	2019	Environmental impact of evolving coffee techNologies	http://dx.doi.org/10.1007/s11367-018-1575-0	coffee brewing system	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	6,5 years of coffee brewer lifetime	No	No	No	No	No statement	No	No	No
101	Hidalgo-Crespo, J; Moreira, CM; Jervis, FX; Soto, M; Amaya, JL; Banguera, L	2022	Circular ecoNomy of expanded polystyrene container production: Environmental benefits of household waste recycling considering renewable energies	http://dx.doi.org/10.1016/j.egyr.2022.01.071	food containers	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1.00 kg of 5 × 5 inch. with an average weight of 5.00 grams EPS food containers in Guayaquil, Ecuador, meaning that 200 food containers are needed to fulfill the total weight	Comprehensive	Advanced	Recycle	No	High	Quantitative	Brief	No
102	Horowitz, N; Frago, J; Mu, DY	2018	Life cycle assessment of bottled water: A case study of Green2O products	http://dx.doi.org/10.1016/j.wasman.2018.02.043	bottled water	Manufacturing	Manufacture of beverages	cradle-to-grave	12 bottles, as this amount is typically found in one pack of Green 20 water bottles	Comprehensive	Advanced	Recycle	No	High	Quantitative	Brief	No
103	Iyer, RK; Pilla, S	2021	Environmental profile of thermoelectrics for applications with continuous waste heat generation via life cycle assessment	http://dx.doi.org/10.1016/j.scitotenv.2020.141674	thermoelectric modules	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of electricity generation	Comprehensive	Advanced	Reuse, Remanufacture, Recycle	No	Low	Qualitative	Brief	No
104	Jang, H; Jang, Y; Jeong, B; Cho, NK	2021	Comparative Life Cycle Assessment of Marine Insulation Materials	http://dx.doi.org/10.3390/jmse9101099	Out of scope			Out of scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
105	Jang, H; Jeong, B; Zhou, PL; Ha, S; Nam, D; Kim, J; Lee, JU	2020	Development of Parametric Trend Life Cycle Assessment for marine SOx reduction scrubber systems	http://dx.doi.org/10.1016/j.jclepro.2020.122821	marine SOx reduction scrubber systems	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	correlations between input parameters and emission levels	No	Basic	Recycle	No	No statement	No	No	No
106	Jasper, FB; Spathe, J; Baumann, M; Peters, JF; Ruhland, J; Weil, M	2022	Life cycle assessment (LCA) of a battery home storage system based on primary data	http://dx.doi.org/10.1016/j.jclepro.2022.132899	battery home storage system	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of energy delivered by the considered systems over their lifetime	Brief	Advanced	Recycle, Recover	No	Medium	Quantitative	No	No
107	Jenu, S; Deviatkin, I; Hentunen, A; Myllysilta, M; Viik, S; Pihlatie, M	2020	Reducing the climate change impacts of lithium-ion batteries by their cautious management through integration of stress factors and life cycle assessment	http://dx.doi.org/10.1016/j.est.2019.101023	Li-ion batteries for storage	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	25.3 MWh of electricity, low voltage, delivered to the customers	No	Basic	Recycle	No	Low	No	No	No
108	Jia, XJ; Lv, F; Li, P; Wang, WJ	2020	Life-cycle assessment of p-type multi-Si back surface field (BSF) solar module in China of 2019	http://dx.doi.org/10.1016/j.solener.2019.12.018	p-type multi-Si back surface field (BSF) solar module	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of AC (alternating current) electricity generated by a photovoltaic module	Brief	No	Reduce, Repair	No	Low	Quantitative	No	No
109	Jiang, L; Xiang, D; Tan, YF; Nie, YH; Cao, HJ; Wei, YZ; Zeng, D; Shen, YH; Shen, G	2018	Analysis of wind turbine Gearbox's environmental impact considering its reliability	http://dx.doi.org/10.1016/j.jclepro.2018.01.078	gearbox of a wind turbine	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	A gearbox whose rated power is 2MW, service lifetime equals 20 years and transmission efficiency (the ratio of output power to input power) equals 96%	Brief	Advanced	Reuse, Remanufacture, Recycle	No	High	Quantitative	Brief	No

110	Jonkers, N; Krop, H; van Ewijk, H; Leonards, PEG	2016	Life cycle assessment of flame retardants in an electronics application	http://dx.doi.org/10.1007/s11367-015-0999-z	flame retardants	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	the complete life cycle of a laptop containing flame retarded polymers, with a lifetime of 4 years	Brief	Advanced	Recycle, Recover	No	High	Quantitative	Brief	No
111	Kang, D; Auras, R; Sing, J	2017	Life cycle assessment of Non-alcoholic single-serve polyethylene terephthalate beverage bottles in the state of California	http://dx.doi.org/10.1016/j.resconrec.2016.09.011	PET Bottle	Manufacturing	Manufacture of beverages	cradle-to-grave	amount of PET necessary to deliver 1000 L of beverage	Brief	Advanced	Reduce, Recycle, Recover	No	Medium	Quantitative	Brief	No
112	Karaaslan, E; Zhao, Y; Tatari, O	2018	Comparative life cycle assessment of sport utility vehicles with different fuel options	http://dx.doi.org/10.1007/s11367-017-1315-x	sport utility vehicle (SUV)	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	life cycle of a SUV with 200,000 miles lifetime travel mileage	No	Basic	Repair, Recycle	No	Low	No	No	No
113	Karan, H; Thomson, RC; Harrison, GP	2020	Full life cycle assessment of two surge wave energy converters	http://dx.doi.org/10.1177/0957650919867191	wave energy converter	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh	Brief	Basic	Repair, Recycle	No	No statement	No	Brief	No
114	Karasu, H; Dincer, I	2020	Life cycle assessment of integrated thermal energy storage systems in buildings: A case study in Canada	http://dx.doi.org/10.1016/j.enbuild.2020.109940	integrated borehole type thermal energy storage systems in buildings	Construction	Specialized construction activities	cradle-to-grave	1 m 2 floor area of a house with this thermal energy storage system over its lifetime	Brief	No	Repair, Recycle	No	No statement	No	No	No
115	Karatum, O; Bhuiya, MMH; Carroll, MK; Anderson, AM; Plata, DL	2018	Life Cycle Assessment of Aerogel Manufacture on Small and Large Scales: Weighing the Use of Advanced Materials in Oil Spill Remediation	http://dx.doi.org/10.1111/jiec.12720	aerogels for remediation of oil spills	Water supply; sewerage, waste management and remediation activities	Remediation activities and other waste management services	cradle-to-grave	mass of aerogel needed for cleaning 1 m3 of light crude oil	Brief	Advanced	Reuse, Recycle, Recover	No	High	Quantitative	No	No
116	Karkour, S; Ihara, T; Kuwayama, T; Yamaguchi, K; Itsubo, N	2021	Life Cycle Assessment of Residential Air Conditioners Considering the Benefits of Their Use: A Case Study in Indonesia	http://dx.doi.org/10.3390/en14020447	air conditioning	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	climate control of 1 m2 of living area maintained for one year	Brief	No	Recycle	No	Low	No	No	No
117	Kawajiri, K; Kishita, Y; Shinohara, Y	2021	Life Cycle Assessment of Thermoelectric Generators (TEGs) in an Automobile Application	http://dx.doi.org/10.3390/su132413630	thermoelectric generator	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	one TEG device (specified in Table 1)	Brief	No	Recycle, Recover	No	Low	No	Brief	No
118	Khan, MMH; Deviatkin, I; Havukainen, J; Horttanainen, M	2021	Environmental impacts of wooden, plastic, and wood-polymer composite pallet: a life cycle assessment approach	http://dx.doi.org/10.1007/s11367-021-01953-7	pallet	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1000 trips	Brief	Advanced	Reuse, Repair, Recycle, Recover	No	High	Quantitative	Brief	No
119	Khan, U; Zevenhoven, R; Tveit, TM	2020	Evaluation of the Environmental Sustainability of a Stirling Cycle-Based Heat Pump Using LCA	http://dx.doi.org/10.3390/en13174469	Stirling cycle-based heat pump	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	a boiler (lifespan 15 years or shorter)	Brief	No	Repair, Recycle	No	Medium	No	No	No
120	Kim, S; Park, J	2020	Comparative Life Cycle Assessment of Multiple Liquid Laundry Detergent Packaging Formats	http://dx.doi.org/10.3390/su12114669	packaging for liquid laundry detergent	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	10,000 loads of detergent	Brief	Advanced	Recycle	No	No statement	No	No	No
121	Koiwanit, J; Riensuwarn, F; Palungpaiboon, P; Pornchaloempong, P	2020	Business viability and carbon footprint of Thai-grown Nam Dok Mai mango powdered drink mix	http://dx.doi.org/10.1016/j.jclepro.2020.119991	freeze-dried powdered mango drink mix	Manufacturing	Manufacture of beverages	cradle-to-grave	50 g of mango powdered drink mix	No	No	No	No	No statement	No	No	No
122	Koura, J; Manneh, R; Belarbi, R; El Khoury, V; El Bachawati, M	2020	Comparative cradle to grave environmental life cycle assessment of traditional and extensive vegetative roofs: an application for the Lebanese context	http://dx.doi.org/10.1007/s11367-019-01700-z	two different roofing systems	Construction	Specialized construction activities	cradle-to-grave	building and installing a roofing system of 650 m² and its usage for 1 year	Brief	Basic	Recycle	No	No statement	Quantitative	No	No
123	Krebs-Moberg, M; Pitz, M; Dorsette, TL; Gheewala, SH	2021	Third generation of photovoltaic panels: A life cycle assessment	http://dx.doi.org/10.1016/j.renene.2020.09.054	photovoltaic panels	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	installation and maintenance of grid-connected photovoltaic systems to fulfill the 3.6 GWpower capacity over 30 years	No	Basic	Reuse, Recycle	No	High	Quantitative	Brief	No

124	Kumar, H; Azad, A; Gupta, A; Sharma, J; Bherwani, H; Labhsetwar, NK; Kumar, R	2021	COVID-19 Creating aNother problem? Sustainable solution for PPE disposal through LCA approach	http://dx.doi.org/10.1007/s10668-020-01033-0	personal protective equipment kit	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1 ton of personal protective equipment kit	Brief	No	Reuse, Recover	No	High	Quantitative	No	No
125	Kvocka, D; Lesek, A; Knez, F; Ducman, V; Panizza, M; Tsoutis, C; Bernardi, A	2020	Life Cycle Assessment of Prefabricated Geopolymeric Facade Cladding Panels Made from Large Fractions of Recycled Construction and Demolition Waste	http://dx.doi.org/10.3390/ma13183931	facade cladding panels	Construction	Specialized construction activities	cradle-to-cradle	1 m^2 of façade cladding panel	Comprehensive	Basic	Recycle	No	Medium	Quantitative	Brief	No
126	Lagnelov, O; Larsson, G; Larsolle, A; Hansson, PA	2021	Life Cycle Assessment of AutoNomous Electric Field Tractors in Swedish Agriculture	http://dx.doi.org/10.3390/su132011285	self-driving battery electric tractor	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	one average hectare of arable land growing cereal, 1 ha^-1 y^-1	Brief	Advanced	Repair, Recycle, Recover	No	Medium	Quantitative	No	No
127	Lee, AWL; Neo, ERK; Khoo, ZY; Yeo, ZQ; Tan, YS; Chng, SY; Yan, WJ; Lok, BK; Low, JSC	2021	Life cycle assessment of single-use surgical and embedded filtration layer (EFL) reusable face mask	http://dx.doi.org/10.1016/j.resconrec.2021.105580	face mask	Manufacturing	Other manufacturing	cradle-to-grave	31 12-h days for a single person	Brief	Advanced	Reduce, Reuse, Recover	Yes	High	Quantitative	Brief	No
128	Lee, YD; Ahn, KY; Morosuk, T; Tsatsaronis, G	2015	Environmental impact assessment of a solid-oxide fuel-cell-based combined-heat-and-power-generation system	http://dx.doi.org/10.1016/j.energy.2014.11.035	solid-oxide fuel-cell-based combined-heat-and-power-generation system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	n.d.	No	No	Recover	No	No statement	No	Brief	No
129	Leppakoski, L; Marttila, MP; Uusitalo, V; Levanen, J; Halonen, V; Mikkila, MH	2021	Assessing the Carbon Footprint of Biochar from Willow Grown on Marginal Lands in Finland	http://dx.doi.org/10.3390/su131810097	biochar	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	1 t of dry biochar stored in soil for 100 years	Brief	Advanced	Recover	No	Medium	Quantitative	Brief	No
130	Li, GQ; Xuan, QD; Pei, G; Su, YH; Lu, YS; Ji, J	2018	Life-cycle assessment of a low-concentration PV module for building south wall integration in China	http://dx.doi.org/10.1016/j.apenergy.2018.02.005	low-concentration PV module	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWp electricity supply	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
131	Liang, SB; Gu, HM; Bergman, R	2021	Environmental Life-Cycle Assessment and Life-Cycle Cost Analysis of a High-Rise Mass Timber Building: A Case Study in Pacific Northwestern United States	http://dx.doi.org/10.3390/su13147831	high-rise mass timber building	Construction	Specialized construction activities	cradle-to-grave	1 m^2 of living/working floor area in a mixed-use commercial/residential building in the Pacific Northwestern United States for 60 years	No	Advanced	Repair, Recycle, Recover	No	No statement	Quantitative	Brief	Yes
132	Lima, MSS; Hajibabaei, M; Hesarkazzazi, S; Sitzenfrei, R; Buttgereit, A; Queiroz, C; Haritonovs, V; Gschosser, F	2021	Determining the Environmental Potentials of Urban Pavements by Applying the Cradle-to-Cradle LCA Approach for a Road Network of a Midscale German City	http://dx.doi.org/10.3390/su132212487	urban pavements	Construction	Civil engineering	cradle-to-cradle	1 m^2 of road pavement	Comprehensive	Advanced	Repair, Refurbish, Recycle	No	Medium	Quantitative	No	No
133	Liu, MY; Li, Y; Yuan, XL; Xu, Y; Qiao, L; Wang, QS; Ma, Q	2022	Life Cycle Environmental Impact Assessment of Sulfur-Based Compound Fertilizers: A Case Study in China	http://dx.doi.org/10.1021/acssuschemeng.1c05450	fertilizer	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	1 ton fertilizer	Brief	No	Reduce	No	No statement	Quantitative	Comprehensive	No
134	Liu, W; Chen, C; Wu, HJ; Guo, CH; Chen, YD; Liu, WQ; Cui, ZJ	2019	Environmental life cycle assessment and techNo-ecoNomic analysis of domestic hot water systems in China	http://dx.doi.org/10.1016/j.enconman.2019.111943	domestic hot water system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	energy requirements for using DHW per person, per year, supplied by the DHW system in a typical three-person Chinese household	Brief	Basic	Reduce, Recycle	No	Medium	No	Comprehensive	No
135	Liu, WQ; Liu, H; Liu, W; Cui, ZJ	2021	Life cycle assessment of power batteries used in electric bicycles in China	http://dx.doi.org/10.1016/j.rser.2020.110596	power batteries for electric bicycles	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	100-km driving distance of a typical EB driven by a group of batteries (4 × 12 V, 20 Ah)	Brief	Basic	Reduce, Reuse, Repair, Recycle	No	High	Quantitative	Brief	No
136	Liu, Y; Guo, HB; Sun, C; Chang, WS	2016	Assessing Cross Laminated Timber (CLT) as an Alternative Material for Mid-Rise Residential Buildings in Cold Regions in China-A Life-Cycle Assessment Approach	http://dx.doi.org/10.3390/su8101047	Out of scope			Out of scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope

137	Lo-Iacono-Ferreira, VG; Vinoles-Cebolla, R; Bastante-Ceca, MJ; Capuz-Rizo, SF	2021	Carbon Footprint Comparative Analysis of Cardboard and Plastic Containers Used for the International Transport of Spanish Tomatoes	http://dx.doi.org/10.3390/su13052552	food containers	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	store and transport 1000 t of product from the market of origin to the destination market	Brief	Basic	Reduce, Reuse, Recycle, Recover	No	Medium	Quantitative	Brief	No
138	Loiseau, E; Colin, M; Alaphilippe, A; Coste, G; Roux, P	2020	To what extent are short food supply chains (SFSCs) environmentally friendly? Application to French apple distribution using Life Cycle Assessment	http://dx.doi.org/10.1016/j.jclepro.2020.124166	apples	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	Out of scope	purchase of 1 kg of apples from a retail location	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
139	Ludin, NA; Affandi, NAA; Purvis-Roberts, K; Ahmad, A; Ibrahim, MA; Sopian, K; Jusoh, S	2021	Environmental Impact and Levelised Cost of Energy Analysis of Solar Photovoltaic Systems in Selected Asia Pacific Region: A Cradle-to-Grave Approach	http://dx.doi.org/10.3390/su13010396	photovoltaic systems	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh, 1m^2 PV	No	No	Repair	No	No statement	No	No	No
140	Luo, DQ; Xu, G; Luo, J; Cui, X; Shang, SP; Qian, HY	2022	Integrated Carbon Footprint and EcoNomic Performance of Five Types of Dominant Cropping Systems in China's Semiarid Zone	http://dx.doi.org/10.3390/su14105844	cropping systems	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-gate	1 ha unit area, 1 t product	No	No	No	No	No statement	No	No	No
141	Luo, XJ; Oyedele, LO; Owolabi, HA; Bilal, M; Ajayi, AO; Akinade, OO	2020	Life cycle assessment approach for renewable multi-energy system: A comprehensive analysis	http://dx.doi.org/10.1016/j.enconman.2020.113354	multi-energy system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	not clear	No	No	Recycle	No	No statement	Quantitative	No	No
142	Ma, F; Dong, WH; Fu, Z; Wang, R; Huang, Y; Liu, J	2021	Life cycle assessment of greenhouse gas emissions from asphalt pavement maintenance: A case study in China	http://dx.doi.org/10.1016/j.jclepro.2020.125595	pavement maintenance	Construction	Civil engineering	cradle-to-grave	22,5m^2 section of a highway pavement	No	Basic	Remanufacture, Recycle	No	High	Quantitative	Brief	No
143	Ma, RF; Deng, YL	2022	The electrochemical model coupled parameterized life cycle assessment for the optimized design of EV battery pack	http://dx.doi.org/10.1007/s11367-022-02026-z	EV battery pack	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	single battery pack of the EV	Brief	Basic	Recycle	No	No statement	No	No	No
144	Manda, BMK; Worrell, E; Patel, MK	2015	Prospective life cycle assessment of an antibacterial T-shirt and supporting business decisions to create value	http://dx.doi.org/10.1016/j.resconrec.2015.07.010	antibacterial T-Shirt	Manufacturing	Manufacture of textiles	cradle-to-grave	1 T-Shirt being worn for 100 days	Brief	Basic	Reuse	No	High	Quantitative	Brief	No
145	Martinez, NM; Basallote, MD; Meyer, A; Canovas, CR; Macias, F; Schneider, P	2019	Life cycle assessment of a passive remediation system for acid mine drainage: Towards more sustainable mining activity	http://dx.doi.org/10.1016/j.jclepro.2018.11.224	dispersed alkaline substrate treatment plant	Water supply; sewerage, waste management and remediation activities	Waste collection, treatment and disposal activities; materials recovery	cradle-to-gate	1 m^3 of AMD treated water	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
146	Martinez-Alonso, C; Berdasco, L	2015	Carbon footprint of sawn timber products of Castanea sativa Mill. in the North of Spain	http://dx.doi.org/10.1016/j.jclepro.2015.05.004	sawn timber	Agriculture, forestry and fishing	Forestry and logging	cradle-to-gate	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
147	Martinez-Camara, E; Santamaria, J; Sanz-Adan, F; Arancon, D	2021	Digital Eco-Design and Life Cycle Assessment-Key Elements in a Circular EcoNomy: A Case Study of a Conventional Desk	http://dx.doi.org/10.3390/app112110439	desk	Manufacturing	Manufacture of furniture	cradle-to-grave	n.d.	Brief	No	Recycle	No	Medium	No	Brief	No
148	Martinopoulos, G	2018	Life Cycle Assessment of solar energy conversion systems in energetic retrofitted buildings	http://dx.doi.org/10.1016/j.jobe.2018.07.027	solar conversion system	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	combined solar (thermal and PV) system that is able to cover all the energy requirements (heating, cooling and electricity) of the pre-existing building for their life time	No	No	Recycle	No	No statement	No	No	No
149	McAlister, S; Grant, T; McGain, F	2021	An LCA of hospital pathology testing	http://dx.doi.org/10.1007/s11367-021-01959-1	pathology test	Human health and social work activities	Human health activities	cradle-to-grave	collection and analysis within a Victorian public hospital of a single urine sample	Brief	No	Recycle	No	No statement	No	No	No

									(urinalysis), or a single blood test								
150	McAlister, S; Ou, YJ; Neff, E; Hapgood, K; Story, D; Mealey, P; McGain, F	2016	The Environmental footprint of morphine: a life cycle assessment from opium poppy farming to the packaged drug	http://dx.doi.org/10.1136/bmjopen-2016-013302	morphine	Manufacturing	Manufacture of pharmaceutical products and pharmaceutical preparations	cradle-to-grave	100 mL of intraveNous morphine	No	No	Reduce, Reuse	No	No statement	No	No	Yes
151	McCarthy, D; Matopoulos, A; Davies, P	2015	Life cycle assessment in the food supply chain: a case study	http://dx.doi.org/10.1080/13675567.2014.997197	supply of poultry	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	1000kg of chicken delivered,consumed, disposed	No	No	Recycle	No	No statement	No	No	Yes
152	McPherson, B; Sharip, M; Grimmond, T	2019	The impact on life cycle carbon footprint of converting from disposable to reusable sharps containers in a large US hospital geographically distant from manufacturing and processing facilities	http://dx.doi.org/10.7717/peerj.6204	supply of sharps containers	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	supply of each system for one year	Brief	Basic	Reuse, Recycle	No	High	Qualitative	Brief	Yes
153	Medeiros, DL; Tavares, AOD; Raposo, ALQRES; Kiperstok, A	2017	Life cycle assessment in the furniture industry: the case study of an office cabinet	http://dx.doi.org/10.1007/s11367-017-1370-3	office cabinet	Manufacturing	Manufacture of furniture	cradle-to-grave	one office cabinet (900mm x 1600mm x 480mm)	Brief	Basic	Reduce, Recycle	No	Low	Quantitative	Brief	Yes
154	Mendecka, B; Tribioli, L; Cozzolino, R	2020	Life Cycle Assessment of a stand-alone solar-based polygeneration power plant for a commercial building in different climate zones	http://dx.doi.org/10.1016/j.renene.2020.03.063	stand-alone solar-based power plant	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	fulfilling the annual electric demand of the reference building	No	No	Reduce	No	No statement	No	No	No
155	Mendoza, JMF; D'Aponte, F; Gualtieri, D; Azapagic, A	2019	Disposable baby diapers: Life cycle costs, eco-efficiency and circular ecoNomy	http://dx.doi.org/10.1016/j.jclepro.2018.11.146	baby diapers	Manufacturing	Manufacture of wearing apparel	cradle-to-grave	manufacture and use of 1000 baby diapers	Brief	Basic	Reuse, Recycle	No	High	No	Brief	No
156	Meneses, M; Torres, CM; Castells, F	2016	Sensitivity analysis in a life cycle assessment of an aged red wine production from Catalonia, Spain	http://dx.doi.org/10.1016/j.scitotenv.2016.04.083	red wine	Manufacturing	Manufacture of beverages	cradle-to-grave	75 cl of red wine Crianca 2005	Brief	Advanced	Reuse, Recycle	No	High	Quantitative	Comprehensive	Yes
157	Meyer, DE; Katz, JP	2016	Analyzing the environmental impacts of laptop enclosures using screening-level life cycle assessment to support sustainable consumer electronics	http://dx.doi.org/10.1016/j.jclepro.2015.05.143	laptop enclosure	Manufacturing	Manufacture of computer, electronic and optical products	cradle-to-grave	laptop enclosure with a 17,3-inch display	Comprehensive	Advanced	Reuse, Recycle, Reduce	Yes	High	Quantitative	Comprehensive	No
158	Mistry, M; Koffler, C; Wong, S	2016	LCA and LCC of the world's longest pier: a case study on nickel-containing stainless steel rebar	http://dx.doi.org/10.1007/s11367-016-1080-2	pier	Construction	Civil engineering	cradle-to-grave	not clear	No	Basic	Recycle	No	No statement	No	No	No
159	Montalvo, FF; Garcia-Alcaraz, JL; Camara, EM; Jimenez-Macias, E; Blanco-Fernandez, J	2021	Environmental impact of wine fermentation in steel and concrete tanks	http://dx.doi.org/10.1016/j.jclepro.2020.123602	wine fermentation tank	Manufacturing	Manufacture of beverages	cradle-to-grave	20.000 L wine fermentation tank	Brief	Basic	Recycle	No	Low	No	No	No
160	Moore, AD; Urmee, T; Bahri, PA; Rezvani, S; Baverstock, GF	2017	Life cycle assessment of domestic hot water systems in Australia	http://dx.doi.org/10.1016/j.renene.2016.09.062	hot water system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	annual hot water load of 34,4 MJ/d	No	No	No	No	No statement	No	No	No
161	Morales, MFD; Reguly, N; Kirchheim, AP; Passuello, A	2020	Uncertainties related to the replacement stage in LCA of buildings: A case study of a structural masonry clay hollow brick wall	http://dx.doi.org/10.1016/j.jclepro.2019.119649	brick wall	Construction	Construction of buildings	cradle-to-grave	one sqaure meter of wall	No	Basic	Recycle	No	No statement	No	No	No
162	Morales-Mora, MA; Pijpers, JJH; Antonio, AC; Soto, JD; Calderon, AMA	2021	Life cycle assessment of a Novel bipolar electrodialysis-based flow battery concept and its potential use to mitigate the intermittency of renewable energy generation	http://dx.doi.org/10.1016/j.est.2021.102339	energy storage	Manufacturing	Manufacture of electrical equipment	cradle-to-gate	1 MWh module having a 20-year lifetime	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope

163	Morris, MIR; Hicks, A	2022	Life cycle assessment of stainless-steel reusable speculums versus disposable acrylic speculums in a university clinic setting: a case study	http://dx.doi.org/10.1088/2515-7620/ac4a3d	speculums	Manufacturing	Other manufacturing	cradle-to-grave	conducting 5.000 pelvic exams	Brief	No	Reuse, Recycle	Yes	Low	Qualitative	Brief	No
164	Nakano, K; Ando, K; Takigawa, M; Hattori, N	2018	Life cycle assessment of wood-based boards produced in Japan and impact of formaldehyde emissions during the use stage	http://dx.doi.org/10.1007/s11367-017-1343-6	wood boards	Manufacturing	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	cradle-to-gate; cradle-to-grave	1m³; 16-mm-thick wood-based boards with an exposedsurface area of 7.0 m2 and a service life of 40 years960Int J Life Cycle Assess (2018) 23:957–969	Brief	No	Recycle	No	No statement	No	No	No
165	Napolano, L; Menna, C; Asprone, D; Prota, A; Manfredi, G	2015	Life cycle environmental impact of different replacement options for a typical old flat roof	http://dx.doi.org/10.1007/s11367-014-0807-1	replacement options for a roof	Construction	Specialized construction activities	cradle-to-grave	25m^2 roof replacement	Brief	Advanced	Reuse, Recycle	No	Low	Qualitative	No	No
166	Napolano, L; Menna, C; Asprone, D; Prota, A; Manfredi, G	2015	LCA-based study on structural retrofit options for masonry buildings	http://dx.doi.org/10.1007/s11367-015-0852-4	retrofit for masonry buildings	Construction	Specialized construction activities	cradle-to-grave	1 m2 of masonry wall in the case of LRDM andGRM, 1 m of crack in the case of MI, and 1 m of steel chain inthe case of SCI	Comprehensive	Basic	Recycle	Yes	Low	No	No	No
167	Naranjo, GPS; Bolonio, D; Ortega, MF; Garcia-Martinez, MJ	2021	Comparative life cycle assessment of conventional, electric and hybrid passenger vehicles in Spain	http://dx.doi.org/10.1016/j.jclepro.2021.125883	car-based mobility	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	1km travelled by a passenger in a vehicle	Brief	Basic	Recycle	No	Low	No	Brief	No
168	Niero, M; Hauschild, MZ; Hoffmeyer, SB; Olsen, SI	2017	Combining Eco-Efficiency and Eco-Effectiveness for Continuous Loop Beverage Packaging Systems Lessons from the Carlsberg Circular Community	http://dx.doi.org/10.1111/jiec.12554	beer	Manufacturing	Manufacture of beverages	cradle-to-grave	1 hectoliter (hl) of beer (where 1 hectoliter = 100 liters); assessed in study 169	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
169	Niero, M; Negrelli, AJ; Hoffmeyer, SB; Olsen, SI; Birkved, M	2016	Closing the loop for aluminum cans: Life Cycle Assessment of progression in Cradle-to-Cradle certification levels	http://dx.doi.org/10.1016/j.jclepro.2016.02.122	storage of drinks	Manufacturing	Manufacture of beverages	cradle-to-cradle	containment of 1hl beer	Comprehensive	No	Recycle, Recover	No	High	Quantitative	Brief	No
170	Noya, LI; Vasilaki, V; Stojceska, V; Gonzalez-Garcia, S; Kleynhans, C; Tassou, S; Moreira, MT; Katsou, E	2018	An environmental evaluation of food supply chain using life cycle assessment: A case study on gluten free biscuit products	http://dx.doi.org/10.1016/j.jclepro.2017.08.226	gluten free biscuit	Manufacturing	Manufacture of grain mill products, starches and starch products	cradle-to-grave	1kg of product at factory gate	No	Basic	Reuse, Recycle	No	High	Quantitative	Brief	No
171	Oquendo-Di Cosola, V; Olivieri, F; Ruiz-Garcia, L; Bacenetti, J	2020	An environmental Life Cycle Assessment of Living Wall Systems	http://dx.doi.org/10.1016/j.jenvman.2019.109743	living wall system	Administrative and support service activities	Services to buildings and landscape activities	cradle-to-gate	1m^2 of LWS	No	No	No	No	No statement	No	No	No
172	Oreto, C; Russo, F; Veropalumbo, R; Viscione, N; Biancardo, SA; Dell'Acqua, G	2021	Life Cycle Assessment of Sustainable Asphalt Pavement Solutions Involving Recycled Aggregates and Polymers	http://dx.doi.org/10.3390/ma14143867	asphalt pavement	Construction	Civil engineering	cradle-to-grave	1-km section of a single-carriageway road	Brief	Basic	Reuse, Recycle	Yes	Low	No	Brief	No
173	Pachta, V; Giourou, V	2022	Comparative Life Cycle Assessment of a Historic and a Modern School Building, Located in the City of Naoussa, Greece	http://dx.doi.org/10.3390/su14074216	school building	Construction	Construction of buildings	cradle-to-cradle	60 years for the modern school and 140 years for the historic one; three-story buildings with semi-basement, elevated ground floor and1st floor, while the type and dimensions of their plans are similar	No	No	Recycle	No	No statement	No	No	No

174	Pang, MY; Zhang, LX; Wang, CB; Liu, GY	2015	Environmental life cycle assessment of a small hydropower plant in China	http://dx.doi.org/10.1007/s11367-015-0878-7	hydropower plant	Construction	Civil engineering	cradle-to-grave	1 MWh of net electricity by the plant	No	Basic	Recycle	No	No statement	No	No	No
175	Parajuli, R; Matlock, MD; Thoma, G	2021	Cradle to grave environmental impact evaluation of the consumption of potato and tomato products	http://dx.doi.org/10.1016/j.scitotenv.2020.143662	potato and tomato products	Manufacturing	Processing and preserving of fruit and vegetables	cradle-to-grave	1kg product eaten at the consumer stage	No	Basic	Recycle	No	High	No	No	No
176	Peceno, B; Leiva, C; Alonso-Farinas, B; Gallego-Schmid, A	2020	Is Recycling Always the Best Option? Environmental Assessment of Recycling of Seashell as Aggregates in Noise Barriers	http://dx.doi.org/10.3390/pr8070776	Noise barriers of recycled sheashell	Construction	Specialized construction activities	cradle-to-grave	1m^2 of Noise barrier	Comprehensive	Advanced	Recycle	Yes	High	Quantitative	Brief	No
177	Pedneault, J; Desjardins, V; Margni, M; Conciatori, D; Fafard, M; Sorelli, L	2021	EcoNomic and environmental life cycle assessment of a short-span aluminium composite bridge deck in Canada	http://dx.doi.org/10.1016/j.jclepro.2021.127405	aluminium compsite bridge	Construction	Specialized construction activities	cradle-to-gate	traffic on two lanes over 20m for 75 years	Brief	No	Recycle, Repair	Yes	High	No	Brief	No
178	Perez-Martinez, MM; Noguerol, R; Casales, BI; Lois, R; Soto, B	2018	Evaluation of environmental impact of two ready-to-eat canned meat products using Life Cycle Assessment	http://dx.doi.org/10.1016/j.jfoodeng.2018.05.031	meat products	Manufacturing	Processing and preserving of meat	cradle-to-grave	unit of canned food	Brief	Advanced	Recycle	Yes	Low	No	Brief	No
179	Petrauskiene, K; Skvarnaviciute, M; Dvarioniene, J	2020	Comparative environmental life cycle assessment of electric and conventional vehicles in Lithuania	http://dx.doi.org/10.1016/j.jclepro.2019.119042	vehicle	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	1 km driving distance	Brief	No	Recycle	Yes	Low	No	No	No
180	Petrescu, L; Bonalumi, D; Valenti, G; Cormos, AM; Cormos, CC	2017	Life Cycle Assessment for supercritical pulverized coal power plants with post-combustion carbon capture and storage	http://dx.doi.org/10.1016/j.jclepro.2017.03.225	electricity	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 MWh of net power produced	Brief	No	Recycle	No	No statement	No	No	No
181	Piasecka, I; Baldowska-Witos, P; Piotrowska, K; Tomporowski, A	2020	Eco-Energetical Life Cycle Assessment of Materials and Components of Photovoltaic Power Plant	http://dx.doi.org/10.3390/en13061385	electricity	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1000 MWh of electric power	Brief	No	Reuse, Recycle	Yes	High	Quantitative	Comprehensive	No
182	Pierobon, F; Eastin, IL; Ganguly, I	2018	Life cycle assessment of residual ligNocellulosic biomass-based jet fuel with activated carbon and ligNosulfonate as co-products	http://dx.doi.org/10.1186/s13068-018-1141-9	biobased jet fuel	Manufacturing	Manufacture of coke and refined petroleum products	cradle-to-grave	1 Gj of energy	No	No	Recover	No	No statement	No	No	No
183	Pommier, R; Grimaud, G; Princaud, M; Perry, N; Sonnemann, G	2016	Comparative environmental life cycle assessment of materials in wooden boat ecodesign	http://dx.doi.org/10.1007/s11367-015-1009-1	wooden boat	Manufacturing	Manufacture of other transport equipment	cradle-to-grave	transport of 60 passengers and 20 bikes	No	Basic	Reuse, Recycle, Repair	Yes	High	Quantitative	Brief	No
184	Pons, JJ; Sanchis, IV; Franco, RI; Yepes, V	2020	Life cycle assessment of a railway tracks substructures: Comparison of ballast and ballastless rail tracks	http://dx.doi.org/10.1016/j.eiar.2020.106444	rail tracks	Manufacturing	Manufacture of fabricated metal products, except machinery and equipment	cradle-to-grave	10 km of straight twin-track	Brief	Basic	Recycle, Repair	Yes	Low	No	Brief	No
185	Pourzahedi, L; Eckelman, MJ	2015	Environmental Life Cycle Assessment of NaNosilver-Enabled Bandages	http://dx.doi.org/10.1021/es504655y	bandages	Manufacturing	Other manufacturing	cradle-to-grave	single-use naNosilver-coated bandage	Brief	Basic	Recycle	No	Low	No	Brief	No
186	Quan, JW; Zhao, SQ; Song, DM; Wang, TY; He, WZ; Li, GM	2022	Comparative life cycle assessment of LFP and NCM batteries including the secondary use and different recycling techNologies	http://dx.doi.org/10.1016/j.scitotenv.2022.153105	batteries	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh battery pack	Comprehensive	Advanced	Reuse, Recycle, Repair	Yes	High	No	Brief	No
187	Quang, PK; Dong, DT; Hai, PTT	2021	Evaluating environmental impacts of an oil tanker using life cycle assessment method	http://dx.doi.org/10.1177/1475090221989195	oil tanker	Manufacturing	Manufacture of other transport equipment	cradle-to-grave	74,296t oil tanker wth a 25-year lifetime	No	Basic	Recycle	No	Low	No	No	No
188	Quintana, A; Alba, J; del Rey, R; Guillen-Guillamon, I	2018	Comparative Life Cycle Assessment of gypsum plasterboard and a new kind of bio-based epoxy composite containing different natural fibers	http://dx.doi.org/10.1016/j.jclepro.2018.03.042	building material	Construction	Specialized construction activities	cradle-to-grave	1m^2 of material	Brief	No	Recycle	No	No statement	No	No	No

189	Raluy, RG; Dias, AC	2021	Domestic hot water systems: Environmental performance from a life cycle assessment perspective	http://dx.doi.org/10.1016/j.spc.2021.01.005	hot water system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	providing 42,8L heated water/year with 45 °C during 15 years of service	No	Basic	Recycle	No	Low	No	No	No
190	Raluy, RG; Dias, AC	2020	Life cycle assessment of a domestic gas-fired water heater: Influence of fuel used and its origin	http://dx.doi.org/10.1016/j.jenvman.2019.109786	hot water system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	providing 42,8L heated water/year with 45 °C during 15 years of service	No	Basic	Recycle	Yes	Low	No	No	No
191	Rao, HKR; Gemechu, E; Thakur, U; Shankar, K; Kumar, A	2021	Life cycle assessment of high-performance moNocrystalline titanium dioxide naNorod-based perovskite solar cells	http://dx.doi.org/10.1016/j.solmat.2021.111288	solar cells	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh	No	Basic	Reuse, Recycle	No	Low	No	Brief	No
192	Rashedi, A; Khanam, T	2020	Life cycle assessment of most widely adopted solar photovoltaic energy techNologies by mid-point and end-point indicators of ReCiPe method	http://dx.doi.org/10.1007/s11356-020-09194-1	photovoltaic techNologies	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh	Brief	No	Reuse, Recycle	Yes	No statement	No	No	No
193	Rathore, VK; Mondal, P	2018	Life cycle assessment of defluoridation of water using laterite soil based adsorbents	http://dx.doi.org/10.1016/j.jclepro.2018.01.176	water treatment	Water supply; sewerage, waste management and remediation activities	Water collection, treatment and supply	cradle-to-grave	reduce the the fluoride concentration of 720l water from 10mg/L to 1,5mg/L	No	No	No	No	No statement	No	No	No
194	Raugei, M; Keena, N; Novelli, N; Etman, MA; Dyson, A	2021	Life cycle assessment of an ecological living module equipped with conventional rooftop or integrated concentrating photovoltaics	http://dx.doi.org/10.1111/jiec.13129	photovoltaic systems	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-gate	manufacturing and use of 1 ELM over the first 50 years	No	Basic	Reuse, Recycle	No	No statement	No	No	No
195	Raugei, M; Morrey, D; Hutchinson, A; Winfield, P	2015	A coherent life cycle assessment of a range of lightweighting strategies for compact vehicles	http://dx.doi.org/10.1016/j.jclepro.2015.05.100	vehicle	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-cradle	generalised C segment car	Brief	Basic	Recycle	Yes	High	Qualitative	Brief	No
196	Recanati, F; Marveggio, D; Dotelli, G	2018	From beans to bar: A life cycle assessment towards sustainable chocolate supply chain	http://dx.doi.org/10.1016/j.scitotenv.2017.09.187	chocolate	Manufacturing	Manufacture of food products	cradle-to-grave	1kg of dark chocolate	No	Basic	Recycle	No	No statement	No	No	No
197	Rinaldi, S; Bonamente, E; Scrucca, F; Merico, MC; Asdrubali, F; Cotana, F	2016	Water and Carbon Footprint of Wine: Methodology Review and Application to a Case Study	http://dx.doi.org/10.3390/su8070621	wine	Manufacturing	Manufacture of beverages	cradle-to-grave	0,75 l wine bottle	No	Advanced	Recycle	No	No statement	No	No	No
198	Rios, FC; Grau, D; Chong, WK	2019	Reusing exterior wall framing systems: A cradle-to-cradle comparative life cycle assessment	http://dx.doi.org/10.1016/j.wasman.2019.05.040	wall framing system	Construction	Specialized construction activities	cradle-to-cradle	enclosure of a single-family house over its lifetime (thermal resistance R-15)	Comprehensive	No	Reuse, Remanufacture, Recycle	No	High	Qualitative	Comprehensive	No
199	Rixrath, D; Wartha, C	2016	Comparison of different building shells - life cycle assessment	http://dx.doi.org/10.1002/ieam.1760	building shell	Construction	Specialized construction activities	cradle-to-grave	A conventionalconstruction building shell for single-family houses is com-pared with 2 different wood constructions	Brief	Basic	Recycle	No	Low	No	No	No
200	Rizan, C; Brophy, T; Lillywhite, R; Reed, M; Bhutta, MF	2022	Life cycle assessment and life cycle cost of repairing surgical scissors	http://dx.doi.org/10.1007/s11367-022-02064-7	surgical scissors	Manufacturing	Other manufacturing	cradle-to-grave	one use of a 17-cm, straight Mayo reusable surgical scissor	Comprehensive	Advanced	Repair, Reuse, Recycle	No	High	Quantitative	Comprehensive	No
201	Rodrigo-Bravo, A; Cuenca-Romero, LA; Calderon, V; Rodriguez, A; Gutierrez-Gonzalez, S	2022	Comparative Life Cycle Assessment (LCA) between standard gypsum ceiling tile and polyurethane gypsum ceiling tile	http://dx.doi.org/10.1016/j.enbuild.2022.111867	gypsum tile	Manufacturing	Manufacture of other non-metallic mineral products	cradle-to-grave	1 m^2 of gypsum tile of a 15 mm thickness	Brief	Basic	Recycle	No	No statement	No	Brief	No
202	Ross, SA; Cheah, L	2017	Uncertainty Quantification in Life Cycle Assessments Interindividual Variability and Sensitivity Analysis in LCA of Air-Conditioning Systems	http://dx.doi.org/10.1111/jiec.12505	air conditioning	Electricity, gas, steam and air conditionin	Electricity, gas, steam and air conditionin	cradle-to-grave	lifetime of a 2,5 kW rated inverter air-conditioning system used to cool a single	Brief	Basic	Recycle, Recover	No	No statement	No	No	Yes

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203	Rossi, F; Parisi, ML; Maranghi, S; Manfrida, G; Basosi, R; Sinicropi, A	2019	Environmental impact analysis applied to solar pasteurization systems	http://dx.doi.org/10.1016/j.jclepro.2018.12.020	solar pasteurization system	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 l of treated water	Brief	Basic	Recycle	No	Low	No	No	No
204	Rupp, M; Handschuh, N; Rieke, C; Kuperjans, I	2019	Contribution of country-specific electricity mix and charging time to environmental impact of battery electric vehicles: A case study of electric buses in Germany	http://dx.doi.org/10.1016/j.apenergy.2019.01.059	bus	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-operation	1 passenger being transported over a distance of 1 km [pkm]	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
205	Russo, C; Cappelletti, GM; Nicoletti, GM; Michalopoulos, G; Pattara, C; Palomino, JAP; Tuomisto, HL	2016	PRODUCT ENVIRONMENTAL FOOTPRINT IN THE OLIVE OIL SECTOR: STATE OF THE ART	http://dx.doi.org/10.30638/eemj.2016.218						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
206	Sahoo, K; Bergman, R; Runge, T	2021	Life-cycle assessment of redwood lumber products in the US	http://dx.doi.org/10.1007/s11367-021-01937-7	redwood lumber	Manufacturing	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	cradle-to-grave	1m^3 redwood lumber	Brief	Basic	Recover	No	No statement	No	No	No
207	Sahoo, K; Upadhyay, A; Runge, T; Bergman, R; Puettmann, M; Bilek, E	2021	Life-cycle assessment and techNo-ecoNomic analysis of biochar produced from forest residues using portable systems	http://dx.doi.org/10.1007/s11367-020-01830-9	biochar	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	1 t of biochar sold to a consumer	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
208	Saibuatrong, W; Cheroennet, N; Suwanmanee, U	2017	Life cycle assessment focusing on the waste management of conventional and bio-based garbage bags	http://dx.doi.org/10.1016/j.jclepro.2017.05.006	garbage bag	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1 bag of 20 x 40 cm	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
209	Sala, S; Castellani, V	2019	The consumer footprint: Monitoring sustainable development goal 12 with process-based life cycle assessment	http://dx.doi.org/10.1016/j.jclepro.2019.118050						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
210	Salgado, RA; Apul, D; Guner, S	2020	Life cycle assessment of seismic retrofit alternatives for reinforced concrete frame buildings	http://dx.doi.org/10.1016/j.jobe.2019.101064	seismic retrofit techNology	Construction	Construction of buildings	cradle-to-grave	the dimensions and materials required by each of the three alternatives to conform the original structure to the target limit state of collapse prevention	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
211	Salwa, HN; Sapuan, SM; Mastura, MT; Zuhri, MYM	2020	Life Cycle Assessment of Sugar Palm Fiber Reinforced-Sago Biopolymer Composite Takeout Food Container	http://dx.doi.org/10.3390/app10227951	biocomposite takeout food container	Manufacturing	Manufacture of rubber and plastics products		1 parcel containing 1 kg	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
212	Santoyo-Castelazo, E; Solano-Olivares, K; Martinez, E; Garcia, EO; Santoyo, E	2021	Life cycle assessment for a grid-connected multi-crystalline silicon photovoltaic system of 3 kWp: A case study for Mexico	http://dx.doi.org/10.1016/j.jclepro.2021.128314	grid-connected photovoltaic system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh	No	No	No	No	No statement	No	Brief	Yes
213	Schiavoni, S; Sambuco, S; Rotili, A; D'Alessandro, F; Fantauzzi, F	2017	A nZEB housing structure derived from end of life containers: Energy, lighting and life cycle assessment	http://dx.doi.org/10.1007/s12273-016-0329-9	end-of-life shipping containers	Construction	Specialized construction activities	cradle-to-grave	14 m^2 of floor area	Brief	Basic	Reuse, Recycle	No	No statement	No	No	No
214	Schulte, M; Hammar, T; Stendahl, J; Seleborg, M; Hansson, PA	2021	Time dynamic climate impacts of a eucalyptus pulp product: Life cycle assessment including biogenic carbon and substitution effects	http://dx.doi.org/10.1111/gcbb.12894	pulp-based beverage carton	Manufacturing	Manufacture of beverages			Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope

215	Schulte, M; Lewandowski, I; Pude, R; Wagner, M	202 1	Comparative life cycle assessment of bio-based insulation materials: Environmental and ecoNomic performances	http://dx.doi.org/10.1111/gcbb.12825	insulation	Constructio n	Constructio n of buildings	cradle-to-grave	insulating 1m^2 of external wall of a residential building with 0,24 Wm^2K^-1 for 70 years, fulfilling legal fire resistance and health and safety standards	No	No	Reuse, Recycle, Recover	No	No stateme nt	No	Brief	No
216	Sen, B; Onat, NC; Kucukvar, M; Tatari, O	201 9	Material footprint of electric vehicles: A multiregional life cycle assessment	http://dx.doi.org/10.1016/j.jclepro.2018.10.309	passenger vehicle	Manufactur ing	Manufactur e of motor vehicles, trailers and semi-trailers	cradle-to-grave	300,000 km driven	Brief	Basic	Recycle	No	Low	No	No	No
217	Shafique, M; Luo, XW	202 2	Environmental life cycle assessment of battery electric vehicles from the current and future energy mix perspective	http://dx.doi.org/10.1016/j.jenvman.2021.114050						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
218	Sherman, JD; Raibley, LA; Eckelman, MJ	201 8	Life Cycle Assessment and Costing Methods for Device Procurement: Comparing Reusable and Single-Use Disposable Laryngoscopes	http://dx.doi.org/10.1213/ANE.0000000000002683	laryngoscope handle and tongue blades	Manufactur ing	Other manufacturi ng	cradle-to-grave	1 handle and 1 blade for a single patient encounter	Brief	Basic	Reuse, Refurbish, Recycle	No	Low	Quantitative	Brief	No
219	Shi, JL; Li, T; Peng, ST; Liu, ZC; Zhang, HC; Jiang, QH	201 5	Comparative Life Cycle Assessment of remanufactured liquefied natural gas and diesel engines in China	http://dx.doi.org/10.1016/j.jclepro.2015.03.080						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
220	Shi, JL; Li, T; Zhang, HC; Peng, ST; Liu, ZC; Jiang, QH	201 5	Energy consummation and environmental emissions assessment of a refrigeration compressor based on life cycle assessment methodology	http://dx.doi.org/10.1007/s11367-015-0896-5	refrigeration compressor for AC systems	Manufactur ing	Manufactur e of electrical equipment	cradle-to-grave	a C-SB5HP R22 refrigeration compressor used for five years	Brief	Basic	Reduce, Reuse, Remanufact ure, Recycle	No	Low	No	Brief	Yes
221	Shi, SN; Zhang, HR; Yang, W; Zhang, QR; Wang, XJ	201 9	A life-cycle assessment of battery electric and internal combustion engine vehicles: A case in Hebei Province, China	http://dx.doi.org/10.1016/j.jclepro.2019.04.301						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
222	Shu, X; Guo, YF; Yang, WX; Wei, KX; Zhu, GH	202 1	Life-cycle assessment of the environmental impact of the batteries used in pure electric passenger cars	http://dx.doi.org/10.1016/j.egyr.2021.04.038	battery	Manufactur ing	Manufactur e of electrical equipment	cradle-to-grave	battery with capacity of 28 kWh	Brief	No	Recycle	No	No stateme nt	No	No	Yes
223	Siegert, MW; Saling, P; Mielke, P; Czechmann, C; Emara, Y; Finkbeiner, M	202 0	Cradle-to-grave life cycle assessment of an ibuprofen analgesic	http://dx.doi.org/10.1016/j.scp.2020.100329	Eudorlin Extra (iboprofen)	Manufactur ing	Manufactur e of pharmaceuti cal products and pharmaceuti cal preparations	cradle-to-grave	treatment of an adult patient in Germany with the purpose of pain relief for 4 days	No	No	Recycle, Recover	No	No stateme nt	No	Brief	No
224	Silva, DAL; de Oliveira, JA; Filleti, RAP; de Oliveira, JFG; da Silva, EJ; Ometto, AR	201 8	Life Cycle Assessment in automotive sector: A case study for engine valves towards cleaner production	http://dx.doi.org/10.1016/j.jclepro.2018.02.252	exhaust valves for automotive use	Manufactur ing	Manufactur e of motor vehicles, trailers and semi-trailers	cradle-to-grave	Seal the combustion chambers and control the release of flue-gases in a four-cylinder gasoline engine of a passenger vehicle during 300,000 km of drive	Comprehensive	Basic	Reduce, Recycle	No	High	Quantitative	No	No
225	Silva, DAL; Firmino, AS; Ferro, FS; Christoforo, AL; Leite, FR; Lahr, FAR; Kellens, K	202 0	Life cycle assessment of a hot-pressing machine to manufacture particleboards: hotspots, environmental indicators, and solutions	http://dx.doi.org/10.1007/s11367-020-01755-3	particleboard	Manufactur ing	Manufactur e of machinery and equipment n.e.c.	cradle-to-grave	use of a wardrobe model made of particleboard, with storage capacity of 40 kg (or 3.7 m^3) of goods for 5 years	Comprehensive	Basic	Reduce	Yes	High	Quantitative	No	No
226	Silvestre, JD; Pargana, N; de Brito, J; Pinheiro, MD; Durao, V	201 6	Insulation Cork Boards-Environmental Life Cycle Assessment of an Organic Construction Material	http://dx.doi.org/10.3390/ma9050394	insulation cork boards	Constructio n	Constructio n of buildings	cradle-to-cradle	area of application of the insulation (m^2)	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
227	Sim, J; Prabhu, V	201 8	The life cycle assessment of energy and carbon emissions on wool and nylon carpets in the United States	http://dx.doi.org/10.1016/j.jclepro.2017.09.203	carpet	Manufactur ing	Manufactur e of rubber and plastics products	cradle-to-grave	0.09m^2 of wool carpet tile	Comprehensive	Advanc ed	Remanufact ure, Recycle	No	High	No	No	No

228	Singh, JKD; Molinari, G; Bui, J; Soltani, B; Rajarathnam, GP; Abbas, A	2021	Life Cycle Assessment of Disposed and Recycled End-of-Life Photovoltaic Panels in Australia	http://dx.doi.org/10.3390/su131911025	Photovoltaic system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh	Comprehensive	Advanced	Recycle	No	Low	No	Comprehensive	No
229	Smith, M; Lal, P	2022	Environmental and ecoNomic assessment of hard apple cider using an integrated LCA-LCC approach	http://dx.doi.org/10.1016/j.spc.2022.04.026						Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
230	Soulions, M; Panaras, G; Fokaides, PA; Papaefthimiou, S; Kalogirou, SA	2018	Solar water heating for social housing: Energy analysis and Life Cycle Assessment	http://dx.doi.org/10.1016/j.enbuild.2018.03.048	water heating systems	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 system	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
231	Soust-Verdaguer, B; Llatas, C; Moya, L	2020	Comparative BIM-based Life Cycle Assessment of Uruguayan timber and concrete-masonry single-family houses in design stage	http://dx.doi.org/10.1016/j.jclepro.2020.121958	house	Construction	Construction of buildings	cradle-to-grave	1 m^2 of heating area	Brief	No	Repair	No	Low	No	Brief	Yes
232	Souza, HHD; Lima, AMF; Esquerre, KO; Kiperstok, A	2017	Life cycle assessment of the environmental influence of wooden and concrete utility poles based on service lifetime	http://dx.doi.org/10.1007/s11367-017-1293-z	utility pole	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 km of distribution network supporting medium voltage power distribution for a period of 50 years	Brief	Basic	Reuse, Recycle	No	High	Quantitative	Brief	No
233	Stoppato, A; Benato, A	2020	Life Cycle Assessment of a Commercially Available Organic Rankine Cycle Unit Coupled with a Biomass Boiler	http://dx.doi.org/10.3390/en13071835	Organic Rakine Cycle turbogenerators	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of electricity production	No	No	No	No	No statement	No	No	No
234	Stropnik, R; Sekavcnik, M; Ferriz, AM; Mori, M	2018	Reducing environmental impacts of the ups system based on PEM fuel cell with circular ecoNomy	http://dx.doi.org/10.1016/j.energy.2018.09.201	uninterruptible power supply system with polymer membrane fuel cell	Manufacturing	Manufacture of computer, electronic and optical products	cradle-to-grave	1 kWh of produced electric energy	Comprehensive	Advanced	Reuse, Recycle	No	High	Quantitative	Comprehensive	No
235	Sun, X; Liu, JR; Lu, B; Zhang, P; Zhao, MN	2017	Life cycle assessment-based selection of a sustainable lightweight automotive engine hood design	http://dx.doi.org/10.1007/s11367-016-1254-y	lightweight automotive engine hood	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	transportation service of an engine hood used in a passenger car over its lifetime of 150,000 km	Brief	Basic	Recycle, Recover	No	Low	Quantitative	No	No
236	Suppipat, S; Hu, AH; Trinh, LTK; Kuo, CH; Huang, LH	2022	A comparative life cycle assessment of toothpaste cream versus toothpaste tablets	http://dx.doi.org/10.1016/j.spc.2021.10.021	toothpaste tablets	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	brushing teeth for 2 min twice a day for 6 months	Brief	Basic	Reuse, Recycle	No	Low	No	No	Yes
237	Svanes, E; Johnsen, FM	2019	Environmental life cycle assessment of production, processing, distribution and consumption of apples, sweet cherries and plums from conventional agriculture in Norway	http://dx.doi.org/10.1016/j.jclepro.2019.117773	plums, apples and sweet cherries	Manufacturing	Processing and preserving of fruit and vegetables	cradle-to-grave	1 kg of fruit eaten by consumer	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
238	Svanes, E; Oestergaard, S; Hanssen, OJ	2019	Effects of Packaging and Food Waste Prevention by Consumers on the Environmental Impact of Production and Consumption of Bread in Norway	http://dx.doi.org/10.3390/su11010043	bread	Manufacturing	Manufacture of food products	cradle-to-grave	1 kg of bread produced, distributed and consumed in Norway	Brief	Basic	Reuse	No	Low	No	Brief	No
239	Tagliaferri, C; Evangelisti, S; Acconcia, F; Domenech, T; Ekins, P; Barletta, D; Lettieri, P	2016	Life cycle assessment of future electric and hybrid vehicles: A cradle-to-grave systems engineering approach	http://dx.doi.org/10.1016/j.cherd.2016.07.003	battery electric vehicle	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	1 km driven by one vehicle (car)	Comprehensive	Advanced	Recycle	No	Low	Quantitative	No	No
240	Tamburini, E; Costa, S; Summa, D; Battistella, L; Fano, EA; Castaldelli, G	2021	Plastic (PET) vs bioplastic (PLA) or refillable aluminium bottles - What is the most sustainable choice for drinking water? A life-cycle (LCA) analysis	http://dx.doi.org/10.1016/j.envres.2021.110974	bottles for drinking water	Manufacturing	Manufacture of beverages	cradle-to-grave	containing beverage for consumption is “one year of use”	Brief	Basic	Reuse, Recycle, Recover	No	Low	No	No	No
241	Tan, QY; Song, QB; Li, JH	2015	The environmental performance of fluorescent lamps in China, assessed with the LCA method	http://dx.doi.org/10.1007/s11367-015-0870-2	fluorescent lamps	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	operating time of FLs in the use stage	Brief	No	Recycle	No	Low	No	No	No

242	Tannous, S; Manneh, R; Harajli, H; El Zakhem, H	2018	Comparative cradle-to-grave life cycle assessment of traditional grid connected and solar stand-alone street light systems: A case study for rural areas in LebaNon	http://dx.doi.org/10.1016/j.jclepro.2018.03.155	street lightning system	Construction	Specialized construction activities	cradle-to-grave	light up the rural areas for 12 h per day over 20 years	Comprehensive	Advanced	Recycle	No	Low	Quantitative	No	No
243	Teffera, B; Assefa, B; Bjorklund, A; Assefa, G	2021	Life cycle assessment of wind farms in Ethiopia	http://dx.doi.org/10.1007/s11367-020-01834-5	wind farm	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of average electricity	Brief	Advanced	Recycle	No	Low	Quantitative	No	No
244	Temizel-Sekeryan, S; Hicks, AL	2021	Cradle-to-grave environmental impact assessment of silver enabled t-shirts: Do naNo-specific impacts exceed Non naNo-specific emissions?	http://dx.doi.org/10.1016/j.impact.2021.100319	silver enabled t-shirts	Manufacturing	Manufacture of textiles	cradle-to-grave	145 g silver enabled PES textile (indicates men's t-shirt with a large size) during its lifetime of 100 laundering cycles	No	No	No	No	No statement	No	No	No
245	Thirametoakkhara, C; Lerkkasemsan, N	2019	Life cycle assessment of diuron from cradle to grave: case study in agave farm	http://dx.doi.org/10.1016/j.jclepro.2019.117712	diuron	Manufacturing	Manufacture of chemicals and chemical products	cradle-to-grave	1 metric ton of diuron	No	No	No	No	No statement	No	No	No
246	Thomson, RC; Chick, JP; Harrison, GP	2019	An LCA of the Pelamis wave energy converter	http://dx.doi.org/10.1007/s11367-018-1504-2	Pelamis wave energy converter	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of output electrical power	Brief	Basic	Recycle	No	Low	No	Brief	No
247	Tian, XY; Stranks, SD; You, FQ	2021	Life cycle assessment of recycling strategies for perovskite photovoltaic modules	http://dx.doi.org/10.1038/s41893-021-00737-z	1 kWh of output electrical power	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1m^2 of envisioned perovskite PV module	Comprehensive	No	Recycle	No	High	Quantitative	No	No
248	Ticha, M; Zilka, M; Stieberova, B; Freiberg, F	2016	Life cycle assessment comparison of photocatalytic coating and air purifier	http://dx.doi.org/10.1002/ieam.1786	photocatalytic coating and air purifier	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	purification of 100 cubic meters of air in an enclosed space over a period of one year	Brief	No	Recycle	No	No statement	No	No	No
249	Tsang, MP; Sonnemann, GW; Bassani, DM	2016	Life-cycle assessment of cradle-to-grave opportunities and environmental impacts of organic photovoltaic solar panels compared to conventional techNologies	http://dx.doi.org/10.1016/j.solmat.2016.04.024	organic photovoltaic solar panels	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	an average kWh of electricity generation over 25 years using a solar rooftop array	Brief	Basic	Recycle	No	Low	No	Brief	No
250	Tsoy, N; Prado, V; Wypkema, A; Quist, J; Mourad, M	2019	Anticipatory Life Cycle Assessment of sol-gel derived anti-reflective coating for greenhouse glass	http://dx.doi.org/10.1016/j.jclepro.2019.02.246	Coating of greenhouse glass	Construction	Specialized construction activities	cradle-to-grave	Production of 1692.30 kg of tomatoes in greenhouses during 30 years.	Comprehensive	Advanced	Recycle	No	Low	No	No	No
251	Uctug, FG; Atlugkoyun, AI; Inaltekin, M	2019	Environmental life cycle assessment of yoghurt supply to consumer in Turkey	http://dx.doi.org/10.1016/j.jclepro.2019.01.127	Yoghurt	Manufacturing	Manufacture of dairy products	cradle-to-grave	1 ton of yoghurt.	Brief	Advanced	Reduce, Recover	No	Low	No	No	No
252	Uihlein, A	2016	Life cycle assessment of ocean energy techNologies	http://dx.doi.org/10.1007/s11367-016-1120-y	Ocean energy devices	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of electricity delivered to the grid.	Brief	Basic	Reuse, Recycle, Recover	No	Low	No	No	No
253	Upadhyayula, VKK; Parvatker, AG; Baroth, A; Shanmugam, K	2019	Lightweighting and electrification strategies for improving environmental performante of passenger cars in India by 2030: A critical perspective based on life cycle assessment	http://dx.doi.org/10.1016/j.jclepro.2018.11.153	Passenger car	Manufacturing	Manufacture of motor vehicles, trailers and semi-trailers	cradle-to-grave	Total life time driving distance of 150,000 kms over 15 years is considered.	Brief	No	Recycle, Recover	No	Low	No	No	No
254	Usva, K; Sinkko, T; Silvenius, F; Riipi, I; Heusala, H	2020	Carbon and water footprint of coffee consumed in Finland-life cycle assessment	http://dx.doi.org/10.1007/s11367-020-01799-5	Coffee	Manufacturing	Manufacture of food products	cradle-to-grave	1 l of consumed coffee.	Brief	Basic	Recover	No	No statement	No	No	No
255	Vinyes, E; Asin, L; Alegre, S; Munoz, P; Boschmonart, J; Gasol, CM	2017	Life Cycle Assessment of apple and peach production, distribution and consumption in Mediterranean fruit sector	http://dx.doi.org/10.1016/j.jclepro.2017.02.102	Apple and peach	Manufacturing	Processing and preserving of fruit and vegetables	cradle-to-grave	production of one kg of fruit.	Brief	Basic	No	No	Low	No	Brief	No

256	Violante, AC; Donato, F; Guidi, G; Proposito, M	2022	Comparative life cycle assessment of the ground source heat pump vs air source heat pump	http://dx.doi.org/10.1016/j.renene.2022.02.075	Heat pump	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	1 kWh of energy supplied for the air conditioning of a single office.	Brief	No	Reuse	No	No statement	No	No	No
257	Vitali, A; Grossi, G; Martino, G; Bernabucci, U; Nardone, A; Lacetera, N	2018	Carbon footprint of organic beef meat from farm to fork: a case study of short supply chain	http://dx.doi.org/10.1002/jsfa.9098	Organic beef meat	Manufacturing	Processing and preserving of meat	cradle-to-grave	1 kg of cooked beef.	Brief	Basic	Recycle	No	No statement	No	No	No
258	Vytisk, J; Honus, S; Koc, V; Pagac, M; Hajnys, J; Vujanovic, M; Vrtek, M	2022	Comparative study by life cycle assessment of an air ejector and orifice plate for experimental measuring stand manufactured by conventional manufacturing and additive manufacturing	http://dx.doi.org/10.1016/j.susmat.2022.e00431	Air ejector	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	Production of an air ejector.	Brief	Advanced	Recycle	No	Low	Quantitative	No	No
259	Wang, LK; Wang, Y; Du, HB; Zuo, J; Li, RYM; Zhou, ZH; Bi, FF; Garvlehn, MP	2019	A comparative life-cycle assessment of hydro-, nuclear and wind power: A China study	http://dx.doi.org/10.1016/j.apenergy.2019.04.099	Hydro-, nuclear and wind power	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of electricity generation.	Brief	Basic	Reduce, Recycle, Recover	No	High	Quantitative	Brief	No
260	Wang, YX; Tang, BJ; Shen, M; Wu, YZ; Qu, S; Hu, YJ; Feng, Y	2022	Environmental impact assessment of second life and recycling for LiFePO4 power batteries in China	http://dx.doi.org/10.1016/j.jenvman.2022.115083	LiFePO4 power batteries	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh of stored and delivered energy.	Comprehensive	Advanced	Reuse, Recycle	No	High	Quantitative	Comprehensive	No
261	Weber, S; Peters, JF; Baumann, M; Weil, M	2018	Life Cycle Assessment of a Vanadium Redox Flow Battery	http://dx.doi.org/10.1021/acs.est.8b02073	Vanadium Redox Flow Battery	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	Provision of 1 MWh of electricity by the battery over the 20 year lifetime of a hypothetical renewables support application.	Comprehensive	Advanced	Recycle, Recover	No	High	Quantitative	Brief	No
262	Wen, B; Jin, Q; Huang, H; Tandon, P; Zhu, YH	2017	Life cycle assessment of Quayside Crane: A case study in China	http://dx.doi.org/10.1016/j.jclepro.2017.01.146	Quayside Crane	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	Complete life cycle of a 1,785,055 kg QC made in China, exported to Dubai and used for 20 years.	Brief	Basic	Recycle, Recover	No	High	Quantitative	Comprehensive	No
263	Weththasinghe, KK; Akash, A; Harding, T; Subhani, M; Wijayasundara, M	2022	Carbon footprint of wood and plastic as packaging materials - An Australian case of pallets	http://dx.doi.org/10.1016/j.jclepro.2022.132446	Pallets	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	Completing 100 trips using the MDWD pallet, carrying the same load.	Comprehensive	Advanced	Reuse, Recycle, Recover	No	High	Quantitative	Comprehensive	No
264	Wiedemann, SG; Biggs, L; Clarke, SJ; Russell, SJ	2022	Reducing the Environmental Impacts of Garments through Industrially Scalable Closed-Loop Recycling: Life Cycle Assessment of a Recycled Wool Blend Sweater	http://dx.doi.org/10.3390/su14031081	Garments	Manufacturing	Manufacture of wearing apparel	cradle-to-grave	One garment over its lifetime, with impacts reported per wear event in Europe.	Comprehensive	Advanced	Recycle, Recover	Yes	High	Quantitative	Comprehensive	No
265	Wolfram, P; Wiedmann, T; Diesendorf, M	2016	Carbon footprint scenarios for renewable electricity in Australia	http://dx.doi.org/10.1016/j.jclepro.2016.02.080	Electricity generation techNologies	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	One kWh and total annual final demand of electricity consumed in Australia.	No	No	No	No	No statement	No	No	No
266	Wong, EYC; Ho, DCK; So, S; Poo, MCP	2022	Sustainable consumption and production: Modelling product carbon footprint of beverage merchandise using a supply chain input-process-output approach	http://dx.doi.org/10.1002/csr.2193	Carbonated drink	Manufacturing	Manufacture of beverages	cradle-to-grave	A carbonated drink in an aluminium can.	Brief	Basic	Recycle	No	No statement	No	No	No
267	Xiao, RF; Zhang, Y; Liu, X; Yuan, ZW	2015	A life-cycle assessment of household refrigerators in China	http://dx.doi.org/10.1016/j.jclepro.2015.02.031	Household refrigerators	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	The complete life cycle of a 61 kg direct-cooling double-door refrigerator made in China, used for 10 years (24 h/day), and disposed of in China through a state-of the-art recycling system.	Brief	Advanced	Recycle	No	Low	Quantitative	Comprehensive	No
268	Xie, JB; Fu, JX; Liu, SY; Hwang, WS	2020	Assessments of carbon footprint and energy analysis of three wind farms	http://dx.doi.org/10.1016/j.jclepro.2020.120159	Wind farm	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh of electricity generation.	Brief	No	Recycle, Recover	No	No statement	No	No	No

269	Xu, L; Pang, MY; Zhang, LX; Poganietz, WR; Marathe, SD	2018	Life cycle assessment of onshore wind power systems in China	http://dx.doi.org/10.1016/j.resconrec.2017.06.014	Onshore wind power system	Electricity, gas, steam and air conditioning supply	Electricity, gas, steam and air conditioning supply	cradle-to-grave	1 kWh electricity generation provided by the 220 kV step-up transformer.	Comprehensive	Advanced	Recycle, Recover	No	Low	No	No	No
270	Xu, Q; Hu, KL; Wang, XL; Wang, DH; Knudsen, MT	2019	Carbon footprint and primary energy demand of organic tea in China using a life cycle assessment approach	http://dx.doi.org/10.1016/j.jclepro.2019.06.136	Organic tea	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	Two functional units were chosen: 1 kg of dry tea for cradle to supermarket gate and 1 cup of tea for cradle to grave.	Brief	Basic	Recycle	No	No statement	No	No	No
271	Yavor, KM; Lehmann, A; Finkbeiner, M	2020	Environmental Impacts of a Pet Dog: An LCA Case Study	http://dx.doi.org/10.3390/su12083394	Pet Dog	Agriculture, forestry and fishing	Crop and animal production, hunting and related service activities	cradle-to-grave	One average dog: life of an average dog assuming an average weight of 15 kg and an average life expectancy of 13 years.	Comprehensive	Advanced	Recover	No	Low	Quantitative	Comprehensive	No
272	Yilmaz, E; Aykanat, B; Comak, B	2022	Environmental life cycle assessment of rockwool filled aluminum sandwich facade panels in Turkey	http://dx.doi.org/10.1016/j.jobe.2022.104234	Facade pannels	Construction	Specialized construction activities	cradle-to-gate-to-disposal	1m² sandwich panel with insulation.	Brief	Basic	Recover	No	No statement	No	No	No
273	Yuan, ZW; Zhang, Y; Liu, X	2016	Life cycle assessment of horizontal-axis washing machines in China	http://dx.doi.org/10.1007/s11367-015-0993-5	Washing machine	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	A single horizontal-axis washing machine during its 10-year service life in China.	Comprehensive	Advanced	Recycle	No	Low	Quantitative	Brief	No
274	Yudhistira, R; Khatiwada, D; Sanchez, F	2022	A comparative life cycle assessment of lithium-ion and lead-acid batteries for grid energy storage	http://dx.doi.org/10.1016/j.jclepro.2022.131999	Batteries	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	1 kWh energy delivered.	Brief	Basic	Recycle, Recover	No	Low	Qualitative	Brief	No
275	Zackrisson, M; Fransson, K; Hildenbrand, J; Lampic, G; O'Dwyer, C	2016	Life cycle assessment of lithium-air battery cells	http://dx.doi.org/10.1016/j.jclepro.2016.06.104	Battery cells	Manufacturing	Manufacture of electrical equipment	cradle-to-grave	One vehicle kilometre.	Brief	Basic	Recycle, Recover	No	Low	Qualitative	Brief	No
276	Zafeiridou, M; Hopkinson, NS; Voulvoulis, N	2018	Cigarette Smoking: An Assessment of Tobacco's Global Environmental Footprint Across Its Entire Supply Chain	http://dx.doi.org/10.1021/acs.est.8b01533	Cigarettes	Manufacturing	Manufacture of tobacco products	cradle-to-grave	A tonne of produced and consumed tobacco, equivalent to 1 million cigarette sticks.	Brief	Basic	No	No	No statement	No	No	No
277	Zanghelini, GM; Cherubini, E; Dias, R; Kabe, YHO; Delgado, JJS	2020	Comparative life cycle assessment of drinking straws in Brazil	http://dx.doi.org/10.1016/j.jclepro.2020.123070	Drinking straws	Manufacturing	Manufacture of paper and paper products	cradle-to-grave	to drink 300 ml of a generic liquid from a regular glass	Brief	Basic	Reuse, Recycle	No	Low	Quantitative	Brief	No
278	Zhai, YJ; Zhang, TZ; Tan, XF; Wang, GL; Duan, LC; Shi, QP; Ji, CX; Bai, YY; Shen, XX; Meng, J; Hong, JL	2022	Environmental impact assessment of ground source heat pump system for heating and cooling: a case study in China	http://dx.doi.org/10.1007/s11367-022-02034-z	Heat pump	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-gate	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope	Out of Scope
279	Zhang, BY; Tong, YF; Singh, S; Cai, H; Huang, JY	2019	Assessment of carbon footprint of naNo-packaging considering potential food waste reduction due to shelf life extension	http://dx.doi.org/10.1016/j.resconrec.2019.05.030	Packaging	Manufacturing	Manufacture of rubber and plastics products	cradle-to-grave	1 kg of food product and the required amount of naNo-packaging materials.	Brief	Basic	Reduce	No	No statement	No	No	No
280	Zhang, JY; Yuan, HY; Deng, YL; Abu-Reesh, IM; He, Z; Yuan, C	2019	Life cycle assessment of osmotic microbial fuel cells for simultaneous wastewater treatment and resource recovery	http://dx.doi.org/10.1007/s11367-019-01626-6	Fuel cells	Manufacturing	Manufacture of computer, electronic and optical products	cradle-to-grave	1 unit of wastewater treatment.	Brief	Basic	Recycle, Recover	No	Low	Quantitative	Brief	No
281	Zhang, JY; Yuan, HY; Deng, YL; Zha, YC; Abu-Reesh, IM; He, Z; Yuan, C	2018	Life cycle assessment of a microbial desalination cell for sustainable wastewater treatment and saline water desalination	http://dx.doi.org/10.1016/j.jclepro.2018.07.197	Wastewater treatment and desalination	Water supply; sewerage, waste management and remediation activities	Water collection, treatment and supply	cradle-to-grave	1 L of water being treated.	Brief	Basic	Recycle, Recover	No	Low	Quantitative	Brief	No

282	Zhang, LG; Spatari, S; Sun, Y	2020	Life cycle assessment of Novel heat exchanger for dry cooling of power plants based on encapsulated phase change materials	http://dx.doi.org/10.1016/j.apenergy.2020.115227	Heat exchanger	Manufacturing	Manufacture of machinery and equipment n.e.c.	cradle-to-grave	1 kWh of electricity produced.	Brief	Basic	Reuse, Recycle	No	No statement	No	No	No
283	Zhou, ZW; Alcala, J; Kripka, M; Yepes, V	2021	Life Cycle Assessment of Bridges Using Bayesian Networks and Fuzzy Mathematics	http://dx.doi.org/10.3390/app11114916	Bridge	Construction	Civil engineering	cradle-to-grave	n.d.	Brief	No	Repair	No	Low	No	No	No
284	Zhou, ZW; Alcala, J; Yepes, V	2020	Bridge Carbon Emissions and Driving Factors Based on a Life-Cycle Assessment Case Study: Cable-Stayed Bridge over Hun He River in Liaoning, China	http://dx.doi.org/10.3390/ijerph17165953	Bridge	Construction	Civil engineering	cradle-to-grave	n.d.	Brief	Basic	Repair	No	Low	No	No	No

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