GLA Circular Economy Metrics Study

Circular Economy metrics to support building design requirements

Greater London Authority

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Quality information

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Executive Summary

Aims

This report reviews and compares existing circular economy (CE) metrics used to assess circularity in building designs. Its purpose is to determine which metric delivers the most demonstrable circular economy outcomes to support future policy development in London's built environment.

Methodology

The review involved compiling academic research and grey literature, followed by an appraisal to identify the metrics that are most aligned with policy objectives. A stakeholder engagement session was organised as part of the process to refine and validate the list of initially gathered metrics. A longlist of 13 metrics was assessed using defined criteria, reducing to a shortlist of 5. These were evaluated in detail, considering their benefits, limitations, policy alignment, data requirements, and practical applicability.

Key Findings

Following assessment against initial criteria, **five leading metrics** were shortlisted for in-depth evaluation:

- **EU Level(s) Indicator 2.2** (Construction and demolition waste and materials)
- **Flex 4.0**
- **Madaster Circularity Indicator**
- **Whole Building Circularity Indicator (WBCI)** by Khadim et al.
- **Transformation Capacity** by Durmisevic

The initial criteria considered the input process (the applicant performing an assessment based on the associated methodology) and outputs (the information which can be used to determine response to policy) and included the following elements: objective input data; robust with a scientific basis; transparent assumptions and methodological parameters; free to use; measurable results; and outcome simple to comprehend.

Following further assessment, the **WBCI** emerged as having the **most comprehensive methodology**, encompassing multiple CE dimensions (resource circularity, adaptability, longevity, and disassembly), and producing a single composite score to benchmark building circularity.

The **Madaster** metric, which builds on the Ellen MacArthur Foundation's Material Circularity Indicator, provides a detailed layer-by-layer analysis and a single score but does not yet capture the full range of CE principles addressed by the WBCI.

Upon further testing, a **modular approach** combining **Madaster, EU Level(s), Flex 4.0, and Transformation Capacity** could offer granular insights into specific circularity aspects, especially in early-stage design. Figure 6 inserted below from Section 7 of the report illustrates which metrics produce a single outcome versus multiple outcomes, and whether they address multiple aspects of the circular economy or focus on a single dimension.

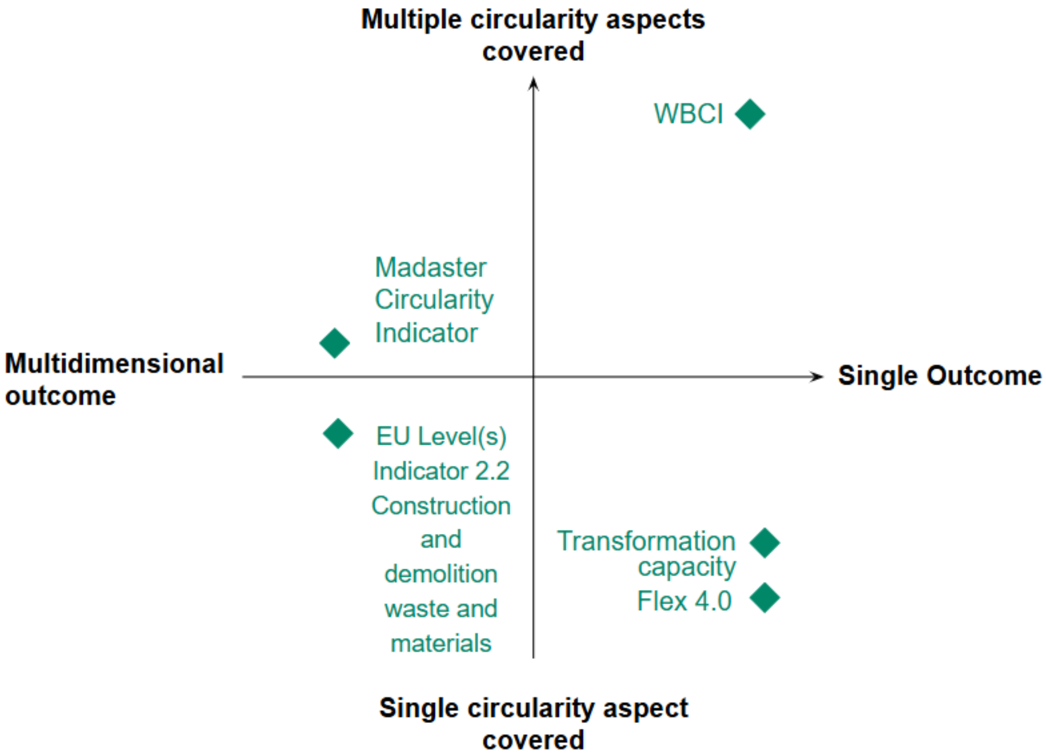


Figure 5. Results Matrix

Each of the shortlisted circular economy metrics has the potential to support London policy, provided that their current limitations are addressed, they are aligned with future policy objectives and appropriately adapted for referable applications. This mainly involves enhancing data availability, establishing standardised assumptions and clear guidance, validating indicators and weighting factors, and testing of the metrics.

1. Introduction

AECOM has been appointed by the Greater London Authority (GLA) to produce a report that identifies and reviews the most effective for measuring circularity in new developments. This section outlines the aims of the commission, along with the scope and limitations of the study.

1.1 Aims of this document

The purpose of this report is to review the different circular economy metrics (and their associated methodologies) used to measure circularity in building designs and assess which one achieves the most demonstrable circular economy outcomes for London's built environment.

This document forms part of the evidence base for the review of The London Plan 2021. The outcomes of this study will inform changes to Policy SI7 of the draft new London Plan.

This study seeks to answer the following questions:

- How could the process and methodology for assessing the circularity of new developments in planning decisions be more specific, measurable, and quantitatively robust? What barriers or inefficiencies currently impact this process?
- How could changes to circular economy methodologies and/or metrics enhance clarity for developers and decision makers in terms of what outcomes are expected to be delivered and how? How could such changes provide greater clarity for monitoring developments and policies?
- Is there any weighting that should be applied to circular economy metrics and/or methodologies to deliver greater carbon savings?
- What are the strengths and weaknesses of existing circular economy metrics and methodologies for quantifying circular economy outcomes for developments?
- Which of these existing circular economy metrics or methodologies would be most viable for application in London?

1.2 Scope and limitations

The scope of this study includes:

- Reviewing existing circular economy methodologies and metrics used to assess circularity in building design, with a focus on identifying those that deliver the most demonstrable outcomes for London's built environment.
- Identifying the approaches that are most effective in achieving circular economy outcomes in new developments.
- Conducting a stakeholder engagement session to gather insights from relevant industry experts.
- Undertaking a literature review of current practices, tools, and frameworks related to circularity in construction.

- Using the findings from the literature review to address the research questions set out in the aims of this study.

Where this report forms part of the evidence base for the next London Plan, the findings and conclusions will inform ongoing policy development, however, the study does not seek to provide specific policy recommendations. The following exclusions to the study should also be noted:

- This study is limited to identifying and reviewing existing methodologies through a literature review and a single stakeholder engagement session. It does not involve practical testing or application of the metrics. As such, the findings highlight the *potential* of different metrics to be applied at a London-wide scale. Further testing and validation would be required to confirm the outcomes of this study.
- The analysis is based on publicly available information, along with select academic and industry studies accessible to AECOM through corporate research subscriptions. Where certain methodologies or tools were located behind paywalls, only the provider's descriptions and accessible summaries were reviewed. While these were assessed critically, some conclusions may be based on assumptions and may carry a degree of bias due to limited access to full content.

2. Context and overview

To enable the review of the industry methodologies and metrics, it is necessary to understand the GLA's definition of a circular economy and the relevant policy context. Therefore, this section examines prevailing definitions of the circular economy, with particular focus on its application to the built environment.

It provides a summary of the process for implementing current policy requirements and how circular economy statements are assessed.

2.1 Definition of circular economy

The European Parliament frames the transition to a circular economy as a process of "sharing, leasing, reusing, repairing, refurbishing and recycling existing materials and products as long as possible. In this way, the life cycle of products is extended." It emphasises efficient resource management across the entire life cycle. [1]

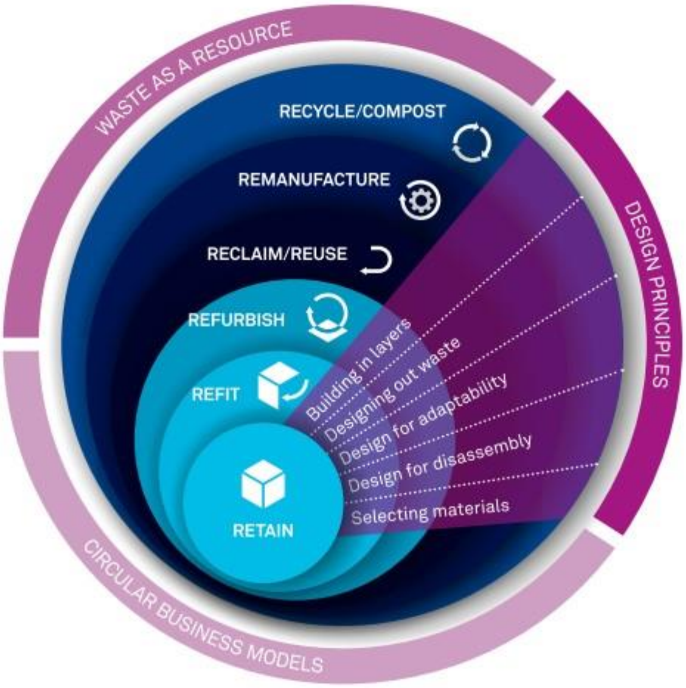
Similarly, the UK Government describes the circular economy as "moving away from our current linear economy (make-use-dispose) towards one where our products, and the materials they contain, are valued differently; creating a more robust economy in the process." [2]

A Circular Economy is defined in London Plan Policy SI7 as "one where materials are retained in use at their highest value for as long as possible and are then reused or recycled, leaving a minimum of residual waste." This represents a shift away from the traditional linear model - where materials are extracted, used, and disposed of - toward a system designed to keep resources in circulation. [3]

All three definitions emphasise extending the life cycle of materials and products through strategies such as reuse, repair, refurbishment, and recycling, thereby minimising waste and maximising resource efficiency. This shared understanding forms the fundamental basis for selecting the methodologies reviewed in this study.

2.1.1 Circular Economy in the built environment

Figure 1 considers how the circular economy can be applied to the built environment through retaining the existing value of materials, including through treating waste as a resource and engaging with circular business models (such as take-back schemes and closed-loop recycling processes). The diagram illustrates that diminishing returns are gained by moving through the hierarchy outwards, prioritising retention, retrofit and refurbishment of buildings, and then aiming to reclaim, reuse and remanufacture components, with the least preferred option being recycling materials produced by the building or demolition process. This diagram is included in the London Plan and the GLA's circular economy guidance.



Source: Building Revolutions (2016), David Cheshire, RIBA Publishing ©

Figure 1. Circular Economy hierarchy for building approaches

The London Plan recognises that large scale developments present opportunities for innovative building design that avoids waste, supports high recycling rates and helps London transition to a circular economy, where materials, products and assets are kept at their highest value for as long as possible. This can include minimising use of new materials through both the reuse of existing materials and application of lean design principles for the new proposal. In line with Figure 1, Section 3.3.10 of the London Plan sets out six circular economy principles which applicants should consider throughout the design process and which are defined further through the London Plan Guidance (LPG):

- **building in layers** – ensuring that different parts of the building are accessible and can be maintained and replaced where necessary.
- **designing out waste** – ensuring that waste reduction is planned in from project inception to completion, including consideration of standardised components, modular build and re-use of secondary products and materials.
- **designing for longevity** – ensuring that premature end-of-life for components is avoided through consideration of maintenance and durability.
- **designing for adaptability or flexibility** – ensuring that potential for long-term and short-term changes to occupancy patterns and use types have been considered and can be supported by the design.
- **designing for disassembly** – ensuring that building design supports removal of components with minimal damage to allow for reuse, recycling and replacement.
- **using systems, elements or materials that can be re-used and recycled** – ensuring that the life cycle of products and materials has been considered including reuse of materials and specification of recycled content in the new development and potential for new materials to be reused or recycled at the end-of-life.

2.2 Current Planning Policy

According to current policy and guidance, the level of information to be provided by applicants varies by application stage. An overview of the current GLA planning policy and further details regarding minimum submission requirements at different stages can be found in Appendix B.

This study focuses on the potential to implement metrics at planning stage, as this is the point at which the level of compliance is determined and GLA has the greatest degree of influence. The planning stage submission also sets the basis for the level of information, which is to be updated at post-completion stage, where estimated planning stage figures are updated with measured performance.

2.2.1 Implementation, recorded outcomes and limitations

When Circular Economy Statements are submitted to the GLA for referable planning applications, they are reviewed by Circular Economy Officers with technical expertise to assess how the development proposals align with relevant policies. Feedback is provided to applicants requesting additional information where necessary to demonstrate compliance. This feedback is then considered by case officers and development managers, who oversee decision-making. During the planning stage, several rounds of consultation with the GLA often take place, enabling applicants to address comments and ensure their proposals respond to the policy and guidance. This process is briefly summarised in Table 1 below.

Table 1. Summary of GLA policy implementation approach

	Pre-Application	Outline Application	Detailed Application	Post-Construction
Process	Applicant to submit pre-app template	Applicant to submit CE statement (including GLA CE template and supporting studies)	Applicant to submit CE statement (including GLA CE template and supporting studies)	Applicant to submit Post-Construction Report (including supporting information)
GLA Role	Officers attend pre-application meeting with applicant and review template, and provide written feedback	GLA to review CE submission and provide written feedback, with subsequent comments provided following applicant response	GLA to review CE submission and provide written feedback, with subsequent comments provided following applicant response	GLA to compare Post-Construction with Planning Stage submission

GLA has begun to publish annual Circular Economy monitoring reporting [4] which reflects upon the outcomes of Circular Economy Statements submitted in support of applications which received planning approval in the respective year. This reporting presents analysis of planning stage data only; there is currently no published information available relating to CE performance at construction stage.

The monitoring reporting has been aligned with the circular economy statement information requirements as set out in the LPG and presented in Table B.8 in

Appendix B. For qualitative reporting types, including Design Approaches, Design Principles and supporting reports (such as Pre-Redevelopment Audits), the reporting provides a count of the number of applications responding to this requirement. It reports the number of applications where a specific approach is proposed (for example, partial retention and refurbishment), which can be compared to previous years. However, the qualitative format of data collected from applicants does not lend itself to any further numerical analysis.

The published LPG includes figures which were generated from monitored outcomes from circular economy statements submitted from 2020 to 2022. Table 2 of the LPG include quartile measurements of waste intensity and material efficiency reported by applicants. These figures are being used in the GLA CE template and in implementation as a point of comparison to determine whether reported metrics are within a typical range. It is noted in the LPG that applications will be expected to tend towards the median and lower quartile figures in the future. These ranges have been updated through the annual monitoring reporting process to illustrate any improvements in waste minimisation and resource efficiency as a result of the policy. However, the figures have not yet been adopted as specific benchmarks or targets for applicants to meet.

Where applicants should provide confirmation of the project targets at planning stage with respect to the policy targets set out in Section 2.2 above, the annual monitoring reports the average performance level to be targeted.

The post-completion stage reporting requires applicants to provide a comparison between the design and as built performance and to confirm whether they are achieving what they are targeting / committing to at the planning application stage. The Circular Economy Statement Guidance landing page on the GLA website provides sample condition wording for LPAs to adapt to secure this reporting. The Mayor does not have powers post-planning so it is the responsibility of the Local Planning Authority (LPA) to discharge associated conditions. However, condition wording prescribes that applicants should submit post-completion reporting to GLA for information and monitoring. When this ‘as built’ information becomes available, it will help to validate planning stage benchmarks and targets. The London Plan Guidance expresses intent to make reporting and supporting information submitted at post-construction stage available to the public via the London Datastore for transparency and monitoring purposes.

2.2.2 Link to other policy areas

Whilst primarily Circular Economy is addressed in policy through London Plan Policy SI 7 ‘Reducing waste and supporting the circular economy’, there are related policies such as Policy D 3 that encourages optimising the site capacity and sustainable design, and Policy SI 2, ‘Minimising greenhouse gas emissions’

Policy SI 2, like Policy SI 7, introduced a requirement in 2021 for additional sustainability reporting to be provided by applicants at the planning stage:

> *F. Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions.*

Whole Life Carbon (WLC) and Circular Economy (CE) share several similar considerations and informational requirements, which are mapped in Figure 2 below.

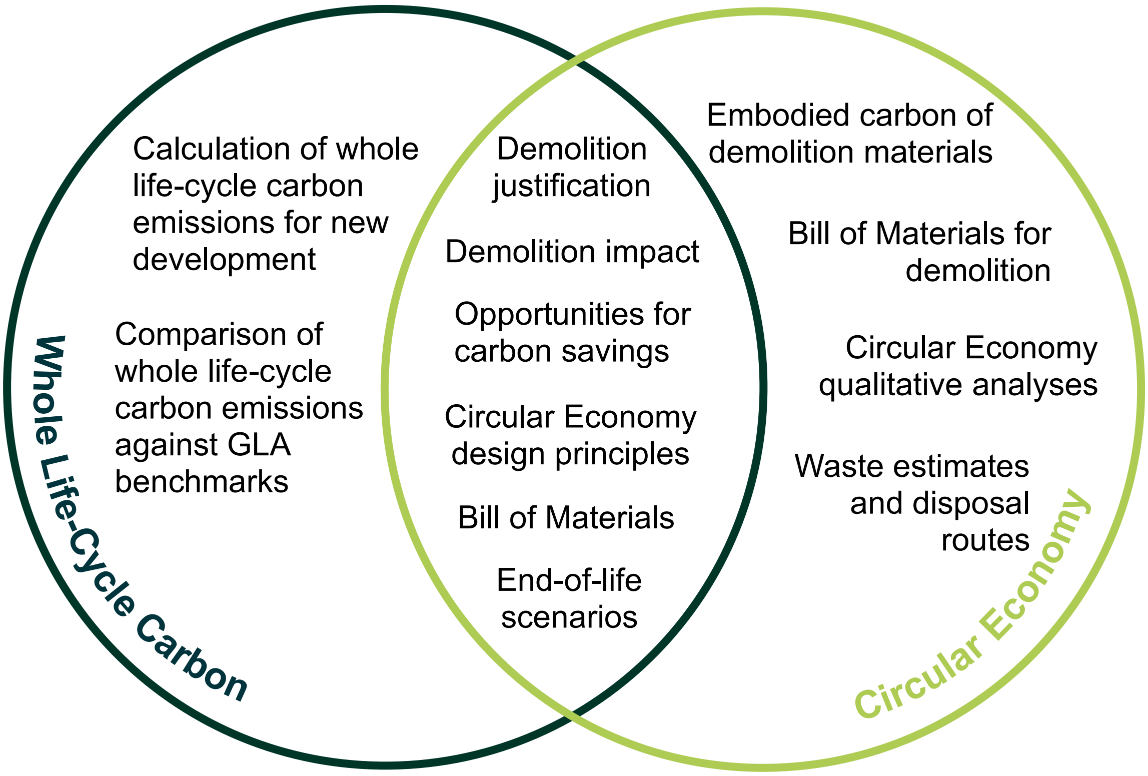


Figure 2. Overlaps between existing WLC and CE policy and guidance

Despite the overlap between the informational requirements, in some cases the outcomes of these are complementary, in other cases they can conflict, either in whole or in part. Some examples of this are provided below:

- **Design for adaptability:** opportunities to design for a potential change in future use type could lead to the over-design of elements (particularly structural elements), which would increase resource consumption and associated embodied carbon. Whilst there is a consensus within the industry that in the case of speculative design decisions, a resolution should be made based on upfront impacts, a careful balance should be considered. [5]
- **Material specifications and end-of-life scenarios:** selecting materials with a lower embodied carbon impact can work against circular economy principles. For example, distribution pipework is typically manufactured from either copper or thermoset plastic (crosslinked polyethylene). Whilst thermoset plastics are significantly lower in embodied carbon, these cannot be reused or recycled at end of life (and are typically incinerated or downcycled) compared to copper pipework which has the potential to be endlessly recycled.

- **Modular construction:** modular or volumetric systems can be beneficial in delivering elements or buildings which generate less construction waste onsite. However, these systems often require additional reinforcement to ensure stability during transport to the site and additional fixings to allow assembly, resulting in higher embodied carbon. The transportation of volumetric elements is typically less efficient than for bulk materials, resulting in higher carbon emissions from freight compared to on-site assembly. Factory-assembled components can also be difficult to disassemble, depending on the method used to manufacture them.

It is important to consider how these conflicts can influence the outcomes and strategies proposed by applicants. This is often a nuanced balance between the benefits to each policy area which could be challenging for a metric to quantify and convey. It is important WLC and CE are considered both in tandem and isolation: to ensure that where conflicts arise a balanced outcome is proposed.

Any metrics or methodologies which consider WLC as part of the rating would need to be scrutinised in additional detail to ensure that any weightings or other considerations do not conflict with the aims of the Policy SI 2.

2.2.3 Other considerations

It is acknowledged that GLA is in communication with ReLondon regarding its ongoing ‘Built environment circular economy targets project’ funded by Ramboll Foundation, and it is understood that ReLondon is seeking to define a circularity metric and any relevant targets to drive ambition for circularity within the built environment. Whilst both studies seek to consider the use of industry metrics for building circularity, the studies differ in terms of their methodologies and overall aims and application.

Whilst it is understood that the GLA’s involvement in the ReLondon project has informed the project brief for this study (including in determining input to the longlist of methodologies for appraisal) and the AECOM project team has been apprised of the draft findings of ReLondon’s study, these should be treated as independent studies. The ReLondon report remains in draft at the time of this study being undertaken.

3. Research methodology

The methodology is based on three key steps:

- to identify and compile existing metrics related to circular economy currently available within industry and academia.
- to establish a set of evaluation criteria against which these metrics could be assessed.
- to evaluate the selected metrics and their calculation methodologies against the selected criteria.

Based on this evaluation, a refined selection of metrics is shortlisted for more in-depth analysis. This final assessment aims to explore their potential for practical implementation, as well as to highlight any limitations and areas requiring further development.

Two key methods of information collection are used to inform the reporting outcomes: a literature review and stakeholder engagement workshop. Section 3.1 and Section 3.2 set out additional detail with respect to the literature review and stakeholder engagement processes respectively. Figure 3 provides an overview of the methodological steps undertaken.

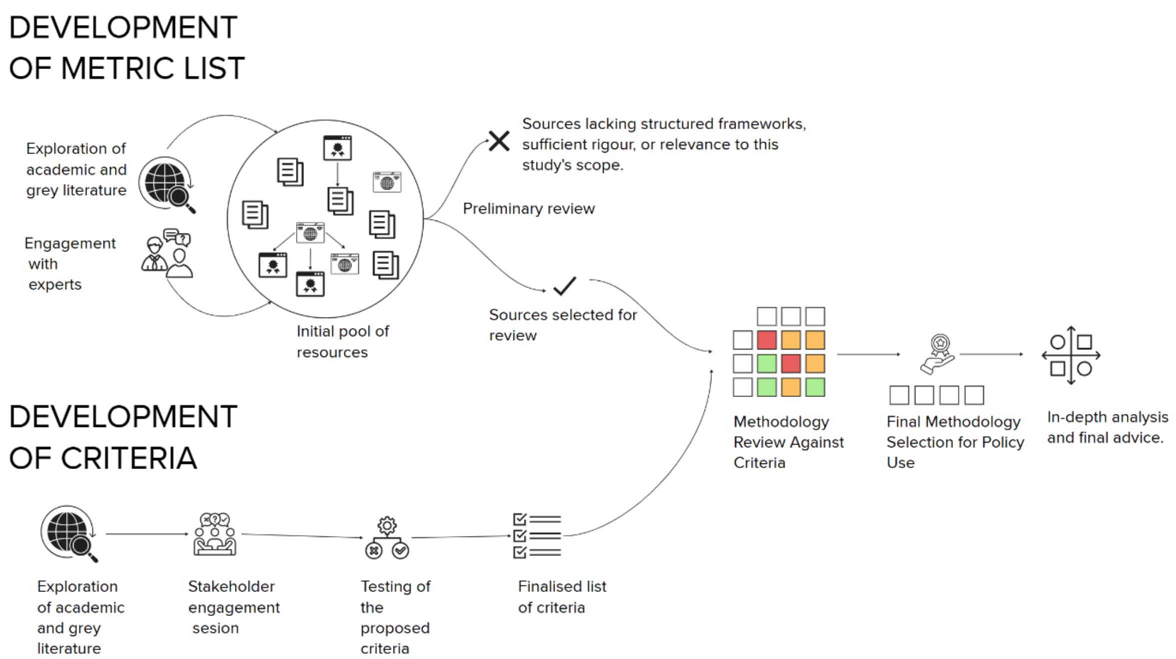


Figure 3. Methodological steps undertaken as part of this study

3.1 Literature review

A multi-method approach was adopted to identify relevant metrics. This included an exploratory web-based search to capture existing circular economy assessment platforms, as well as a targeted academic search via specialised search engines to identify peer-reviewed studies. Input was gathered through direct engagement with circular economy experts, complemented by a stakeholder workshop during which additional metrics and relevant literature were recommended. Furthermore, a snowball technique was employed by examining the references and citations within identified sources to uncover additional relevant materials. The objective of this process was to compile a comprehensive and practice-relevant set of metrics.

Primary sources were used to identify and assess the metrics, focusing on original studies or publications where the metrics were first proposed, rather than relying on secondary reviews or summaries.

The studies selected for further assessment are described in detail in Section 4.4, while those not taken forward are included in Appendix D. Together, these provide a complete list of all studies gathered during the review process. The rationale behind the selection of metrics for further assessment is explained in Section 4.3. Any other relevant references are included in the bibliography (Appendix A).

3.2 Stakeholder engagement

A stakeholder engagement workshop was hosted by the project team on Wednesday 30th April 2025. The aim of the stakeholder engagement workshop was to refine and validate the list of initially gathered metrics, elicit views on the strengths and weaknesses of the metrics, and to discuss the criteria for evaluating the metrics.

The workshop sought to engage a selected group of professionals who have a technical knowledge of circular economy in the built environment. Attendance was limited to a maximum of 15 invitees to ensure all attendees would be offered the opportunity to speak and contribute. To allow for a variety of stakeholders and in-depth discussion and debate, attendance was limited to one representative per organisation. The list of attendees was constructed to provide a cross-section of professionals within the built environment sector including policymakers, researchers and academics, and architects. The list also included a select group of representatives from London boroughs. The workshop aimed to engage individuals with relevant expertise, inviting borough representatives only if their local authority was at an advanced stage in developing or implementing circular economy policies in the built environment. When compiling the list of invitees, notes were made where individuals were known to have a vested interest in any of the metrics discussed, so that this context could be considered when interpreting the workshop outcomes.

A pre-read document was issued to attendees for review prior to the workshop to facilitate preparation for the session and provide material ready for discussion. This included an initial longlist of metrics and a draft set of criteria for consideration.

The workshop was delivered via Microsoft Teams and facilitated using a Mural board. The Mural board was used to facilitate conversations and collaboration between attendees and as a means of recording the inputs of attendees in real time. The Mural board remained accessible to attendees following the session to allow for any final feedback to be captured following the session. Figure 4 provides illustration of the extent of written feedback received from attendees during the workshop session.

Workshop participants were invited to provide verbal feedback upon the questions posed and contribute to the discussion between attendees. This feedback was captured via meeting minutes for future reference and consideration in the study, this is summarised in Section 3.2.1.

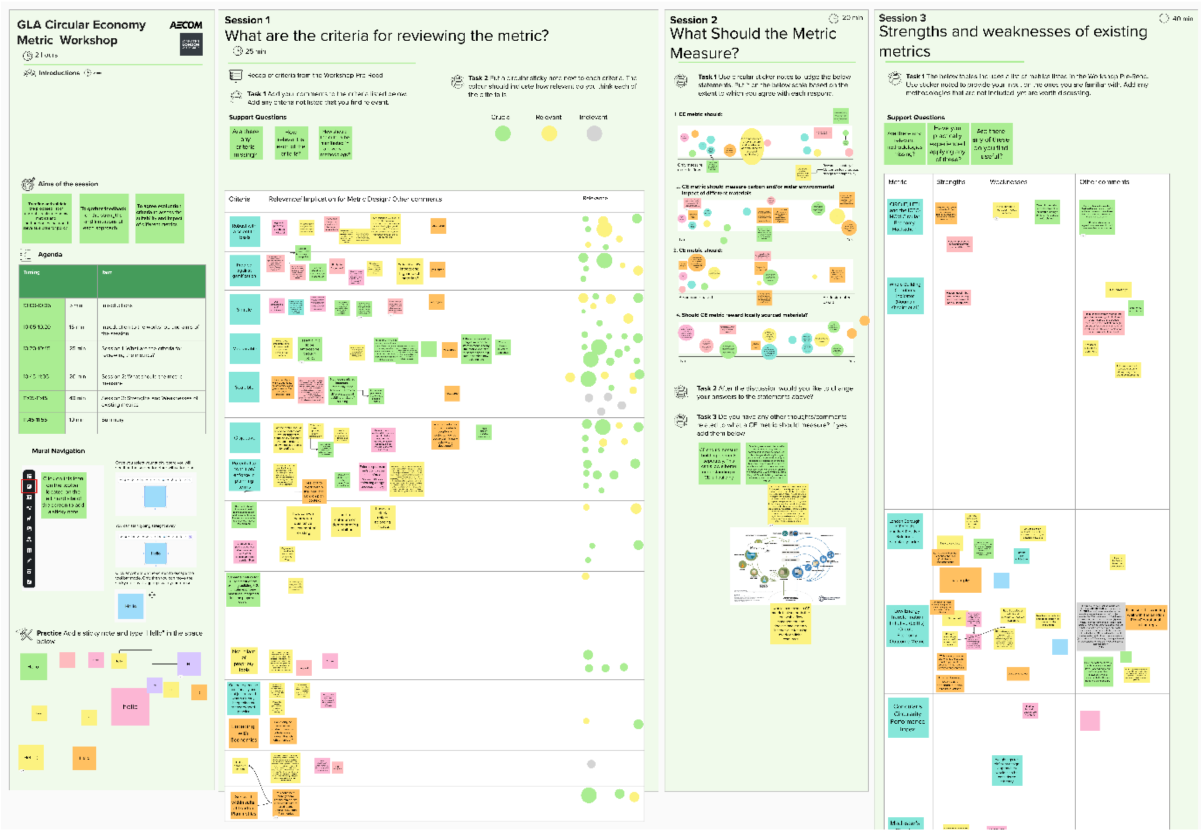


Figure 4. Excerpt of the Mural board following the workshop including stakeholder feedback

3.2.1 Outcomes of the stakeholder engagement session

The workshop was broken into three key sessions to deliver upon the workshop aims. The key feedback and outcomes from these sessions which have informed the study are as follows:

- **Session 1: What are the criteria for reviewing the metrics?**
  - There was consensus that the metric must be measurable, enforceable via policy, and clearly linked to the London Plan's objectives.
  - It should not be restricted by paywalls, ensuring accessibility and transparency.
  - Scientific robustness was seen as essential by many participants, particularly for setting informed benchmarks and targets. However, some noted that it may be less relevant in the context of reporting and facilitating open dialogue with applicants. Nonetheless, it is important to note that the goal of this study is to evaluate whether a more specific, measurable, and quantitatively robust metric has the potential to inform future policy. In that context, the emphasis on scientific robustness is highly relevant to the purpose of this exercise.
  - It should be resistant to manipulation; however, one participant noted that a limited degree of gamification might encourage positive outcomes, depending on how it is structured.

  - While simplicity is preferred, the group emphasised that it is more important for the outcome to be easy to understand than for the metric itself to be easy to calculate.
  - Some participants suggested the metric should integrate economic factors or allow for financial offsets.
  - There were mixed views on scalability— some considered it essential, while others believed that different metrics may be required for building typologies of varying scales. However, a distinction between scalability and applicability must be made. Only metrics with the potential to be used for buildings falling under referable planning applications are in the scope of this study, and ensuring their applicability at that scale is crucial for testing and assessment. Scalability, such as applying the metric at borough level, would be beneficial but is not considered essential within the scope of this study.
- **Session 2: What should the metric measure?**
  - Material flow was seen as the most feasible aspect to measure quantitatively, while aspects such as adaptability and design for disassembly were considered much harder to quantify. Therefore, some participants suggested that these should continue to be assessed qualitatively.
  - There was debate around whether embodied carbon should be included:
    - Some felt it was essential for measurability.
    - Others argued it should remain separate, as embodied carbon is already covered elsewhere in the London Plan.
    - Most agreed that the link between circular economy and embodied carbon should be clearly articulated to ensure policy cohesion.
  - There was a division between prioritising outcome-based metrics, such as measuring the final circularity of materials, and intent-based metrics, like implementing specific adaptability principles:
    - Outcome-based metrics can be enforced and better reflect real-world impact, therefore could be the most beneficial from policy perspective.
    - Intent-based metrics may encourage earlier interventions and broader process improvements.
    - Some participants noted that it depends on the intended purpose of future policy - whether it aims to deliver measurable circularity outcomes or primarily to guide design teams towards specific design principles and actions.
  - Opinions varied on whether the metric should reward locally sourced materials:
    - Some said no, as it falls outside the definition of circularity and is already addressed via embodied carbon.
    - Others argued yes, as local sourcing supports reuse and the local economy.
- **Session 3: Strengths and weaknesses of existing metrics**

– Table 2 sets out and summarises the strengths and weaknesses of the initial list of existing metrics which were discussed during the stakeholder workshop.

Table 2. Strengths and weaknesses of existing metrics

Metric / Methodology	Strengths	Weaknesses
CIRCuIT, LETI, ICEC-MCM Hackathon Pre-Reading: Circularity Metrics for Buildings	Simple and comprehensive starting point.	Still under development, lacks full definition.
Whole Building Circularity Indicator	Applicable at whole building level.	Not widely tested or adopted.
London Borough of Enfield's Circular Index	Simple to use and implement.	Focuses only on input materials; uses subjective scoring.
LETI Circular Economy Outcome Metric	Tested in the Netherlands, provides a clear single score, can be used as threshold or offset.	Complex; uses subjective assumptions; overlaps with embodied carbon.
Concular Circularity Performance Index	Not covered during the session.	Paywalled; lacks open access.
Madaster Circularity Indicator	Clear outcome (0–100% non-virgin material)	Madaster is a paid tool; however, the core methodology remains freely accessible.
Arup Circular Building Toolkit	Offers good guidance	Not a metric
EU Level(s) Indicators	High transparency potential	Less robust compared to other metrics
OneClick LCA Building Circularity Tool	Not covered during the session.	Paywalled; lacks open access.
eTool Material Circularity Indicator	Not covered during the session.	Paywalled; lacks open access.

– The results of this session informed the review of the metrics and the development of the assessment criteria, as detailed in the next section.

In summary, stakeholder input played a significant role in shaping the final criteria used to evaluate the metrics. Participants' comments helped identify which criteria were most crucial for the assessment and clarified which fell within the scope of this study. The session also confirmed the relevance of the longlist of metrics gathered and introduced additional studies that were incorporated into the assessment. However, the session provided limited insight into the strengths and weaknesses of individual metrics, likely due to many of the examples not yet being widely tested.

4. Preliminary Review

This section outlines the process by which a comprehensive list of metrics was selected from an initial pool of resources. It presents the broader conclusions drawn from an initial scan of the gathered studies, explains how these resources were categorised, and describes the rationale used to filter them down to those metrics with the highest potential to inform the future London Plan.

4.1 Overview of wider circularity metrics

On completion of the research phase, an initial filtering process—referred to as the “Preliminary Review” in Figure 3—was undertaken to identify studies with the greatest potential to inform future policy. Five conclusions emerged from this review:

- There are significant differences in the scope, intent, and measurement approaches of existing metrics and their associated methodologies.
- Some metrics explicitly assess circular design principles—such as design for disassembly—as seen in CIRCuIT, LETI, and the ICEC-MCM Circular Economy Hackathon pre-reading materials.
- Other approaches are outcome-based, focusing on measuring material intensity and material sourcing throughout the project lifecycle or evaluating the broader environmental impacts of material use. LETI’s Circular Economy Outcome Metric is one such example.
- Emerging tools, such as the Arup Circular Building Toolkit, have started to incorporate aspects like building utilisation and spatial efficiency into circularity performance assessments.
- Some metrics include broader environmental impacts—particularly embodied carbon—in their evaluations (e.g. Arup Circular Building Toolkit), while others focus solely on material intensity without considering life cycle emissions (e.g. Whole Building Circularity Indicator).

4.2 Categorisation of circularity metrics

The metrics were categorised based on their measurement focus, which in this context is referred to as their *scope*. Through the review process and the stakeholder engagement session, the following key measurement areas were identified:

- Material intensity and resource circularity (proportion of recycled and recyclable material content)
- Waste generation and diversion from landfill
- Design for adaptability and flexibility
- Design for disassembly
- Design for longevity
- Whole Life Carbon
- Wider environmental impacts
- Spatial efficiency

Based on London Plan Guidance and as summarised in Section 2.2, the measurement areas most closely aligned with the London Plan definition of a circular economy are: material intensity and resource circularity, waste generation and diversion from landfill, design for adaptability and flexibility, design for disassembly, and design for longevity. Metrics addressing these factors were therefore considered the most promising for the purpose of this study. It should be noted, however, that both metrics addressing multiple areas and those focusing on a single aspect were selected for evaluation. Metrics were not assessed based on the breadth of their coverage, but rather on their alignment with the policy requirements outlined in Section 2.2 of this report. Some metrics may serve as standalone tools, while others may be more effective when used in combination with complementary resources.

4.3 Approach for developing the metrics longlist

The initial selection process evaluated whether each study aligned with the scope of circularity as defined in the London Plan (see Section 2.2), while also assessing whether the metric offered a clear and structured framework and demonstrated sufficient methodological rigour.

The metrics taken forward for detailed evaluation are presented in Section 6.1.

Appendix D lists the metrics that were excluded from further assessment, along with justifications for their omission. Their exclusion does not imply a lack of merit; rather, they were considered less directly relevant to the specific objectives of this GLA policy-focused review.

4.4 Metrics Longlist

Table 3 provides a brief description of each longlisted metric; alongside the measurement opportunities it offers. Table C.9 in Appendix C provides a more detailed and visual breakdown of the measurement opportunities and the extent to which these are satisfied.

Table 3. A summary of the metrics longlist for further assessment

Metric / Source	Brief Description	Measurement opportunity
Whole Building Circularity Indicator (WBCI)	WBCI consolidates the most comprehensive and rigorous circular economy assessment methodologies—such as VBCI, MCI, and Flex 4.0—and addresses their limitations to develop a holistic framework covering a wide range of key performance indicators (KPIs). It is developed from a life cycle perspective, considering all material flows from origin to disposal or waste treatment. As part of the research study underpinning the methodology's development, validated was undertaken using a case study of a typical Italian residential building.	Resource efficiency and circularity, design for adaptability and flexibility, design for disassembly, design for longevity
London Borough of Enfield's Circular Index	Developed as part of Enfield Council's commitment to become a carbon-neutral organisation by 2040, this building-level metric assesses circularity by evaluating the proportion of materials that are reused, recycled, or recyclable, relative to the use of virgin materials during construction, as well as the disposal or incineration of materials from demolition. It considers both material inputs and	Resource efficiency and circularity

Metric / Source	Brief Description	Measurement opportunity
	waste outputs to quantify the circularity of a development in terms of material flow efficiency. Weighting factors are applied, with the highest assigned to in-situ recovered materials and the lowest to materials derived from non-recyclable and non-renewable sources.	
Madaster Circularity Indicator	Developed by Madaster, this metric is based on the Ellen MacArthur Foundation's Material Circularity Indicator methodology, applied during the construction, use, and end-of-life phases to evaluate a building's circularity score. It incorporates two correction factors that account for the design of unknown materials and products, resulting in a final score that reflects the degree to which material flows across the project lifecycle are linear or circular. While the paid platform offers the benefit of automating the assessment process, the core methodology itself is open access.	Resource efficiency and circularity, design for longevity
EU Level(s) Indicator: **2.1 Bill of Quantities, Materials and lifespans** **2.2 Construction and Demolition Waste and Materials** **2.3 Design for adaptability and renovation** **2.4 Design for deconstruction**	**2.1 Bill of Quantities, Materials, and Lifespans**: Requires the reporting of a structured bill of quantities for the development, including details of materials used, their respective quantities, and estimated service lives. This enables the structured application of Indicators 2.2 to 2.4. **2.2 Construction and Demolition Waste and Materials:** Focuses on estimating the waste generated during the demolition and construction phases of a development. It offers a structured approach to reporting different waste streams, ranging from material reuse to landfill diversion. The methodology includes a visual representation of both best-case and most likely outcomes. **2.3 Design for Adaptability and Renovation:** assesses how easily the building can be adapted or renovated over time. It applies scoring and weighting factors to aspects like column grid span and ease of access to service ducts. **2.4 Design for Deconstruction**: Assesses end-of-life scenarios for each building element. A circularity coefficient is then applied to each element and weighted by either mass or monetary value to generate an overall circularity score for the assessed development.	Diversion of waste from landfill during demotion and construction, adaptability and flexibility, resource circularity at the end of life of the building
OneClick Building Circularity Tool V2	The OneClick Building Circularity Tool v2 enables the calculation of building circularity by assessing material sources and content, construction waste, and end-of-life (EoL) treatment. The updated version introduces the option to either apply predefined EoL scenarios or manually define processing types and distribution of material to waste or EoL pathways. The tool performs circularity calculations at the start of the building lifecycle in alignment with ISO 59020 (2024). It is designed to comply with standards and certifications such as the London Plan Circular Economy Statement requirements and relevant BREEAM credits. The tool is designed to calculate a circularity percentage for an asset or	Resource efficiency and circularity, waste diversion from landfill, design for disassembly

Metric / Source	Brief Description	Measurement opportunity
	building and can be applied at both the material and whole-building level without a fixed scope.	
eTool Material Circularity Indicator	This metric is based on the Ellen MacArthur Foundation's Material Circularity Indicator. It calculates the proportion of materials used in a linear versus circular manner, as well as the utility factor of each product. A weighting factor based on the mass of each element is applied to produce the final circularity score.	Resource efficiency and circularity, design for longevity
Flex 4.0	The FLEX 4.0 methodology is a framework developed to assess the adaptive capacity of buildings. The methodology employs a set of 44 flexibility performance indicators, categorised into 12 general indicators applicable across all building types and 32 specific indicators tailored to building functions, such as schools or offices. Each indicator is assessed on a scale from 1 (Bad) to 4 (Best). The final score is weighted scores for each indicator contextual through flexibility class scores.	Design for adaptability and flexibility
Circular Construction Evaluation Framework (CCEF)	A free-to-use assessment tool designed to quantify the circularity of new or existing construction projects. The CCEF measures how well a building supports disassembly, adaptability, and material reuse by evaluating factors such as modularity, standardisation, reversible connections, and the use of sustainably sourced or bio-based materials. It provides early-stage scoring at both whole-building and component levels.	Design for adaptability, design for disassembly, design for longevity, construction and end of life resource circularity
Verberne Building Circularity Indicator (VBCI)	A multi-layered assessment methodology developed from and expanded upon the Ellen MacArthur Foundation & Granta (2015) Circularity Indicators. It combines four levels: Material (MCI), Product (PCI), System (SCI), and Building (BCI) circularity. It accounts for material input/output, product utility, disassembly potential, system layering, and lifetime importance.	Resource efficiency and circularity, design for disassembly, design for longevity
Transformation Capacity (TC)	The Transformation Capacity Framework developed by Elma Durmisevic evaluates a building's adaptability and disassembly potential through a structured assessment using 14 interdependent "evaluation nodes." Each node is assessed using indiscrete "fuzzy values" ranging from 0 to 1, reflecting the degree of compliance with transformation-friendly design principles. The final transformation capacity is derived by analysing the relationships and weighted interactions among 13 of the nodes, culminating in the calculation of the final node—Transformation Capacity (TC)—which represents the building's overall potential to adapt and transform over time.	Design for disassembly, design for adaptability and flexibility

The next step was to develop the performance rating framework which was used to evaluate this long list of metrics. This process is explained in the next section.

5. Defining criteria for reviewing metrics

To evaluate the metrics outlined in Section 4.4, a set of criteria was established to define what constitutes an appropriate metric for the GLA. It is important to emphasise that these criteria are not intended to assess what the metric measures or which aspects of the circular economy it reflects, but rather to evaluate the comprehensiveness and robustness of the methodology behind it. This distinction is necessary because the specific policy goals of the future London Plan remain unknown. An appropriate metric, therefore, would ultimately be one that aligns with and supports those future goals.

In the absence of defined policy objectives, the purpose of setting criteria now is to identify which existing metrics could potentially be valuable. This approach will allow for a selection of robust and versatile metrics that can be applied across various future scenarios.

5.1 Definition of criterion

The process of selecting the criteria is summarised as follows:

- **Identifying an initial set of criteria through literature review:**
  A literature review was conducted to investigate whether any existing criteria for evaluating circular economy metrics had already been established. As a result, a preliminary list of criteria was developed to form the foundation for this assessment. These criteria included: transparency, objectivity, scalability, measurability, simplicity, robustness with a scientific basis, resistance to gamification, and independence from proprietary tools.
- **Stakeholder engagement session:**
  During the stakeholder engagement session held on 30th April 2025, participants were asked to independently review and comment on the initial criteria, as well as suggest any additional ones they considered relevant. In the second part of the session, participants were asked to categorise the criteria as either “crucial” or “relevant.” The highest voted criteria were assessed further to be applied in the assessment framework evaluation.
- **Refining the criteria:**
  Feedback from the stakeholder session was used to refine the list of assessment criteria. The revised list was subsequently tested and further refined. As part of the testing, two professionals independently applied the criteria to the same metric to ensure the criteria were clearly defined, mutually exclusive, and consistently understood by the project team - supporting alignment and consensus during the assessment process.

Table 4 presents the final list of criteria developed for the assessment of the circular economy metrics. The table provides both a description of the criterion and justification with respect to the implications of this upon the application of the metric for planning purposes.

Table 4. Final list of criteria to evaluate circular economy metrics

Criterion	Description	Implication for Metric Application
Objective input data	This criterion refers to the extent to which input data is objective, standardised, and free from individual interpretation. It considers whether the data is based on measurable properties rather than subjective determination.	Metrics should rely on quantifiable, verifiable data inputs that can be generated consistently by users. Reducing subjectivity enhances potential for comparison, and fairness between assessments.
Robust with scientific basis	A metric should be grounded in established scientific research, empirical data, and/or recognised best practices. This includes consultation with experts, reference to technical literature, and evidence from real-world testing.	Incorporating scientific rigour improves credibility and ensures that the metric reflects current knowledge. It also supports wider industry acceptance and potential policy integration.
Transparent assumptions and methodological parameters	Assumptions and methodological parameters—such as weightings, scoring systems, and thresholds—should be clearly defined, justified, and transparently documented. This refers specifically to the assumptions and parameters that are embedded within or prescribed by the methodology itself. For example, this includes fixed weightings applied to different circular economy strategies.	Clear and justified assumptions reduce the risk of results manipulation and unintended consequences, such as overemphasising less important aspects. Transparent parameters help keep the focus on meaningful outcomes and ensure fair, consistent assessment aligned with policy goals.
Free to use	The methodology, including its inputs, calculations, and outputs, should be accessible without cost or reliance on proprietary software. This includes open access to required data or tools.	A free-to-use metric encourages widespread adoption, enables peer review, and ensures transparency. It also reduces barriers for smaller organisations and public sector users, increasing potential for adoption by boroughs for major applications.
Measurable results	Outputs should be presented in a quantifiable and standardised format (e.g., percentages, absolute values) that allows tracking, benchmarking, and performance comparison.	Measurable results enable metrics to be used as regulatory or policy tools, supporting enforcement, long-term monitoring, and target-setting
Outcome simple to comprehend	The final output should be easily interpretable, intuitive, and clearly linked to performance. Stakeholders should understand what the result means without needing specialist knowledge or extensive contextual explanation.	Simplified and communicable outputs enhance usability, support decision-making, and make the metric suitable for diverse audiences, including non-technical stakeholders and planning officers.

The selected criteria were specifically defined to align with the planning process for referable developments as discussed in Section 2.2.1, covering the full pathway from the preparation of materials for planning by an applicant to its evaluation by a GLA officer.

These criteria can be broadly grouped into two categories: submission-related criteria, which focus on the usability and transparency of the metric from the

Applicant's perspective, and evaluation-related criteria, which focus on the review process - ensuring that the results are easy to interpret and require minimal subjective judgment from a perspective of policy adherence. A simplified overview of how the final criteria is linked to the submission and review process is shown in Figure 5.

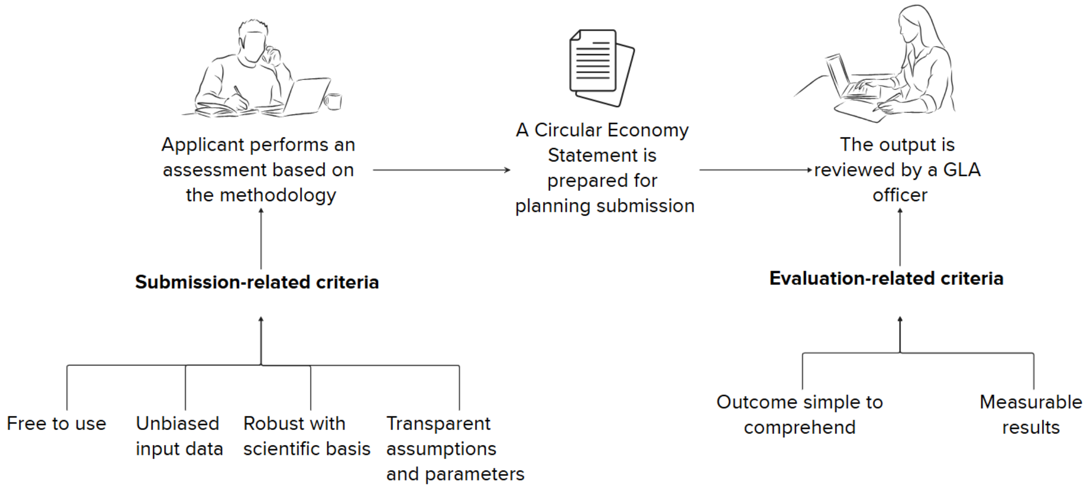


Figure 5. Final criteria mapped to the process of submitting and reviewing the circular economy element of Planning Application

A table of criteria that were considered but ultimately excluded during the development process are summarised in Appendix E, along with the rationale for their omission.

5.2 Performance rating framework

For the performance evaluation of different metrics against the criteria outlined in Section 5.1, a **RAG (Red-Amber-Green)** scale was used. The RAG system offers an intuitive and easily interpretable visual framework, supporting straightforward comparison and consistent assessment. Each level was defined qualitatively as follows:

- **Red – Poor (Score: 1):** The metric or methodology does not meet the expectations of the criterion and has significant limitations.
- **Amber – Moderate (Score: 2):** The metric or methodology partially meets the criterion, with some strengths but also notable gaps or limitations.
- **Green – Good (Score: 3):** The metric or methodology fully meets the criterion, with strong alignment to best practices and minimal limitations.

Each qualitative level was mapped to a numerical value (1–3), allowing for both a visual traffic light system and quantitative analysis to support comparison and scoring. This dual approach ensures transparency while enabling further analysis or aggregation if needed. Table 5 presents the RAG performance bands for each assessment criterion.

Table 5. Performance bands description for each criterion

Criterion	Red – Poor (1)	Amber – Moderate (2)	Green- Good (3)
Objective input data	The input is entirely based on the designer's subjective judgment regarding the circularity performance of their design. Terms such as "good" or "poor" are used without clear definitions or criteria. As a result, the same project could yield significantly different input data depending on who conducts the assessment. It does not define the scope of assessment.	The input includes a mix of objective indicators and subjective judgments. While some data is based on measurable or standardised information, other aspects rely on the designer's interpretation, though this is supported by general guidance or criteria. This approach introduces a degree of consistency while still allowing for variation. Differences between assessments may occur, but they are expected to remain within a reasonable and acceptable range.	The input is objective and based on quantifiable information readily available during the design stage—for example, the predicted recycled content of materials or declared reuse potential, supported by standardised assumptions. The methodology is robust and repeatable, meaning that consistent input data is likely to be generated regardless of who conducts the assessment. While the methodology itself does not specify assumptions, it is assumed that these are readily accessible through established industry guidance, such as the RICS Professional Standards. On this basis, the metric can be considered capable of achieving a full score. It clearly defines the scope of assessment.

Criterion	Red – Poor (1)	Amber – Moderate (2)	Green- Good (3)
Robust with scientific basis	The methodology has been developed without reference to prior research or consultation with industry experts. It has not been tested on real projects and is based primarily on general principles or assumptions without strong empirical evidence. There is a lack of supporting documentation, references, or linked resources to justify the approach.	The methodology incorporates elements grounded in scientific thinking and includes references to grey literature, technical reports, or expert opinion. It may have been informed by consultation with industry stakeholders. While some parts are robust and informed by credible sources, others may lack rigorous validation or have only limited testing in practical applications. The approach shows promise but requires further refinement and broader adoption.	The methodology is underpinned by a well-established scientific foundation, with each component supported by peer-reviewed research, validated data, or widely recognised best practices. It has been developed through a rigorous process and/or in collaboration with experts and has been tested. Comprehensive documentation and references ensure transparency and credibility.
Transparent assumptions and methodological parameters	Assumptions and parameters are based on generalised or intuitive subjective judgments without supporting evidence or testing. They are not grounded in best practice or literature. For example, weighting factors or scoring systems are applied without justification or validation, leading to arbitrary and potentially misleading results.	Assumptions and parameters are partially justified—either by referencing previous studies, expert consultation, or analogous cases—but still rely on some degree of subjective interpretation. While there is an effort to support the choices made, some parameters (e.g. qualitative aspects like flexibility or adaptability) remain difficult to quantify and are not fully validated. The methodology shows improved transparency but lacks full scientific grounding.	All assumptions and parameters are clearly defined, transparently documented, and supported by a strong scientific or empirical basis. They have been validated through research, tested in practical applications, and/or reviewed by a technical or academic community. The methodology demonstrates a high level of rigour and credibility.
Free to use	Inputs are not publicly accessible, and the metric cannot be reviewed or applied without incurring a financial cost. This limits transparency, replicability, and broader industry adoption.	Some components of the metric require access to paid tools or proprietary datasets; however, the core methodology and logic are publicly described. While external verification is possible, it may require additional effort or resources. For example, supporting studies may be behind paywalls, or some calculations depend on licensed software.	The metric is fully open and transparent, with no reliance on proprietary software or paid access. All methods, assumptions, and parameters are publicly documented and freely available, allowing for independent review, replication, and wide application without financial barriers.

Criterion	Red – Poor (1)	Amber – Moderate (2)	Green- Good (3)
Measurable results	The outcome is entirely qualitative and cannot be quantified or measured in a consistent manner. It relies on descriptive assessments without numerical indicators, making it unsuitable for comparing different projects or setting clear performance targets.	The outcome includes both quantitative and qualitative elements. While some aspects can be measured (e.g. approximate values or indicative scores), others remain subjective. This allows for partial comparison between projects, but the lack of full quantifiability limits precision and enforceability.	The metric produces fully quantifiable outcomes. Outputs are clearly defined, trackable, and comparable across projects (e.g. kg of materials reused, % recycled content, % recovery). It enables the establishment of clear performance thresholds and enforceable targets.
Outcome simple to comprehend	The outcome is difficult to interpret or communicate clearly. It lacks intuitive meaning and requires significant effort, prior experience, or multiple case studies to understand what constitutes good or poor performance. The results do not support clear conclusions or actionable guidance. For example, the outcome may be presented as an arbitrary number without context or explanation.	The outcome can be communicated and interpreted with some additional effort and explanation. While the structure and meaning of the output are clear (e.g. a score between 0 and 1 with defined boundaries), it remains difficult to judge what constitutes good or poor performance without further context or case studies. The result provides a foundation for comparison, but interpretation is limited by a lack of established benchmarks in current industry practice.	The outcome can be easily communicated and interpreted. It provides a clear and intuitive indication of the building's performance without requiring reference to multiple case studies or additional explanation. Stakeholders can immediately understand what the results mean and use them to make informed decisions or set targets., e.g. a percentage of recycled content (e.g., 40% recycled materials) with industry benchmarks indicating what levels are considered

5.3 Appraisal of metrics longlist

The metrics selected for evaluation, as summarised in Section 4.4, were assessed using the performance rating framework outlined in Section 5.2. Table 6 below presents the results of this assessment, ranking the metrics from highest to lowest scoring.

The rationale behind each score is provided in Appendix F. It should be noted that this ranking reflects the degree of alignment of each metric with policy-level application, based on the defined criteria. It does not imply a judgment on the overall quality or effectiveness of the metrics in achieving their original objectives. Additionally, the minimum score was automatically assigned when there was no publicly available evidence to justify a higher scoring.

Table 6. Appraisal of metrics using performance rating criteria

Metric	Objective input data	Robust with scientific basis	Transparent assumptions and methodological parameters	Free to use	Measurable results	Outcome simple to comprehend	Final Score (Sum)	Average Score
EU Level(s) Indicator 2.2 Construction and Demolition Waste and Materials	2	3	2	3	3	3	16	2.67
Flex 4.0	2	3	2	3	3	3	16	2.67
Transformation Capacity (TC)	2	3	2	3	3	3	16	2.67
Madaster Circularity Indicator	2	2	3	2	3	3	15	2.50
EU Level(s) Indicator 2.1 Bill of Quantities, Materials and lifespans	2	3	2	3	3	3	15	2.50
WBCI	2	3	2	2	3	2	14	2.33
EU Level(s) Indicator 2.3 Design for adaptability and renovation	2	3	1	3	3	2	14	2.33
EU Level(s) Indicator 2.4 Design for deconstruction	2	3	1	3	3	2	14	2.33
eTool Material Circularity Indicator	2	2	2	2	3	2	13	2.17
London Borough of Enfield's Circular Index	2	1	1	3	3	3	13	2.17
CCEF	2	2	1	3	3	2	13	2.17
OneClick Building Circularity Tool V2	2	2	1	1	3	2	11	1.83

6. Shortlisted metrics

This section explores the shortlist of metrics that scored highly in the appraisal section of this report (Section 5.3). It provides a detailed consideration of their benefits, limitations, alignment with current policy, readiness for implementation at the policy level, and the further work required to enable their effective adoption in future policy frameworks.

6.1 Metrics overview

Table 7 presents the shortlisted metrics that were selected for detailed assessment due to their strong alignment with policy-level requirements, as defined by the evaluation criteria. Appendix F includes a detailed evaluation of each metric.

During the evaluation process, it became evident that some limitations were inherent to the metrics themselves, while others could be addressed—for example, through the development of more standardised assumptions or clearer implementation guidance.

In some cases, metrics were excluded due to significant overlap with those already selected, offering little additional value. For instance, the VBCI, a direct predecessor to the WBCI, was not progressed for detailed assessment despite achieving a high score, as the WBCI builds directly upon VBCI and addresses its key limitations.

Other metrics were excluded due to fundamental issues, such as a lack of scientific rigour or unclear justification for scoring and weighting mechanisms—limitations that could not be reasonably resolved. As such, the evaluation scores should be interpreted as indicative rather than conclusive.

This also explains why, in some instances, metrics with lower scores were selected over higher-scoring ones where their shortcomings were considered more easily mitigated, or where their structure better aligned with policy needs. Additionally, the metrics were not assessed based on how many circular economy areas they cover, but rather on the extent to which their scope aligns with the policy requirements outlined in Section 2.2. This is based on the assumption that some metrics may serve as standalone tools, while others may be more effective when used in combination with others.

Metrics reviewed but not taken forward for detailed assessment are listed in Appendix F along with justifications for their exclusion.

Table 7. Summary of shortlisted metrics

Metric Methodology	Criterion score	What does it measure	Brief Explanation
EU Level(s) Indicator 2.2 Construction + demolition waste + materials	2.67	Diversion of waste from landfill	Despite some limitations, this methodology was progressed due to its robust and credible foundation, and its clear, quantifiable output. Results are easy to interpret and directly support comparison across scenarios, making it well-suited for policy application.
Flex 4.0	2.67	Adaptability and Flexibility	This methodology was progressed due to its scientific credibility, clear structure, and transparent scoring system. The use of defined flexibility classes and numerical outputs makes results easy to comprehend and communicate.
Transformation Capacity (TC)	2.67	Design for disassembly, design for adaptability and flexibility	This methodology was selected due to its scientific credibility and comprehensive evaluation of the interdependence between different building elements. Additionally, the scoring system, supported by clear result interpretation guidance, enhances the usability and clarity of the outcomes.
Madaster Circularity Indicator	2.50	Resource efficiency, diversion of waste from landfill, design for longevity	This methodology offers a transparent, quantifiable scoring system that makes results intuitive and easy to interpret. While the underlying assumptions are not fully peer-reviewed, it is grounded in best practice and widely accessible. The use of percentage-based outputs and breakdown into individual scores supports clear communication and targeted improvement.
WBCI	2.33	Resource efficiency, diversion of waste from landfill, design for disassembly, design for longevity	This is the most comprehensive methodology reviewed, developed through extensive literature review and peer-reviewed research. It quantifies all indicators and outputs a single numerical score (0–1), supporting measurable and comparable results. While some assumptions rely on expert judgement and the methodology requires interpretation effort, the framework is detailed, scientifically grounded, and well-supported—enabling clear evaluation across various building elements.

Table G.24 in Appendix G sets out the full justification for the omission of longlisted metrics which were not progressed for further assessment following initial appraisal.

6.2 Assessment of circularity metrics

Per Table 7 above, the following metrics have been selected as those which illustrate the greatest potential for application in the London policy context according to the assessment against the criteria defined in Section 5 above:

- EU Level(s) Indicator 2.2 Construction and Demolition Waste and Materials
- Flex 4.0
- Madaster Circularity Indicator

- WBCI
- Transformation Capacity

It should be noted that the WBCI methodology relies on the Flex 4.0 and Transformation Capacity metrics, which it incorporates into its assessment. Therefore, any factors discussed in this section that are relevant to these methodologies apply equally to the WBCI.

Through the subsequent sections these methodologies are to be considered in greater detail in terms of the following factors:

- **Benefits:** any highlights of the methodology, including where a 'good' score is achieved with respect to criterion.
- **Alignment with current policy**: This refers to the degree to which the metric aligns with, complements, or reflects the goals, structure, and requirements of existing policy frameworks, highlighting any shared principles, overlapping criteria, or mutual applicability.
- **Limitations:** inherent weaknesses or constraints within a metric that may affect the accuracy, applicability, or completeness of the results.
- **Further work needed:** any additional work and considerations needed to prepare the metric for practical use by applicants.
- **Suitability for implementation and data availability:** consideration of whether the metric has been previously tested and if sufficient data is available at the planning stage.

6.2.1 EU Level(s) Indicator 2.2 Construction and demolition waste and materials

This metric provides a structured framework for quantifying and reporting the amount of waste generated during construction, renovation, and demolition activities. This assessment focuses solely on the part of the indicator methodology related to waste reporting and quantification. While the EU Level(s) manual, beyond the core calculation methodology, also includes extensive guidelines on implementation - such as design integration, responsibilities of involved parties, and reporting processes - this review has focused solely on evaluating the methodological assessment itself. The methodology supports assessments at both the design stage (estimated waste) and the post-construction stage (actual waste generated), enabling consistency and comparability across different phases of a project. The metric quantifies waste by mass and accounts for the proportion that is reused, recycled, used for energy recovery, or sent to landfill.

6.2.1.1 Benefits

- **Standardised Waste Scenarios:** Provides structured, predefined options for waste routes, enhancing comparability and consistency.
- **Robust and Credible Framework:** Developed by the European Commission's Joint Research Centre (JRC), ensuring scientific rigour, peer-reviewed reliability, and alignment with international standards.
- **Transparent and Quantifiable Outputs:** Results are expressed in measurable units (quantities or percentages), supporting target setting and performance tracking.

- **Accessible and Open Source:** Both the methodology and supporting templates are freely available, encouraging widespread adoption without licensing barriers.
- **Straightforward Calculations:** Uses simple mathematical operations without subjective weightings, improving clarity and ease of verification.
- **Benchmarking Capability:** Enables performance comparison between “best-practice” and “most probable” waste scenarios, supporting continuous improvement.
- **Actionable Waste Diversion Insights:** Clearly reports the proportion of waste likely to be reused, recycled, or sent to landfill, helping to identify improvement opportunities.
- **Alignment of data:** The EU and UK share the same waste codes, meaning the framework can be easily translated to the local context.

6.2.1.2 Alignment with current policy

The metric is compatible with GLA requirements for reporting demolition, excavation, and construction waste rates, as well as defining appropriate waste management routes. By normalising waste data per square metre, it enables the assessment of percentage-based targets currently set by the GLA. Additionally, the methodology introduces a higher level of granularity compared to information currently reported in the Recycling and Waste Reporting table in the GLA CE template, and an itemised standardised reporting format, which can enhance the accuracy and consistency of waste assessments across projects. It also provides a valuable performance benchmarking feature by comparing the “best possible” and “probable” waste management scenarios. This offers a clearer understanding of potential versus actual outcomes, enabling the design team to make more strategic decisions and allowing the Circular Economy officer to offer more informed guidance and feedback.

6.2.1.3 Limitations

The use of mass as a normalisation factor may introduce bias towards heavier materials. This can be particularly problematic in the context of waste management and landfill diversion, where material volume may be a more relevant metric. The associated targets are also based on EU-led initiatives and have not been updated since 2020. While assessments are valid if the scope is clearly defined, typical input data is not always specified. Moreover, the methodology lacks clear guidance on best practices for different materials, which can lead to inconsistencies in results between assessors.

6.2.1.4 Further work needed

Recommendations for improvement are as follows: the normalisation factor should be reviewed, particularly to address potential bias towards heavier materials and to ensure relevance across various waste streams. The methodology should also be adapted to align with local standards, including revisions to the scope, as well as material and element categorisation. Additionally, clear guidance should be developed on what constitutes "best possible" and "probable" practice for different materials and elements, in order to improve consistency and reliability between assessors. Finally, normal performance ranges and targets should be defined based on London’s ambitions and local data to ensure contextual relevance.

6.2.1.5 Suitability for implementation and data availability

The metric has been implemented at the EU level and is therefore well-established and mature, making it suitable for adoption. Waste generation is a key performance metric already embedded within UK regulatory frameworks and industry best practices, such as the London Plan and the UK's Waste Strategy. Detailed information on available waste processing and recycling options across the UK - considering regional variations and site-specific factors - is accessible. This alignment with existing UK regulations, data availability, and professional expertise demonstrates the methodology's suitability for effective implementation within the UK construction sector.

At the planning stage, applicants are already required to provide total waste generated during demolition and construction, along with the percentage of waste that is reused off-site, recycled off-site, reused on-site, and reused off-site. Additionally, through the Pre-Demolition Audit, applicants estimate the amounts of different materials generated during demolition and their potential for reuse and recycling. This indicates that applicants already collect much of the information needed to perform this assessment. The proposed framework offers a more structured and consistent approach to reporting this data.

6.2.2 Flex 4.0

The FLEX 4.0 metric is a comprehensive framework developed to assess the adaptive capacity of buildings, enabling them to maintain functionality amidst changing user needs and environmental conditions over time. The metric employs a set of 44 flexibility performance indicators, categorised into 12 general indicators applicable across any building type and 32 specific indicators tailored to building functions, such as schools or offices. Each indicator is assessed on a scale from 1 (Bad) to 4 (Best).

6.2.2.1 Benefits

- **Clearly Defined Scope:** The metric evaluates a comprehensive range of materials and building layers, assigning specific assessment values to each, which supports detailed and targeted analysis.
- **Scientific Rigor and Credibility:** Developed from a research study conducted to scientific standards and published in a peer-reviewed journal, the metric's criteria are well justified and based on a rigorous development process.
- **Expert-Informed Parameters:** Assessment parameters are grounded in extensive literature review and consultation with industry experts, ensuring relevance and robustness.
- **Quantitative and Measurable Outputs:** Each indicator is assigned a quantitative value, enabling the generation of clear numerical outcomes that facilitate target setting, benchmarking, and progress tracking.
- **Open Access and Free to Use:** The metric is openly available, promoting widespread adoption without financial or licensing barriers.
- **Interpretability and User Guidance:** The metric includes clearly defined flexibility classes and descriptive explanations, making it straightforward for users to understand building performance results.

6.2.2.2 Alignment with current policy

The FLEX 4.0 metric aligns with the design principles set out in the London Plan and associated guidance by assessing building flexibility and adaptability through a layered approach. While the current GLA Circular Economy Template requires a largely qualitative evaluation of adaptability, FLEX 4.0 introduces a more structured and quantitative framework. This enhances consistency and allows for a more objective assessment of how design decisions support long-term adaptability and circular outcomes**.**

6.2.2.3 Limitations

The FLEX 4.0 metric, while a significant advancement in assessing building adaptability, presents several important limitations. Primarily, it functions as a **prescriptive evaluation tool** rather than a direct measure of actual building performance. For example, it prescribes the ideal shape for structural elements such as columns, which may unintentionally limit innovative or creative design solutions that could also achieve comparable levels of flexibility.

Additionally, the metric exhibits **subjectivity in categorisation**, with certain categories—such as “large part of the façade components”—lacking precise definitions and sufficient granularity. Without detailed definition of the parameters, the applied values could vary between users as a result of interpretation, influencing the overall circularity score. The **ambiguity in terminology** further compounds this issue; key terms like “component” and “facility zone” are not clearly defined, potentially causing inconsistencies in how building elements are assessed and evaluated.

Finally, despite strong theoretical justification for many parameters, the **validation of the criteria and scoring system** remains limited. The quantification of building flexibility as a circular economy metric has not been fully tested or verified, raising questions about the methodology’s effectiveness in reliably encouraging truly flexible and adaptable building design.

6.2.2.4 Further work needed

To strengthen the credibility and practical relevance of the FLEX 4.0 metric, further work is required in several areas. A key priority is the validation of the criteria and scoring system to ensure consistency and robustness across different building typologies common to referable applications and Circular Economy Statement reporting stages.

This includes a thorough review of the default weighting factors and the 1–4 scoring scale, as well as a detailed evaluation of each of the 44 indicators to confirm that they effectively support the intended policy goals without introducing unintended consequences, e.g. higher embodied carbon.

In parallel, greater clarity in the terminology used is necessary to enable consistent interpretation by different assessors, i.e. an accompanying guidance would need to be developed. There is currently no evidence of the metric being tested within the London context, nor clear benchmarks indicating what constitutes “good” performance. Therefore, extensive testing, implementation, and ongoing monitoring would be necessary before any targets based on this methodology could be confidently enforced.

6.2.2.5 Suitability for Implementation and Data Availability

FLEX 4.0 is a comprehensive metric widely regarded as one of the most robust frameworks for assessing building adaptability and flexibility (as noted by WBCI). However, the quantitative assessment of flexibility is not yet standard practice and remains unregulated. As such, the metric has not been fully tested or validated within a policy context.

In principle, the information required to complete the assessment should be available at the design stage, as it pertains to the general properties and structural elements of the building. However, as outlined in Appendix F, certain criteria may be challenging to implement due to ambiguities in terminology and categorisation.

Additionally, stakeholder feedback highlighted important considerations regarding flexibility and adaptability metrics. These metrics must be tailored to the specific context, needs, and potential future use of a site. For example, indicators like providing excess space may be appropriate in some cases but unnecessary or even detrimental in others. Over-specifying such features risks inefficiencies, including potential overdesign that could increase embodied carbon—particularly if the metric does not differentiate between upfront versus long-term speculative resilience.

Moreover, the applicability of the metric may vary across different development types, such as private residential units, co-living spaces, or office buildings, and should be adjusted accordingly to avoid inappropriate or ineffective assessments.

Therefore, the purpose and relevance of flexibility within a given project must be critically assessed before implementing the methodology. A more context-sensitive approach may be required to ensure FLEX 4.0 supports meaningful design outcomes aligned with local needs and long-term objectives.

6.2.3 Madaster Circularity Indicator

The Madaster Circularity Indicator is a quantitative tool developed to assess the circularity of buildings by evaluating the origin of materials used and their potential for reuse or recycling at the end of a building's life. Based on the Ellen MacArthur Foundation's Material Circularity Indicator, it assigns a score ranging from 0% (fully linear) to 100% (fully circular), reflecting the building's performance in terms of sustainable material sourcing and circular design potential. The methodology considers both the construction phase—by assessing the proportion of recycled, reused, or renewable materials—and the end-of-life phase—by estimating how much of the building's material content can be recovered for future use. To ensure the robustness of results, correction factors are applied to penalise missing or incomplete data, encouraging comprehensive documentation.

6.2.3.1 Benefits

- **Standardisation and Transparency**: The method follows a transparent, quantitatively defined approach. Adjustment factors—such as penalties for unknown materials—are mathematically justified, not arbitrarily weighted, enhancing objectivity.
- **Grounded in Established Frameworks**: The metric is based on the Ellen MacArthur Foundation's scientifically validated Material Circularity Indicator and incorporates best practices and industry standards.
- **Numerical and Intuitive Outputs**: Results are expressed as a percentage from 0% to 100%, making the outcomes intuitive, measurable, and useful for setting targets and identifying areas for improvement.
- **Component-Level Insights**: The output includes breakdowns by building layer, helping identify specific weaknesses and enabling targeted design optimisation.
- **Public Availability**: The metric itself is accessible online and can be applied without financial commitment, supporting broader adoption and experimentation.

6.2.3.2 Alignment with current policy

The Madaster Circularity Indicator, through its use of the Ellen MacArthur Foundation's Material Circularity Indicator, offers a holistic approach that aligns with several GLA requirements. It measures the materials incorporated into a building, rewarding those with recycled content and those that are reused. Additionally, it includes calculations comparing the product's functional lifecycle to a standard benchmark, supporting the principle of designing for longevity. The metric also incentivises waste minimisation and the diversion of waste from landfill, further reinforcing key circular economy objectives promoted by the GLA. Regarding the information currently reported by an Applicant, the metric also requires data from a Bill of Materials that details recycled, reused, and renewable content for each building element, as well as associated waste factors and waste streams. However, rather than presenting this data in a detailed table, the metric consolidates it into a single score intended to represent the overall circularity of the building.

What this approach does not account for - unlike current practice - is the material intensity across different material categories.

6.2.3.3 Limitations

The Madaster Circularity Indicator is highly dependent on the quality of input data. When used with BIM models, the results may be affected by inconsistencies in modelling practices, whereas manual application using quantity schedules can introduce subjectivity. The underlying database that supports material classification and circularity assumptions is only accessible via the paid Madaster platform, limiting transparency for independent users. This especially limits availability of standard assumptions, like end-of-life scenarios, which might lead to inconsistent results. Moreover, the metric quantifies the total mass of materials that are reused, rapidly renewable, or recyclable - without differentiating between these categories. As a result, a building composed entirely of materials that can only be downcycled may receive the same score as one constructed from reused or infinitely recyclable materials. Finally, although the normalisation of results by element mass is a widely accepted approach, it has been criticised as potentially inappropriate for building-level assessments, as it may disproportionately favour heavier elements and thus skew the results.

6.2.3.4 Further work needed

Further development of the Madaster Circularity Indicator should focus on establishing a clearly defined methodological scope and a consistent set of assumptions tailored to building typologies common to referable applications and Circular Economy Statement reporting stages. Introducing a standardised framework for input data requirements, material classification protocols, and circularity assumptions would significantly enhance the consistency, transparency, and comparability of results to set targets, which could be included in future guidance. Additionally, the penalisation applied for missing or incomplete information should be reviewed and calibrated to reflect the varying levels of data availability at different stages of a project, ensuring fairer and more accurate assessments throughout the design and construction process. For example, at the Pre-Application and Detailed Application stages, typically only the design concept is established without detailed material specifications. Accurate material data usually becomes available only at the Post-Construction stage.

A standard lifecycle for construction products should also be established, enabling the consistent calculation of the utility factor - i.e., the actual lifespan of a product compared to a defined standard product lifecycle - across assessments. Lastly, it should be reviewed considering policy objectives whether materials that are reused, recyclable, or renewable should be rewarded equally, or whether appropriate and evidence-based weighting factors should be applied.

6.2.3.5 Suitability for Implementation and Data Availability

The metric has been developed as a paid product and has already seen application within the construction industry. Its foundation is robust and demonstrates potential for implementation as a comprehensive process. It relies on information typically available at early design stages—such as the quantity of different materials, their recycled content, or whether they are reused. Therefore, assuming the aspects outlined in Section 6.2.3.4 are addressed, the metric could, in theory, be implemented at a policy level.

6.2.4 WBCI

WBCI (Whole Building Circularity Indicator) is a comprehensive metric developed to measure circularity within the building environment. It is based on an extensive review of the literature and builds upon the most comprehensive previous studies in the field. WBCI utilises the Ellen MacArthur Foundation's Material Circularity Indicator (MCI) methodology as its core framework and further develops it by expanding the Value-Based Circularity Indicator (VBCI) study to better accommodate the complexity of building environments. Additionally, WBCI incorporates the Flex 4.0 framework, which allows for accounting for the flexibility of buildings over time. The methodology identifies key performance indicators (KPIs) at four levels: material, product, system, and building. By addressing circularity across these multiple scales, WBCI offers a robust and nuanced approach to evaluating and improving circularity performance in complex building projects.

6.2.4.1 Benefits

- **Integration of Best Practices:** WBCI consolidates advancements from multiple established metrics (such as VBCI, MCI, and Flex 4.0), effectively combining their strongest features. This integration allows WBCI to cover a wide and comprehensive range of Key Performance Indicators (KPIs) related to building circularity.
- **Life Cycle Perspective:** Developed with a holistic life cycle approach, WBCI accounts for all material flows from origin through to disposal or waste treatment. This ensures a thorough assessment of a building's environmental impact over its entire lifespan.
- **Industry-Relevant and Quantifiable Inputs:** Many input parameters rely on quantifiable data and industry-standard practices—such as Bills of Materials—which are supported by well-established assumptions. This makes the methodology practical and aligned with common professional workflows.
- **Validated through Case Study:** The metric has been tested on a typical Italian residential building, providing practical validation and demonstrating its applicability in real-world scenarios.
- **Scientific Rigor and Peer-Reviewed Publication:** Developed through an extensive literature review of over 50 key documents and published in a reputable peer-reviewed journal (Building and Environment), WBCI is grounded in solid academic research, enhancing its credibility.
- **Fully Quantified and Measurable Outputs:** WBCI delivers numerical, measurable results expressed as a single value between 0 and 1, enabling clear quantification of circularity performance. This allows stakeholders to set concrete targets and goals based on the assessment outcomes.

6.2.4.2 Alignment with current policy

The metric addresses several GLA circular economy objectives. It quantifies material inputs and outputs to measure material efficiency. It includes parameters for Design for Disassembly and Design for Longevity and incorporates design flexibility by evaluating a building's capacity to accommodate changes in use or layout over time. The metric considers end-of-life scenarios and tracks material flows that can be diverted from landfill. Moreover, these principles are applied to relevant building layers, which are analysed separately within the methodology. These elements support the measurement of construction waste reduction and material reuse in line with GLA guidelines.

6.2.4.3 Limitations

The metric employs weighting factors as a normalisation tool to balance the importance of different building layers and criteria, particularly for flexibility scoring. However, these weighting factors are based on proposed values from the literature and rely on subjective judgement, which can introduce bias and reduce the objectivity of the results. In addition, for criteria related to flexibility and Design for Disassembly, WBCI provides guidance but does not clearly specify which standard assumptions should be applied when specific design details are unknown. This ambiguity may lead to inconsistent interpretations and variability in assessment outcomes among professionals.

While the metric outlines the scope of the assessment across different building levels and elements, it does not precisely define the boundaries or extent of that scope. This lack of clarity can affect the consistency and comparability of results between different projects.

Furthermore, the full metric is published in a peer-reviewed scientific journal that is not open access, meaning that access requires purchase through a journal platform. This may limit the availability and wider adoption. Lastly, although the output is quantified as a single numerical value between 0 and 1, without additional benchmarks or comparative studies, it is difficult to interpret what constitutes good or poor performance.

Even though the metric requires separate calculations at material, element, and system levels, it is unclear whether they could be used to evaluate performance of different circularity areas, e.g., of adaptability.

6.2.4.4 Further work needed

To enhance the robustness and practical application of the WBCI metric, further work is needed to establish standardised assumptions and clear guidance, particularly for design aspects that remain undefined during early project stages, when the Pre-Application and Detailed Application is submitted and reviewed. Developing a consensus on weighting factors used as normalisation parameters would improve the objectivity and comparability of results across applications. Additionally, expanding the scope of validation through more diverse case studies, including different building types and London context, would strengthen confidence in the methodology's applicability. To support wider adoption of the metric in applicable projects, it would be beneficial to enhance accessibility—for example, by developing a GLA template based on the metric.

Finally, establishing benchmarks or reference values through broader industry collaboration would assist both users and planning officers in interpreting circularity scores and setting meaningful performance targets. Currently, the metric has not been evaluated specifically within the context of the London built environment or the London Plan. The evaluation to date was conducted on an existing Italian residential building. While this provides validation of the metric itself, more extensive testing and adaptation would be required to develop suitable targets for building typologies common to referable applications and Circular Economy Statement reporting stages. Lastly, it would be beneficial to evaluate whether the metric can provide useful information in different areas of circularity, e.g., adaptability, or whether only the final score provides a useful indication of performance.

6.2.4.5 Suitability for Implementation and Data Availability

From a development perspective, the metric demonstrates a high level of robustness and appears well-structured for conducting circularity assessments. It offers a comprehensive framework that aligns with current ambitions in sustainable construction. However, its practical applicability remains uncertain due to its inherent complexity and the lack of real-world testing. As the metric has not yet been applied to project in their design stage, further development is required to evaluate its accuracy in reflecting the circularity of buildings and its effectiveness in supporting future policy objectives. Additional pilot studies and stakeholder engagement are recommended to validate its usability, scalability, and relevance within industry practice.

6.2.5 Transformation Capacity

The Transformation Capacity metric, developed by Elma Durmisevic, assesses a building's adaptability and disassembly potential through a structured evaluation of 14 interdependent *evaluation nodes*. Each node is scored using "fuzzy logic values" ranging from 0 to 1, representing the degree of alignment with transformation-friendly design principles. The overall *Transformation Capacity (TC)* is calculated by analysing the weighted interactions among 13 of these nodes, with the final node representing the cumulative adaptability potential of the building. The evaluation incorporates three levels of decomposition: material-level, technical, and physical decomposition. This methodology was developed primarily for scientific research purposes rather than direct application within the construction industry.

6.2.5.1 Benefits

- **Comprehensive and Acknowledged by Industry:** The metric represents one of the most comprehensive assessments of building design for disassembly and is frequently referenced in circular economy frameworks.
- **Scientific Rigor and Academic Publication:** It was developed as a doctoral study at TU Delft and meets high standards of scientific rigour.
- **Detailed Methodological Basis:** The assessment is grounded in detailed analysis of interdependent building elements, ensuring that the proposed indicators are well justified.
- **Measurable and Comparable Outputs:** It produces a normalised numerical score ranging from 0 to 1, enabling easy interpretation and comparison across different designs.
- **Guidance to Supports Consistency:** A structured interpretation framework categorises elements into high, medium, and low disassembly potential, supporting consistent analysis.

- **Public and Freely Available:** The metric is openly accessible and free to use, making it suitable for both research and policy applications.

6.2.5.2 Alignment with current policy

The metric aligns with the design principles outlined in the London Plan and its associated guidance by evaluating building adaptability and design for disassembly through a structured approach. Unlike the current GLA Circular Economy Template—which relies largely on qualitative assessments—this metric offers a more systematic and quantitative framework. As a result, it enhances consistency, reduces subjectivity, and supports a more objective evaluation of how design choices contribute to long-term adaptability and circular outcomes.

6.2.5.3 Limitations

The metric has been designed for the purpose of reviewing existing buildings for scientific purposes. Therefore, its application as intended in this study requires a high level of detail regarding the interconnections between different elements. Such detail may not be appropriate at the design stages referred to in relevant applications and Circular Economy Statement reporting stages. Although the "fuzzy values" are thoroughly justified, they remain subjective, as design for disassembly is not inherently a quantifiable feature.

6.2.5.4 Further work needed

Previous studies, including VBCI and WBCI, have reviewed the Transformation Capacity metric and used it to assess design for disassembly in buildings. Both have integrated the metric into a holistic circular economy metric, adopting only some of its performance indicators while leaving out others, without providing clear justification. This suggests they may have considered certain indicators unnecessary for evaluating design for disassembly. Further work would therefore be beneficial to evaluate which Transformation Capacity indicators best align with future policy objectives and London context.

Moreover, the original study advocates for a thorough evaluation of the interdependencies among different layers of the building system. In contrast, the VBCI and WBCI frameworks simplify these complex relationships into linear models. Future research should critically assess whether this linear simplification is appropriate, or if a more nuanced, interdependent systems approach is necessary to accurately reflect the dynamics of building components within circular economy frameworks. Such investigations would be essential to ensure the development of effective, evidence-based policies that capture the complexity of design for disassembly and resource circularity.

6.2.5.5 Suitability for Implementation and Data Availability

The metric was not designed for broad implementation within the industry but rather to enable a thorough scientific assessment of buildings. Therefore, further work is required to adapt the methodology for practical application. The data needed for this assessment primarily concerns the connections between different building elements, which, to a reasonable extent, should be available as part of the design documentation. Consequently, no additional external data should be necessary for the evaluation process.

7. Results

This section evaluates how the shortlisted metrics may be applied in the formulation of future policy, considering the evolving and yet undefined policy needs and objectives. Given this uncertainty, this section presents alternative pathways for implementing the shortlisted metrics. The analysis is grounded in the scope of each metric and the specific parameters they aim to measure. Additionally, this section explores the potential interactions between these metrics to illustrate how they could collectively contribute to a more comprehensive and integrated metric and summarised their limitations.

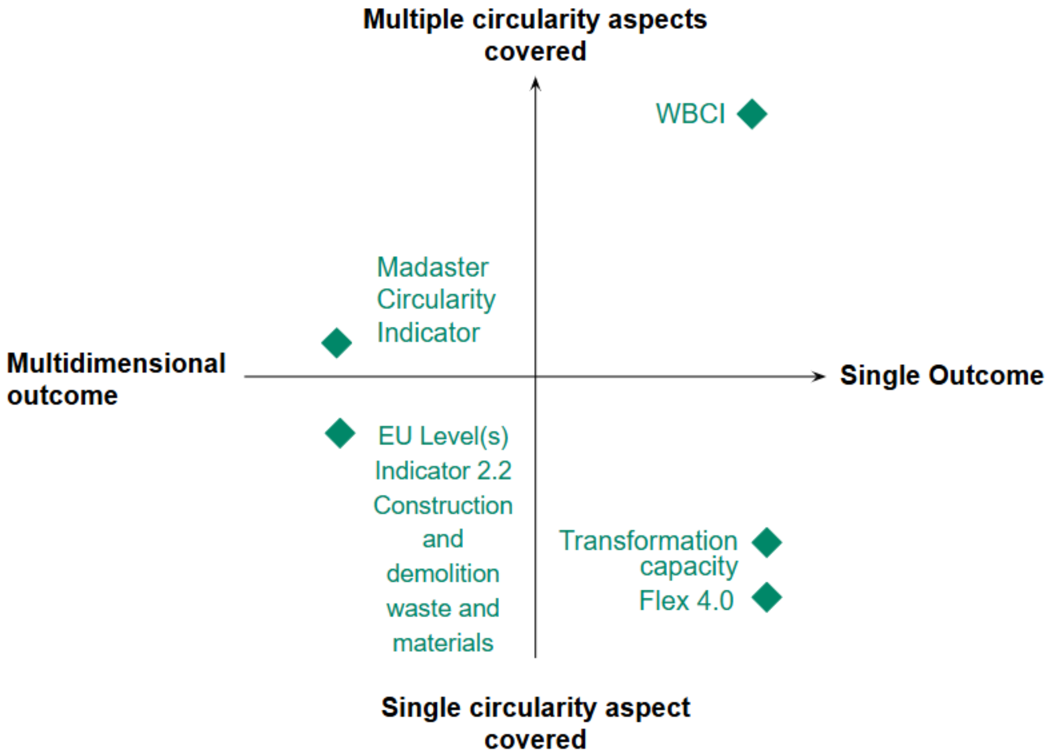


Figure 6. Results Matrix

As illustrated in Figure 6, the outcomes of the assessment have been categorised into the following types:

- Multiple circularity aspects covered: These metrics aim to develop a holistic circularity measure by capturing several dimensions of circular design.
- Single circularity aspect covered: These focus on one specific aspect of circularity, such as flexibility or design for disassembly.
- Multidimensional outcomes: Different aspects or elements of the building are evaluated and presented separately, resulting in a more granular outcome.
- Single outcome: The metric produces a singular, consolidated final score.

7.1 Justification of Methodology Positioning within the Results Matrix

The WBCI is the most comprehensive metric, encompassing multiple aspects of the circular economy, including resource circularity, flexibility, design for longevity, and design for disassembly. It also produces a single composite score that indicates how linear or circular a building is.

The Madaster metric, which utilises the Ellen MacArthur Foundation's Material Circularity Indicator (MCI), assesses resource efficiency across various stages of the building lifecycle, as well as design for longevity. While not yet as comprehensive as the WBCI, it generates a single percentage score and further breaks down results by individual building layers, allowing for detailed analysis of each component.

7.2 Future consideration

All these five metrics could be applied at the policy level, depending on the specific requirements and goals of future policy frameworks. A singular outcome may be beneficial for setting clear and tangible targets. However, multidimensional outcomes offer valuable insights into specific areas where a building may be over- or under-performing, enabling more targeted advice and guidance.

The Madaster metric, when used alongside the EU Level(s) indicator, Flex 4.0, and Transformation Capacity, offers a robust framework for assessing distinct aspects of circularity—such as material reuse, adaptability, and the potential for future transformation. Together, these tools provide targeted insights into specific dimensions of the circular economy within building design.

In contrast, the Whole Building Circularity Indicator (WBCI) offers an integrated approach, drawing on the principles of the Ellen MacArthur Foundation's Material Circularity Indicator while addressing some of its known limitations. By incorporating metrics like Flex 4.0 and Transformation Capacity, the WBCI allows for a more holistic evaluation of how circularity aspects interact across different building levels

As outlined in Section 6.2, only studies with limitations that could potentially be addressed were reviewed in detail. However, these limitations should still be acknowledged. Figure 6 presents the final scoring for each metric, based on the performance rating framework described in Section 5.2. Where maximum scores were not achieved for certain criteria, this highlights potential areas of limitation.

It should be noted that all metrics reviewed may require further development, particularly in relation to the creation of standardised assumptions to ensure objective and consistent inputs. Both Madaster and WBCI present some limitations in terms of accessibility. Madaster does not offer an open-access database, although its methodology is publicly available. In contrast, the WBCI is published in a peer-reviewed scientific journal that is not open access; however, efforts could be made to increase its availability to a wider audience.

In terms of output clarity, only WBCI presents a notable limitation: results are expressed as a single numerical value between 0 and 1. Without accompanying benchmarks or comparative studies, it is difficult to interpret what constitutes strong or weak performance.

Except for Madaster, which deliberately limits its assumptions, all other metrics would benefit from further analysis to determine whether their scoring and weighting systems are appropriate and produce reliable, meaningful results.

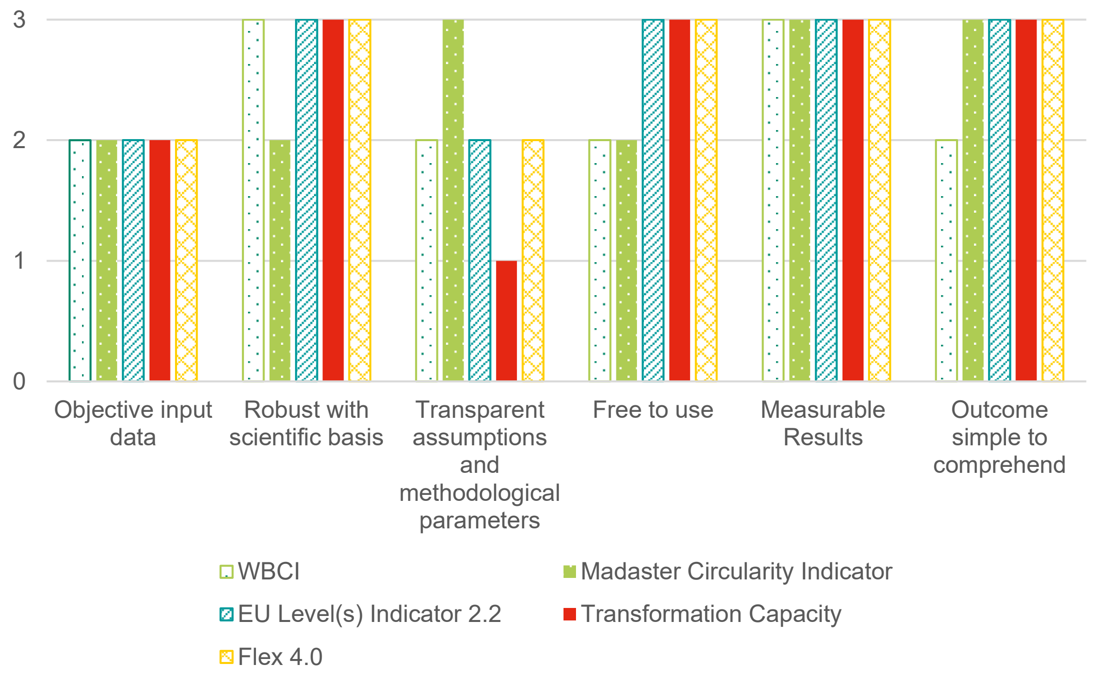


Figure 7. Scores achieved by each shortlisted metric based on selected evaluation criteria

In conclusion, while each metric contributes valuable insights to the assessment of circularity, further refinement is needed to improve consistency, transparency, and usability if applied on a policy level.

8. Discussion

This section discusses the findings with respect to each of the research questions (as stated in Section 1.1) based on the exploration through the previous sections:

How could the process and methodology for assessing the circularity of new developments in planning decisions be more specific, measurable, and quantitatively robust? What barriers or inefficiencies currently impact this process?

The current assessment process relies heavily on narrative statements, resulting in a lack of consistency and measurable evidence. One major barrier lies in the variability and limited rigour of Pre-Redevelopment and Pre-Demolition Audits, which are essential to understanding reuse potential yet often differ significantly in scope and format. Additionally, there is limited integration between stated design intentions and their delivery mechanisms—commitments are often presented without clear metrics or evidence of feasibility.

To address this, the process could be strengthened by:

- **Adopting metrics with harmonised methodologies** (e.g. **Flex 4.0**, **WBCI**, **Transformation Capacity**) that introduce structured, quantitative evaluation of circular strategies from early design stages.
- **Embedding key performance indicators (KPIs)**, such as reuse potential, adaptability scores, and lifecycle material flows, into submission requirements to enable benchmarking across developments.
- **Introducing progressive thresholds** to guide minimum performance expectations while allowing flexibility across typologies.

Current inefficiencies are exacerbated by fragmented governance. For example, the lack of alignment between Greater London Authority (GLA) policy and borough-level planning creates inconsistencies in implementation. Moreover, limited post-submission follow-up, such as construction-stage verification, hinders accountability. Without systems for tracking outcomes beyond planning, it remains difficult to evaluate real-world performance.

How could changes to circular economy methodologies and/or metrics enhance clarity for developers and decision makers in terms of what outcomes are expected to be delivered and how? How could such changes provide greater clarity for monitoring developments and policies?

To enhance clarity, CE methodologies need to go beyond conceptual frameworks and offer clear, actionable guidance on both expected outcomes and delivery pathways. Current templates often include overlapping sections (e.g. on design principles and design approach) and rely on high-level claims with minimal quantification, leaving room for inconsistent interpretation.

Revisions to methodologies could address this by:

- **Streamlining reporting formats** (e.g. incorporating structured elements from **EU Level(s) Indicator 2.2**) to reduce duplication and encourage comprehensive but focused submissions.

- **Translating qualitative commitments into measurable outcomes**, as it has been achieved, for example in the WBCI metric, which quantifies aspects like linear versus circular flow of material, design for adaptability and design for disassembly.
- **Clarifying expectations** through standard definitions of “good practice” and “beyond compliance”, providing developers with reference points and planners with criteria for consistent evaluation.

These changes would also enable more reliable policy monitoring, as quantifiable submissions could be more easily compared against borough-wide or city-level goals.

As discussed further in Section 10, monitoring and reporting of performance will be key to the ongoing development and implementation of policy, including the adoption of any specific metrics and/or targets.

A feedback loop between pre-application expectations and post-construction evidence would be essential to this—something currently missing from the process. Achieving this level of clarity and consistency would require a governance shift, including stronger alignment of GLA policy across boroughs and potentially the development of a centralised data platform to track outcomes over time. This could include both annual monitoring currently published by GLA (and discussed in Section 2.2.1 above), and utilisation of the London Datastore to provide valuable as-built information to industry.

Is there any weighting that should be applied to circular economy metrics and/or methodologies to deliver greater carbon savings?

Yes - there is a strong link between circular economy outcomes and embodied carbon reduction, particularly when strategies such as structural retention, use of reclaimed components, and incorporation of recycled content are applied. These practices contribute significantly to carbon savings by reducing reliance on virgin materials and minimising waste at end-of-life.

However, many current methodologies do not adequately reflect this link. For instance, Madaster does not apply differentiated weighting based on material source, reuse potential, or recyclability — a limitation of Ellen MacArthur’s Foundation Material Circularity Indicator also highlighted in the VBCI research paper. In contrast, the London Borough of Enfield’s approach includes weightings that reward reused materials more than recycled ones. Yet, this method lacks transparency regarding how these weightings were determined.

The absence of a standardised approach to weighting various circular routes (e.g., reuse vs. recycling vs. downcycling) limits the ability of circular economy assessments to drive carbon savings effectively. Addressing this gap likely requires intervention at the policy level, supported by further quantitative research to ensure any weightings align with environmental priorities and policy goals. For example, distinguishing between closed-loop recycling (no loss of quality) and downcycling could help target higher-quality resource loops, with different values assigned accordingly.

Another limitation of existing methodologies is the failure to account for transport-related emissions. Materials reused locally are often scored the same as those transported from afar, despite the substantial difference in embodied carbon.

Introducing geographic weighting to favour local reuse could align circular economy scoring more closely with whole life carbon goals.

That said, it is important to acknowledge the boundary between circularity metrics and embodied carbon accounting. While both assess aspects of sustainability, they serve different functions. As discussed in stakeholder sessions, retaining separate assessments for Whole Life Carbon (WLC) and Circular Economy (CE) is valuable — provided both are backed by clear targets. This dual approach encourages design teams to strike a meaningful balance between carbon performance and material circularity, avoiding unintended trade-offs.

What are the strengths and weaknesses of existing circular economy metrics and methodologies for quantifying circular economy outcomes for developments?

Existing circular economy (CE) methodologies have made significant progress in translating circularity principles into measurable outcomes, which is a considerable achievement in a field where many concepts — such as adaptability or design for disassembly — are not inherently quantifiable. As evidenced in Table C.9 Detailed summary of the metrics longlist for further assessment in Appendix C, all shortlisted methodologies provide structured ways to assess material flows, resource retention, and waste minimisation. This measurable approach is crucial for setting tangible targets and guiding early-stage design decisions.

One notable strength is the clarity and structure offered by EU Level(s). It provides a consistent reporting format and a step-by-step process that enhances transparency and comparability across projects. Its alignment with broader European sustainability goals also makes it a useful reference framework for policymakers and developers alike.

Similarly, the WBCI (Whole Building Circularity Indicator) represents a strong step forward in methodology development. One of its key advantages is that it draws from the best available practices across existing tools, integrating them into a cohesive and comprehensive framework. This enables the development of a circularity score, which allows for benchmarking and performance comparison, enhancing accountability and helping to inform policy direction.

That said, there are still challenges to overcome. Some scoring systems — especially those addressing qualitative aspects like disassembly or flexibility — remain inherently subjective. Ensuring consistent input data is another common issue, particularly where methodologies lack clear boundaries, structured material categories, or assumptions suitable for early-stage assessments. This can lead to variability in results, depending on who is conducting the assessment.

Which of these existing circular economy metrics or methodologies would be most viable for application in London?

At this stage, no single methodology can be definitively recommended without first establishing London's specific future policy goals, as any chosen tool must directly respond to the outcomes and priorities the policy intends to deliver. However, a comparative evaluation of the shortlisted methodologies highlights two promising pathways.

The Whole Building Circularity Indicator (WBCI) stands out as the most comprehensive option, offering a composite score that captures a wide range of circular economy outcomes—including resource flow, flexibility, design for longevity, and disassembly. It draws on best-in-class metrics such as Flex 4.0 and Transformation Capacity, and addresses limitations found in earlier tools like the Material Circularity Indicator.

Alternatively, a modular approach combining Madaster (which applies the MCI across building layers), EU Level(s), Flex 4.0, and Transformation Capacity could provide more granular insights aligned to specific areas of performance. This route allows tailoring depending on the scope and focus of future policy.

Ultimately, each methodology has strengths, and their interoperability should be further explored. A hybrid framework could balance the clarity of a single score with the diagnostic value of multi-dimensional results—supporting both policy development and performance monitoring as London's circular economy strategy evolves. Nonetheless, all reviewed methodologies have limitations and require further development before they can be applied at the policy level. It should be noted that applying either WBCI metric or utilising modular approach would involve addressing limitations at the level of individual methodologies. These primarily concern the establishment of standardised assumptions to ensure consistent and objective results, improving accessibility, testing assumptions, and ensuring that the output is easy to comprehend. A detailed analysis of the limitations and areas for further development for each shortlisted metric can be found in Section 6.2.

9. Conclusions

Through the application of defined criteria to the longlist of metrics, this section summarises the ones most suitable for application within the London policy context.

The shortlisted frameworks - EU Level(s) Indicator 2.2, Flex 4.0, Madaster Circularity Indicator, VBCI, WBCI, and Transformation Capacity - demonstrate significant potential to inform and support future circular economy policies.

While each metric presents unique benefits and varying degrees of alignment with existing policies, they also exhibit certain limitations and require further development before full implementation can be realised.

Key areas for further work include enhancing data availability, establishing standardised assumptions and clear guidance, validating indicators and weighting factors and testing of the metrics. These steps are essential, before any of the shortlisted metrics can be considered at a London policy level.

Combining multidimensional metrics, such as Madaster with EU Levels, Flex 4.0, and Transformation Capacity, alongside more comprehensive frameworks like WBCI, could foster a more integrated and robust approach to circularity evaluation. This would enable policymakers to set tangible targets while also gaining granular insights into specific building performance aspects, ultimately supporting a more effective and adaptable circular economy strategy.

10. Next steps

The context of existing Circular Economy policy and guidance in London and readiness of available industry metrics and methodologies to measure circularity in the built environment will require further work before a new metrics could be fully implemented in policy.

Figure 8 illustrates the key actions which will need to be undertaken to support the use of new metrics as part of the planning process and order in which these need to be addressed. The actions have been structured to reflect four key phases of developing and implementing policy: policy, guidance, monitoring and reporting.

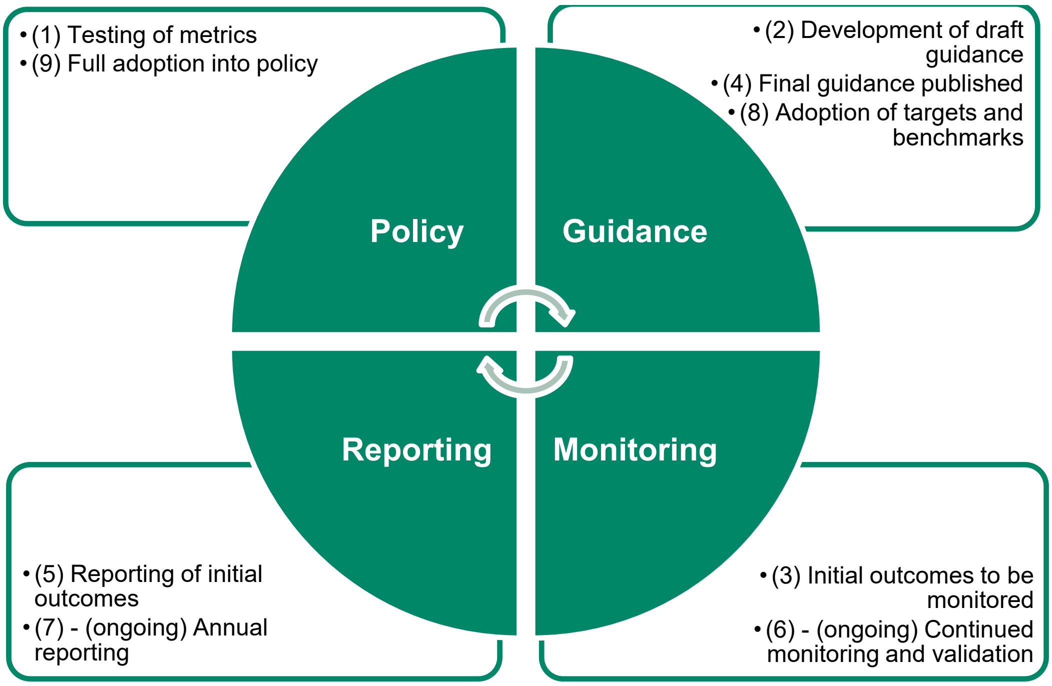


Figure 8. Process map for implementation of new CE metrics and methodologies

The following list indicates the order in which actions should be undertaken including any key considerations at each stage, based on the evolution of the existing policy and guidance for circular economy:

1. **Testing of metrics:** Testing of metrics should be undertaken prior to implementation in policy to ensure that these are appropriate for use for referable-scale development in a London context at planning application stage. This should classify whether any limitations identified are fundamental (e.g. the metric is not appropriate for use) or potential (e.g. these could be resolved through the development of guidance or standardisation).
2. **Development of guidance:** Any necessary guidance should be developed to support applicants in responding to the requirements of policy. This should seek to address any potential limitations identified in testing (e.g. standardising assumptions). It is expected that public consultation would be required on any published guidance.
3. **Monitoring of initial outcomes from applicants:** Outcomes and performance reported by applicants at planning stage in response to the draft guidance. This

should also be used to identify any common issues and unforeseen impacts the metric is having in implementation.

4. **Final guidance published:** Following consultation and informed by the initial 1-2 years of implementation, final guidance should be developed and published to support the policy. This could also include any spreadsheets or other tools required to report on circularity.
5. **Reporting of outcomes:** Initial outcomes from the monitoring should be reported, this could be done alongside the publication of the final guidance to provide applicants with information about expected ranges of performance.
6. **Continued monitoring and validation of performance against initial outcomes:** Following the publication of guidance and initial outcomes, continued monitoring should be undertaken to validate consistency with the performances reported by applicants against the draft guidance. Similar to the figures in the current LPG (March 2022), the initial outcomes could act as informal benchmarks / targets.
7. **Annual reporting:** Annual reporting should be undertaken to determine whether the use of the metrics is having the intended impact on circularity strategies over time in line with the policy intentions.
8. **Adoption of targets and benchmarks:** Following a sufficient period of monitoring (3+ years) to validate achievable levels of performance from planning stage data, the initial outcomes could be refined to be adopted as a set of benchmarks to add weight to the metric as part of the planning process. As far as possible, this should be supported by measured outcomes from post-completion stage data and wider industry testing and reporting. The figures presented in Appendix 4 of the LPG are now supported by several years worth of planning stage monitoring reporting.
9. **Full adoption into policy:** Following further annual monitoring and reporting to validate applicant's performance against targets and benchmarks, the metric could be fully adopted into policy. This could be in the form of an absolute target / threshold, relative target / threshold or benchmark range (e.g. 'business as usual,' 'good practice,' 'best practice') defined as appropriate to the type of outcome of the metric. This could be via direct reference in policy or via a cross reference to a supplementary guidance or addendum document.

Appendix A Bibliography

[1] European Parliament , “Circular Economy: Definition, Importance and Benefits. [online] European Parliament,” 2023.

[2] Department for Environment, Food & Rural Affairs, “Waste prevention programme for England,” gov.uk, 2013. [Online]. Available: https://www.gov.uk/government/publications/waste-prevention-programme-for-england..

[3] Greater London Authority, “The London Plan,” 2021.

[4] Greater London Authority , “London Plan Guidance, Circular Economy Statements,” Greater London Authority, London , 2022.

[5] H. Watt, D. Buck, P. Hodgson, C. Kitching and D. Densley Tingley, “Assessing the upfront carbon cost of structural adaptability,” *Structures,* vol. 71, 2025.

[6] Khadim, N., Agliata, R., Thaheem, M.J. and Mollo, L, “hole building circularity indicator: A circular economy assessment framework for promoting circularity and sustainability in buildings and construction,” 2023.

[7] Enfield Council, “ Enfield Draft Local Plan Pre-Publication,” p. 117–138, 2023.

[8] Madaster, “Madaster Circularity Indicator Explained,” 2021.

[9] Dodd, N., Donatello, S. and Cordella, M., “Level(s) indicator 2.1: Bill of Quantities, materials and lifespans – User manual: introductory briefing, instructions and guidance (Version 1.1),” European Commission Joint Research Centre, 2021.

[10] Dodd, N., Donatello, S. and Cordella, M., “Level(s) indicator 2.2: Construction and Demolition waste and materials – User manual: introductory briefing, instructions and guidance (Version 1.1),” European Commission Joint Research Centre., 2021.

[11] Dodd, N., Donatello, S. and Cordella, M., “Level(s) indicator 2.3: Design for adaptability and renovation – User manual: introductory briefing, instructions and guidance (Version 2.0),” European Commission Joint Research Centre, 2021.

[12] Dodd, N., Donatello, S. and Cordella, M., “Level(s) indicator 2.4: Design for deconstruction – User manual: introductory briefing, instructions and guidance (Version 2.0),” European Commission Joint Research Centre, 2021.

[13] Thornton, J, “Building Circularity V2,” One Click LCA Help Centre, 2024. [Online]. Available: https://oneclicklca.zendesk.com/hc/en-us/articles/15602310529820-Building-Circularity-V2 . [Accessed 02 06 2025].

[14] eTool, “Materials Efficiency Metric,” eTool Knowledge Base, 2020. [Online]. Available: https://support.etoollcd.com/index.php/knowledgebase/materials-efficiency-metric/ . [Accessed 02 06 2025].

[15] Geraedts, R., “FLEX 4.0, A Practical Instrument to Assess the Adaptive Capacity of Buildings,” *Energy Procedia,* pp. 568-579, 2016.

[16] Dams, B., Maskell, D., Shea, A., Allen, S., Driesser, M., Kretschmann, T., Walker, P. and Emmitt, S., “A circular construction evaluation framework to promote designing for disassembly and adaptability,” *Journal of Cleaner Production,* vol. 316, 2021.

[17] Verberne, J., “Building Circularity Indicators : an Approach for Measuring Circularity of a Building,” *Department of the Built Environment. Eindhoven University of Technology,* 2016.

[18] Durmisevic, E., “Transformable Building Structures: Design for Disassembly as a Way to Introduce Sustainable Engineering to Building Design & Construction,” 2006.

[19] “Not published; shared as a pre-read with the hackathon participants.”.

[20] ARUP, “Circular Buildings Toolkit,” [Online]. Available: https://ce-toolkit.dhub.arup.com/. [Accessed 15 05 2025].

[21] Ellen MacArthur Foundation, “Material Circularity Indicator (MCI),” [Online]. Available: https://www.ellenmacarthurfoundation.org/material-circularity-indicator. [Accessed 15 05 2025].

[22] BCI Gebouw, “Whitepaper Building Circularity Index - BCI Gebouw,” 2023. [Online]. Available: https://www.bcigebouw.nl/en/whitepaper-building-circularity-index/. [Accessed 02 06 2025].

[23] Akanbi, L.A., Oyedele, L.O., Omoteso, K., Bilal, M., Akinade, O.O., Ajayi, A.O., Davila Delgado, J.M. and Owolabi, H.A, “Disassembly and deconstruction analytics system (D-DAS) for construction in a circular economy,” *Journal of Cleaner Production,* vol. 223, p. 386–396, 2019.

[24] Platform CB’23, “English - Platform CB’23,” [Online]. Available: https://platformcb23.nl/english/. [Accessed 02 06 2025].

[25] Zhang, N., Han, Q. and de Vries, B., “Building Circularity Assessment in the Architecture, Engineering, and Construction Industry: A New Framework,” *Sustainability ,* 2021.

[26] Lindgren, M. , “Circular Building Assessment Prototype - BAMB,” BAMB Buildings as Material Banks, 2018. [Online]. Available: https://www.bamb2020.eu/post/cba-prototype/ . [Accessed 02 06 2025].

[27] Concular, “ Circularity Performance Index (CPX),” Concular, [Online]. Available: https://concular.de/circularity-performance-index/. [Accessed 02 06 2025].

Appendix B Current Planning Policy

The section below presents an overview of the current planning policy, providing essential context for the analysis presented in this report.

The London Plan 2021 introduced two circular economy policies. London Plan Policy D3 *Optimising site capacity through the design-led approach* highlights that development proposals should:

> *"aim for high sustainability standards … and take into account the principles of the circular economy."*

The principles as defined by the London Plan as referenced by Policy D3 are detailed in Section 2.1.1 above.

Policy SI7 *Reducing waste and supporting the circular economy* focusses on waste reduction, waste management and resource efficiency. Policy SI 7 B sets out that all referable planning applications should include a Circular Economy Statement:

> B. *Referable applications should promote circular economy outcomes and aim to be net zero-waste. A Circular Economy Statement should be submitted, to demonstrate:*
>
> - how all materials arising from demolition and remediation works will be re-used and/or recycled
> - how the proposal's design and construction will reduce material demands and enable building materials, components and products to be disassembled and re-used at the end of their useful life
> - opportunities for managing as much waste as possible on site
> - adequate and easily accessible storage space and collection systems to support recycling and re-use
> - how much waste the proposal is expected to generate, and how and where the waste will be managed in accordance with the waste hierarchy
> - how performance will be monitored and reported.

Policy SI 7 A also sets out specific targets which applicants should commit to achieving via the proposals, as follows:

- meet or exceed the municipal waste recycling target of 65 per cent by 2030
- meet or exceed the targets for each of the following waste and material streams:
  - construction and demolition – 95 per cent reuse/recycling/recovery
  - excavation – 95 per cent beneficial use

The London Plan is supplemented by the London Environment Strategy which includes a target for 75 per cent recycling rate for business waste by 2030. Whilst this is implemented as part of GLA's CE & Waste policy area, it is not explicitly referenced in the current London Plan.

Applicants are also expected to provide a commitment to specifying 20 per cent reused and recycled content (by value of materials), including supporting calculations to illustrate. Similarly, this is set via London Plan guidance rather than being a requirement of policy.

London Plan Guidance (LPG): Circular Economy Statements was published on 25th March 2022 following an initial primer document and subsequent consultation guidance version. The March 2022 LPG sets out how applicants should develop Circular Economy Statements in accordance with London Plan Policy SI 7 “Reducing waste and supporting the circular economy” for referable planning applications. It also includes guidance on how the design of new buildings, and prioritising the reuse and retrofit of existing structures, can promote circular outcomes.

The LPG sets out that the Circular Economy Statement must include two parts: a written report and the CE template spreadsheet. The LPG also sets out that the CE submission should include a Pre-Redevelopment Audit, Pre-Demolition Audit, and Operational Waste Management Plan as supporting information.

The template is broken down into five key reporting tables for applicants to complete at planning stage. These are as follows:

- Circular Economy Targets
- Circular Economy Design Approaches
- Circular Economy Design Principles
- Recycling and Waste Reporting
- Bill of Materials

The level of information required to be provided varies by application stage, as presented in Table B.8 below in line with the LPG. At the pre-application stage, the focus is on strategic-level information which relates to the approaches for redevelopment (including demolition and retention) and high-level strategies for new development.

At application stage, the information requirements expand to include detailed strategic information, including supporting assessments, specific measurements and commitments in response to the design principles and quantitative estimates of waste and materials.

Applicants should be conditioned to provide a post-construction Circular Economy Statement prior to the occupation of the development. This reporting should include the outcomes as monitored on-site and in implementation, to update and compare to the estimated figures provided in reporting tables at planning stage, explaining the reasons for any differences. Applicants should reflect on the measures and commitments made at planning stage. Applicants should also provide lessons learned with respect to the implementation, monitoring and reporting process.

Table B.8 London Plan Guidance minimum submission requirements at different stages

Information requirements	Pre-Application (Suggested) RIBA 0-2	Outline Application RIBA 0-2	Full Application / Reserved Matters RIBA 2-3	Post-Construction RIBA 4-7
CE targets (LPG Section 4.2)	Encouraged	Yes	Yes	Yes (Actual)
CE design approaches (LPG Sections 2.3-2.5 and 4.3)	Yes	Yes	Yes	N/A
CE design principles (LPG Sections 2.1, 4.4-4.5)	Yes	Yes (by building layer)	Yes (by building layer)	No
Pre-Redevelopment Audit (LPG Section 4.6)	Encouraged	Yes	Yes	N/A
Pre-Demolition Audit (LPG Section 4.6)	Encouraged	Yes	Yes	N/A
Bill of Materials (LPG Section 4.7)	No	Yes (Estimated)	Yes (Estimated)	Yes (Actual)
End of life strategy (LPG Section 4.7)	No	No	Yes	Encouraged
Operational Waste Management Plan (LPG Section 4.8)	No	No	Yes	Encouraged
Recycling and waste reporting (LPG Section 4.9)	No	Yes (Estimated)	Yes (Estimated)	Yes (Actual)
Lessons learnt and key achievements (LPG Section 4.10)	N/A	N/A	N/A	Yes

Source: London Plan Guidance: Circular Economy Statements (Greater London Authority, March 2022)

Appendix C Detailed metrics longlist

Table C.9 Detailed summary of the metrics longlist for further assessment presents a detailed description and scope of longlists of metrics. For details regarding its development please refer to section 4 of this report.

Table C.9 Detailed summary of the metrics longlist for further assessment

Metric / Source	Description	Outcome	Links to Circular Economy Principles addressed by existing policy				
			Material intensity and material source	Waste generation and diversion from landfill	Design for Adaptability	Design for disassembly	Design for longevity
Whole building circularity indicator (WBCI) [6]	WBCI consolidates the most comprehensive and rigorous circular economy assessment methodologies—such as VBCI, MCI, and Flex 4.0—and addresses their limitations to develop a holistic framework covering a wide range of key performance indicators (KPIs). It is developed from a life cycle perspective, considering all material flows from origin to disposal or waste treatment. As part of the research study underpinning the methodology's development, validated was undertaken using a case study of a typical Italian residential building.	Score between 0-1, where 0 means fully linear and 1 means fully circular	**PARTIALLY** Resource efficiency and circularity are measured using the Material Circularity Indicator, adapted specifically for the built environment.	**PARTIALLY** The waste sent to landfill is not explicitly quantified. However, waste diversion from landfill is rewarded in the final score	**YES** Through utilising Building Flexibility Score (Flex 4.0) methodology.	**YES** Through utilising Design Disassembly Factor methodology developed by Elma Durmisevic)	**YES** Through measuring the functional lifecycle of products used.
London Borough of Enfield's Circular Index [7]	Developed as part of Enfield Council's commitment to become a carbon-neutral organisation by 2040, this building-level metric assesses circularity by evaluating the proportion of materials that are reused, recycled, or recyclable, relative to the use of virgin materials during construction, as well as the disposal or incineration of materials from demolition. It considers both material inputs and waste outputs to quantify the circularity of a development in terms of material flow efficiency. Weighting factors are applied, with the highest assigned to in-situ recovered materials and the lowest to materials derived from non-recyclable and non-renewable sources.	Percentage between 0 and 100% Material Value Retention (MVR)	**PARTIALLY** Through quantifying % of reused, recycled and virgin material input; The metric does not explicitly measure material intensity	**YES** It quantifies waste management routes for demolition waste but does not account for waste generated during the use phase or at the end of the building's lifecycle.	**NO**	**NO**	**NO**

Metric / Source	Description	Outcome	Links to Circular Economy Principles addressed by existing policy				
			Material intensity and material source	**Waste generation and diversion from landfill**	**Design for Adaptability**	**Design for disassembly**	**Design for longevity**
Madaster Circularity Indicator [8]	Developed by Madaster, this metric quantifies the circularity of buildings by evaluating material usage, durability, and potential for reuse. It tracks the materials' life cycle from design to end-of-life, focusing on reducing waste and improving resource efficiency. The indicator helps guide sustainable design by enabling the tracking and management of materials within buildings, promoting circular economy principles.	Circularity score: 0-100% non-virgin materials: 0-100% Utility: 0-100% Recoverable content: 0-100% The scores are separately applied to site, structure, skin, services, space plan, stuff and the total is calculated.	**PARTIALLY** Resource efficiency and circularity are measured using the Material Circularity Indicator.	**PARTIALLY** The waste sent to landfill is not explicitly quantified. However, waste diversion from landfill is rewarded in the final score	**NO**	**NO**	**YES** Through measuring the functional lifecycle of the products used.
EU Level(s) Indicator **2.1 Bill of Quantities, Materials and lifespans** [9] **2.2 Construction and Demolition Waste and Materials** [10] **2.3 Design for adaptability and renovation** [11] **2.4 Design for deconstruction** [12]	**2.1 Bill of Quantities, Materials and Lifespans:** Requires reporting of a structured bill of quantities for the building, including materials used, their quantities, and estimated service lives. Supports life cycle assessment and circularity tracking. **2.2 Construction and Demolition Waste and Materials:** Focuses on estimating and reducing waste generated during construction, renovation, and end-of-life. Promotes material recovery, reuse, and alignment with waste management hierarchy. **2.3 Design for Adaptability and Renovation:** Assesses how easily the building can be adapted or renovated over time. Encourages flexible layouts, modular systems, and long-term functionality to extend building lifespan. **2.4 Design for Deconstruction:** Evaluates the extent to which the building is designed for disassembly, reuse, and recycling at end-of-life. Encourages reversible connections, standardised components, and material passports.	Bill of Quantities, Materials and Lifespans: Bill of materials Construction and Demolition Waste and Materials: Recycling and waste quantities Design for Adaptability and Renovation: Weighted adaptability score Design for Deconstruction: Circularity score	**NO**	**YES** Through indicator 2.2 Construction and Demolition Waste and Materials	**YES** Through indicator 2.3 Design for adaptability and renovation	**YES** Through indicator 2.4 Design for deconstruction	**NO**

Metric / Source	Description	Outcome	Links to Circular Economy Principles addressed by existing policy				
			Material intensity and material source	Waste generation and diversion from landfill	Design for Adaptability	Design for disassembly	Design for longevity
OneClick Building Circularity Tool V2 [13]	The OneClick Building Circularity Tool v2 enables the calculation of building circularity by assessing material sources and content, construction waste, and end-of-life (EoL) treatment. The updated version introduces the option to either apply predefined EoL scenarios or manually define processing types and distribution of material to waste or EoL pathways. The tool performs circularity calculations at the start of the building lifecycle in alignment with ISO 59020 (2024). It is designed to comply with standards and certifications such as the London Plan Circular Economy Statement requirements and relevant BREEAM credits. The tool is designed to calculate a circularity percentage for an asset or building and can be applied at both the material and whole-building level without a fixed scope.	A circularity score (a percentage between 0–100%), along with the percentage of materials recovered and returned, EU Taxonomy Table, bill of materials containing information on design for disassembly and adaptability for each material or element.	**PARTIALLY** By measuring the percentages of materials recovered and returned.	**YES** Through quantifying the percentage and mass of materials diverted from landfill.	**YES** Through yes/ no assessment for each element.	**YES** Through selecting “structural role”, “accessibility limited by” and “connection type for each element”	**NO**
eTool Material Circularity Indicator [14]	This metric is based on the Ellen MacArthur Foundation’s Material Circularity Indicator. It calculates the proportion of materials used in a linear versus circular manner, as well as the utility factor of each product. A weighting factor based on the mass of each element is applied to produce the final circularity score.	Mass of materials, recycled content estimation, percentage of renewable material (reused and non-reused), % of material that at the end of life is send to landfill, recycles, reused, recovered for energy, composted	**PARTIALLY** Resource efficiency and circularity are measured using the Material Circularity Indicator	**PARTIALLY** The waste sent to landfill is not explicitly quantified. However, waste diversion from landfill is rewarded in the final score	**NO**	**NO**	**NO**
Flex 4.0 [15]	The FLEX 4.0 methodology is a framework developed to assess the adaptive capacity of buildings. The methodology employs a set of 44 flexibility performance indicators, categorised into 12 general indicators applicable across all building types and 32 specific indicators tailored to building functions, such as schools or offices. Each indicator is assessed on a scale from 1 (Bad) to 4 (Best). The final score is weighted scores for	The methodology results in the assignment of flexibility classes based on the achieved flexibility score.	**NO**	**NO**	**YES** Through assessing characteristics of a structure that could allow/ prevent adaptation	**YES** Through assessing disassembly potential of different building elements	**NO**

Metric / Source	Description	Outcome	Links to Circular Economy Principles addressed by existing policy				
			Material intensity and material source	Waste generation and diversion from landfill	Design for Adaptability	Design for disassembly	Design for longevity
	each indicator contextual through flexibility class scores.						
Circular Construction Evaluation Framework (CCEF) [16]	A free-to-use assessment tool designed to quantify the circularity of new or existing construction projects. The CCEF measures how well a building supports disassembly, adaptability, and material reuse by evaluating factors such as modularity, standardisation, reversible connections, and the use of sustainably sourced or bio-based materials. It provides early-stage scoring at both whole-building and component levels.	The methodology produces two levels of scoring: a circularity percentage at the whole-building level and an average circularity percentage at the element level, based on the performance of individual building components.	**PARTIALLY** The methodology evaluates the percentage of reused and recycled materials in the building. However, it does not directly measure material intensity	**NO**	**NO**	**YES** Circularity is measured by assessing the overall design approach at the whole-building level, as well as the reversibility of connections and the presence of Environmental Product Declarations (EPDs) at the element level.	**YES** Through assessing durability of products
Verberne Building Circularity Indicator (VBCI) [17]	A multi-layered assessment methodology developed from and expanded upon the Ellen MacArthur Foundation & Granta (2015) Circularity Indicators. It combines four levels: Material (MCI), Product (PCI), System (SCI), and Building (BCI) circularity. It accounts for material input/output, product utility, disassembly potential, system layering, and lifetime importance.	The methodology yields a singular Building Circularity Indicator, expressed as a dimensionless value ranging from 0 to 1, representing the degree of circularity within the assessed building system.	**PARTIALLY** Resource efficiency and circularity are measured using the Material Circularity Indicator	**YES** Through the quantification of waste streams directed to landfill disposal or energy recovery processes	**NO**	**YES** Through incorporation of DDF (Design for Disassembly Factor) into the methodology outcome	**YES** Through measuring the functional lifecycle of the products used.
Transformation Capacity (TC) [18]	The Transformation Capacity Framework developed by Elma Durmisevic evaluates a building's adaptability and disassembly potential through a structured assessment using 14 interdependent "evaluation nodes." Each node is assessed using indiscrete "fuzzy values" ranging from 0 to 1, reflecting the degree of compliance with transformation-friendly design principles. The final transformation capacity is derived by analysing the relationships and weighted interactions among 13 of the nodes, culminating in the calculation of the final node—Transformation Capacity (TC)—which represents the building's overall potential to adapt and transform over time.	TC – Transformation Capacity is a value ranging between 0 and 1.: TC > 0.67 indicates high disassembly potential 0.33 < TC ≤ 0.67 indicates medium disassembly potential TC ≤ 0.33 indicates low disassembly potential	**NO**	**NO**	**NO**	**YES** Through assessing disassembly potential at different functional levels of a building.	**NO**

Appendix D Resources excluded from the study

Table D.10 lists tools, metrics and methodologies excluded during the preliminary review (see Section 4) due to insufficient structure, rigour, or relevance to the study's scope.

Table D.10 Resources excluded from the study including justification for exclusion

Metric	Descriptions	Justification for exclusion
CIRCuIT, LETI and the ICEC-MCM CIRCULAR ECONOMY HACKATHON – 12 January 2023 PRE-READING: CIRCULARITY METRICS FOR BUILDINGS [19]	Research project by CIRCuIT completed in 2021, intended to develop circular economy indicators. It represents the set of building-level indicators identified through a series of workshops. These have been mapped to the GLA's London Plan Guidance and Circular Economy Statements.	Although the methodology provides a foundational basis for developing metrics, it lacks sufficient maturity and cannot be considered a fully ready-to-apply approach. It does not specify units, calculation methods, or clearly defined outputs. At this stage, it is evident that the methodology is not suitable for application at a policy-level scale and, therefore, has been excluded from the assessment.
Arup Circular Building Toolkit [20]	Arup's Circular Building Toolkit is a practical guide to help design teams embed circular economy principles in building projects, focusing on material reuse, adaptability, and whole-life value ratio. It operates based on the 3 principles: - Design and build for longer term use-productivity and utilisation of space - Develop a new material mindset-reduction of virgin and non-renewable materials. Also promotes materials that avoid pollutants - Learn from completed project-contains a library of completed circular building projects	Although the methodology is established and used in practice, it is primarily tailored to support building design rather than to measure circular economy outcomes. Therefore, it was deemed unsuitable for the objectives of this study.
Material Circularity Indicator [21]	The Material Circularity Indicator (MCI), developed by the Ellen MacArthur Foundation in collaboration with the Circular Economy 100 network, is a metric designed to assess the circularity of products and materials. It quantifies how restorative a product's material flows are by measuring the proportion of recycled and renewable materials used, the product's lifespan, and the degree to which materials are recovered and reused at end-of-life. The MCI provides a standardized way to evaluate and compare the circularity performance of products.	Although the methodology is one of the most established and widely used for assessing the circularity of products, it is not specifically tailored to the construction industry and cannot be directly applied to meet the relevant policy objectives. However, this study does cover some methodologies that have adapted the Material Circularity Indicator (MCI) into approaches more suitable for the built environment. For this reason, it has been decided not to assess this study further.

Metric	Descriptions	Justification for exclusion
Building Circularity Index (BCI) [22]	Developed by Alba Concepts in collaboration with TU Eindhoven, this methodology underpins the Building Circularity Index© (BCI) and the BCI Gebouw tool. Designed for early-stage assessment of real estate circularity, it contributes to national efforts to make circularity measurable. The whitepaper outlines the calculation rules, highlights the importance of stakeholder awareness, and identifies key challenges and opportunities toward harmonising circularity measurement methods.	The whitepaper Circular Real Estate Measurement Method is currently available only in Dutch, which limits accessibility for non-Dutch-speaking stakeholders and restricts its direct applicability in international or English-language research and standardisation efforts. Until an official English translation is provided, its methodologies and findings cannot be fully evaluated or integrated into comparative assessments.
Disassembly and Deconstruction Analytics System (D-DAS) [23]	This study proposes a methodology to evaluate circularity in building design by integrating a disassembly and deconstruction analytics system into the Building Information Modelling (BIM) process. The system architecture comprises four interconnected layers: (i) Data Storage, (ii) Semantic Layer, (iii) Analytics and Functional Models, and (iv) Application Layer. These enable three key functionalities implemented as plug-ins in Revit 2017: (1) Building Whole Life Performance Analytics, (2) Building Element Deconstruction Analytics, and (3) Design for Deconstruction Advisor. By simulating various design scenarios, the system allows early-stage assessment of design decisions in terms of material recovery and circularity potential.	While the study primarily focuses on input data and software development rather than evaluating assessment outcomes, this aspect was not found to be aligned with the study's objectives and has therefore been excluded from further assessment.
CB'23 [24]	Developed as a collaborative initiative between Dutch public agencies and industry partners, Platform CB’23 aims to accelerate the transition to circular construction. Its methodology enables the measurement of circularity across all construction sectors (including buildings and infrastructure), at various scales (from material to area), and throughout all project phases.	The Platform CB’23 measurement method has not been considered for the assessment in this study, as it remains under development and lacks the methodological maturity required for consistent and reliable application. Several indicators still allow for broad interpretation, and the complexity of required data limits its accessibility. As such, the method is not yet sufficiently robust for integration into comparative or standardised assessment frameworks.

Metric	Descriptions	Justification for exclusion
Building Circularity and Material Passport calculation model [25]	This study aims to address the inconsistencies in existing Building Circularity (BC) assessment methods within the Architecture, Engineering, and Construction (AEC) industries. It proposes a new framework comprising three components: a redefined material flow model with three circularity cycles and five indicators, a Material Passport (MP) outlining required data, and a calculation method for quantifying circularity.	The Material Passport part of this study is not relevant to this assessment. While the Building Circularity component appears to be a promising methodology—integrating circularity rates across layers, elements, and materials with environmental and economic considerations—it lacks a clear explanation of how these indicators interact. The absence of defined relationships limits the methodological transparency and practical applicability. As such, the approach is considered insufficiently developed for inclusion in this study.
The Circular Building Assessment (CBA) [26]	The Circular Building Assessment (CBA) within the Buildings as Material Banks (BAMB) project is a methodology to evaluate the reuse and recovery of building materials and components. It assesses resource productivity based on design decisions and material selection.	The methodology, although promising and relevant, appears to focus more on assessing existing buildings in terms of their suitability as material banks. Given that this study is focused on quantifying circularity in new developments, the methodology was deemed out of scope.
Concular Circularity Performance Index [27]	The Circularity Performance Index provides a quantitative assessment of building elements and entire structures with respect to their circularity and sustainability. It considers factors from both before and after use, including material reuse. This index can be applied to both existing buildings and new developments, but should be evaluated alongside other indicators such as health impacts, ESG criteria, and residual value.	This is a paid tool with very limited publicly available information. As such, it could not be properly reviewed as part of this study, as the core methodology was not accessible.

Appendix E List of excluded criteria

Table E.11 can be read alongside Section 5 of this report. The table documents criteria which were considered for the evaluation of circular economy metrics however ultimately excluded during the development process. The table also details the considerations for their exclusion.

Table E.11 Criteria excluded from the final selection to evaluate circular economy metrics

Criteria	Reason for exclusion
Linked to policy objectives	While alignment with policy is important, the objectives of the future policy are currently unknown. Metrics were shortlisted only if they broadly aligned with the current understanding of circular economy principles based on policy and guidance. However, flexibility was considered more beneficial at this stage to accommodate potential future policy directions and desired outcomes.
Proofed against manipulation	This was deemed more relevant to how a metric is applied rather than how it should be assessed. Additionally, it overlaps with the existing criteria of *Objective Input Data* and *Transparent Assumptions and Methodological Parameters.*
Simple to perform	Although ease of use is advantageous, it was not prioritised if more complex methodologies offered more accurate or meaningful outcomes. Accuracy and rigour were considered more important than simplicity.
Scalable	During the initial review of different methodologies, their applicability to buildings typically covered by referable applications was taken into account. As such, the selected methodologies can already be considered broadly scalable, and further assessment against this criterion was deemed unfeasible. While scalability is theoretically valuable, it was not treated as a core characteristic of the methodologies themselves. Instead, it was viewed as an implementation-related factor—dependent on how a methodology is applied in practice—and therefore considered outside the scope of this assessment.
Allows for engagement with economic factors	Stakeholder feedback highlighted concerns that economic factors in circularity are often subjective, inconsistent, and difficult to regulate. Moreover, financial offsetting—commonly used in carbon-related policies—does not align well with circular economy principles and may introduce unintended or misaligned incentives.
Considers existing and new buildings separately	This was considered an application-level consideration rather than a necessary characteristic of the assessment methodology. While the distinction between existing and new buildings is important, a simple categorical split may overlook important nuances—especially in complex cases such as heritage buildings.
Guides the team through the design and delivery process	While guiding design teams through the design process can be a beneficial feature, it was not considered a core focus of this study. This assessment specifically reviews methodologies that can be used at the policy level to evaluate circular economy outcomes, rather than tools intended primarily to support or influence the design process. As such, design guidance is considered an application-level benefit rather than a necessary characteristic of a circularity metric and falls outside the scope of this evaluation.

Appendix F Full metrics evaluation

Table F.12 to Table F.23 present the longlisted metrics and their scores as per Section 5.3 of this report with justification for each score.

Table F.12 Evaluation of metric with justification RAG scoring – Whole Building Circularity Indicator (WBCI)

Criteria	Score	Explanation
Objective input data	2	Some inputs are based on quantifiable data that are already standard in industry practice—such as the development of a Bill of Materials—for which established assumptions are readily available, for example, through the RICS Professional Standards. For criteria related to flexibility and Design for Disassembly, the framework provides descriptions and guidance to support evaluation. However, it lacks clear instructions on which standard assumptions should be applied when specific design details remain undefined. This can lead to inconsistent results among professionals applying the framework. While the framework outlines the scope of assessment across different building levels and elements, it does not clearly define the boundaries or extent of that scope, which may further impact consistency and comparability.
Robust with scientific basis	3	The methodology was developed through an extensive review of existing literature, including over 50 shortlisted documents focused on building circularity indicators. It was subsequently tested on an existing building. The research paper is published in the journal Building and Environment, which follows a peer-review process.
Transparent assumptions and methodological parameters	2	All parameters and assumptions are to some extent justified, primarily through references to previous studies. However, some parameters—particularly those related to flexibility scoring and the weighting of importance across different building layers—although published in scientific literature, are proposed values and rely on subjective judgement.
Free to use	2	The publication is not open access and must be purchased through a scientific journal platform. However, once accessed, it provides the full methodology. It is noted that supporting resources are available upon request by contacting the author of the study.
Measurable results	3	The assessment quantifies all the indicators, and the output is fully numerical and measurable. It could be used to develop targets and goals.
Outcome simple to comprehend	2	The outcome can be communicated and interpreted with some additional effort and explanation. It is presented as a single value between 0 and 1, with defined boundaries. However, in the absence of further studies or benchmarks, it is difficult to determine what constitutes good or poor performance.

Table F.13 Evaluation of metric with justification RAG scoring – London Borough of Enfield's Circular Index

Criteria	Score	Explanation
Objective input data	2	Inputs are based on quantifiable data that are already standard in industry practice—such as the development of a Bill of Materials—for which established assumptions are readily available, for example, through the RICS Professional Standards. Nevertheless, the methodology lacks a clearly defined scope of assessment. For criteria related to flexibility and Design for Disassembly, the framework offers descriptions and guidance to support evaluation. However, considering that the methodology is intended to be applied during early design stages, standardised assumptions for materials that have not yet been specified would be necessary to ensure objective and consistent inputs. Additionally, the flexibility component of the methodology is based on Flex 4.0, for which user inputs have been assessed as moderately objective.
Robust with scientific basis	1	The metric is based on general principles without strong empirical support. No documentation is available to show how the methodology was developed or whether it has been peer-reviewed.
Transparent assumptions and methodological parameters	1	The weighting factors assigned to different materials lack evidential support and therefore appear to be based on subjective judgment. Similarly, the target set is not substantiated, and the rationale behind it is not explained.
Free to use	3	The methodology is available as part of the Enfield Draft Local Plan, published in December 2023, and is open access.
Measurable results	3	The metric is fully quantifiable, as it is based on the percentage composition of materials. The output is a purely quantitative value, expressed as a percentage between 0% and 100%.
Outcome simple to comprehend	3	The outcome is expressed as a percentage between 0% and 100%, making it intuitive and easy to understand. The inclusion of a 50% target further clarifies what constitutes desirable performance.

Table F.14 Evaluation of metric with justification RAG scoring – Madaster Circularity Indicator

Criteria	Score	Explanation
Objective input data	2	A distinction must be made between the input data used when applying the methodology via the Madaster platform and when applying it independently. The platform uses BIM data (typically from IFC files), which enables automation but may lack accuracy due to inconsistent modelling practices. In contrast, independent application would rely on a Bill of Materials or quantity schedule, generally offering more reliable material quantities prepared under established standards and guidance. However, while Madaster automates material classification and value assignment—enhancing consistency—manual application requires subjective assumptions, which may reduce result reliability. Despite the standardised calculation principles, some degree of subjectivity is present in both approaches. To calculate the utility factor, the industry-average functional lifespan of the product (in years) must be known. However, standard assumptions are not clearly indicated in the methodology, which presents a risk of inconsistent or subjective input data.
Robust with scientific basis	2	Madaster methodology is grounded in established environmental and circularity frameworks, but it is not the outcome of a single, unified scientific study. Instead, it reflects a combination of best practices, industry standards, and expert input, rather than peer-reviewed research. Many elements of the methodology are based on the Ellen MacArthur Foundation's Material Circularity Indicator (MCI), which has a robust and scientifically validated foundation. However, its adaptation to the built environment—while aligned with best practice—has not been supported by a clearly defined scientific validation specific to the construction sector.
Transparent assumptions and methodological parameters	3	The adjustment factors—namely the penalties applied for unknown materials and for products with unspecified layers or brands—are clearly defined and mathematically justified. They do not appear to be subjectively inflated. The methodology relies on quantitative calculations and does not incorporate weighted values based on subjective judgements, thereby enhancing its transparency and objectivity.
Free to use	2	The methodology is publicly available and accessible online, allowing for its full application without financial commitment. However, the underlying database containing standard assumptions for material circularity properties is only accessible through the Madaster platform and requires a paid subscription. This limits full transparency and reproducibility when applying the methodology independently.
Measurable results	3	The assessment quantifies all the indicators, and the output is fully numerical and measurable. It could be used to develop targets and goals.
Outcome simple to comprehend	3	The outcome is expressed as a percentage between 0% and 100%, making it intuitive and easy to interpret. The overall score is further broken down into individual component scores, which clearly highlight specific areas where the building performs poorly and where targeted improvements can be made.

Table F.15 Evaluation of metric with justification RAG scoring – EU Level(s) Indicator 2.1 Bill of Quantities, Materials and lifespans

Criteria	Score	Explanation
Objective input data	2	The Bill of Quantities used to inform this assessment is a standardised and regulated document. For use life, the methodology applies predefined assumptions based on common standard product lifespans. Materials are categorised into tiers with clearly defined criteria, enhancing consistency and comparability within the assessment process. However, a limitation arises when a product does not align with a predefined category. In such cases, it remains unclear what material or component breakdowns should be assumed—particularly when information is unavailable, as is often the case with complex systems such as façades.
Robust with scientific basis	3	The methodology was developed by the European Commission and is considered a robust and structured framework, grounded in widely accepted standards. It was created by the Joint Research Centre (JRC), which conducts independent, scientific research. The JRC's work is peer-reviewed, published in international scientific journals, and aligned with global standards.
Transparent assumptions and methodological parameters	2	All calculations and inputs in the methodology are mathematically straightforward, with no subjective factors or weightings applied. For standard assumptions—such as the expected service life of materials and elements, and typical waste rates—the methodology references external sources, including RICS (2017) and eTool (2017). However, it does not clearly justify the selection of these sources or explain the rationale behind the specific values used. As a result, while the assumptions appear reasonable and aligned with industry practice, the transparency of their basis could be improved.
Free to use	3	Both the template and the methodology are freely available to download and use.
Measurable results	3	All results are measurable and expressed either as quantities of materials or as percentages. In theory, this enables the methodology to be used for setting clear, quantifiable targets.
Outcome simple to comprehend	2	The methodology outputs total material quantities and percentage breakdowns by category for different building elements. It also normalises material mass and cost per square metre (m^2) of the building, enabling comparative assessment. However, it does not provide benchmarks or thresholds to define what constitutes good or poor performance. This contrasts with current guidance framework, which offers material intensity ranges and indicates whether a result falls below or above standard norms.

Table F.16 Evaluation of metric with justification RAG scoring – EU Level(s) Indicator 2.2 Construction and Demolition Waste and Materials

Criteria	Score	Explanation
Objective input data	2	The assessment is based on the Bill of Quantities, which has been rated as providing a moderate level of objectivity in terms of input data. A positive aspect of the methodology is that it offers standardised options for likely end-of-life waste scenarios. However, several aspects—such as wastage rates—still require some degree of subjective assumption.
Robust with scientific basis	3	The methodology was developed by the European Commission and is considered a robust and structured framework, grounded in widely accepted standards. It was created by the Joint Research Centre (JRC), which conducts independent, scientific research. The JRC's work is peer-reviewed, published in international scientific journals, and aligned with global standards, ensuring the credibility and reliability of the methodology.
Transparent assumptions and methodological parameters	2	Most of the calculations and values used are mathematically straightforward, with no subjective weightings or factors applied. The primary assumption is the decision to normalise the results by the weight and cost of the materials. However, the justification for this decision was not clearly identified within the methodology. As a result, while the assumptions may be reasonable and aligned with industry practice, their scientific basis and transparency could be further strengthened.
Free to use	3	Both the template and the methodology are freely available to download and use.
Measurable results	3	All results are measurable and expressed either as quantities of materials or as percentages. In theory, this enables the methodology to be used for setting clear, quantifiable targets.
Outcome simple to comprehend	3	The methodology's output includes an assessment of construction waste, categorised by the proportion that can be reused or recycled, ultimately indicating the percentage of waste diverted from landfill. This information can be readily used to identify opportunities for improving waste management outcomes. Additionally, comparing the most probable waste scenarios with best-practice scenarios clearly demonstrates the building's performance in terms of waste streams.

Table F.17 Evaluation of metric with justification RAG scoring – EU Level(s) Indicator 2.3 Design for adaptability and renovation

Criteria	Score	Explanation
Objective input data	2	The input data consists of adaptability scores assigned to various aspects of the building, based on clearly defined and measurable boundaries for each building element. A potential limitation arises when assessing bespoke buildings—for example, those without a uniform grid layout—as it may be unclear how to classify certain features. In such cases, results may vary depending on whether the assessor assumes a minimum, maximum, median, or average value for parameters such as column spacing.
Robust with scientific basis	3	The methodology was developed by the European Commission and is considered a robust and structured framework, grounded in widely accepted standards. It was created by the Joint Research Centre (JRC), which conducts independent, scientific research. The JRC's work is peer-reviewed, published in international scientific journals, and aligned with global standards, ensuring the credibility and reliability of the methodology.
Transparent assumptions and methodological parameters	1	The methodology is based on assumptions about which building features enable adaptability, and to what extent, by assigning individual scores. It also applies weightings to different adaptability categories to reflect their relative importance. However, the methodology does not provide a clear rationale for these assumptions or explain the basis on which the scoring and weighting factors have been developed. It is not evident whether they are derived from empirical research, expert consensus, or specific literature sources.
Free to use	3	Both the template and the methodology are freely available to download and use.
Measurable results	3	The methodology assigns measurable values to each of the adaptability metrics and clearly quantifies their meaning. In theory, the resulting score can be used to establish clear performance targets and support design decisions aimed at enhancing adaptability.
Outcome simple to comprehend	2	The score ranges from 0 to 100, which is quite intuitive. It is also divided into separate adaptability metrics, allowing evaluation of which indicators the building is performing well in and which ones require improvement. However, general performance benchmarks are lacking, making it difficult to determine whether the indicated performance is good or poor.

Table F.18 Evaluation of metric with justification RAG scoring – EU Level(s) Indicator 2.4 Design for deconstruction

Criteria	Score	Explanation
Objective input data	2	The input for Level 1 is entirely subjective, as it requires the assessor to review a list of design concepts and qualitatively evaluate whether and how they have been addressed. From Level 2 onwards, a more structured assessment is introduced. However, the assessor is still required to make judgments for each element, and although a decision tree is provided in Figure 4, there are no standardised assumptions for different materials. As a result, overly optimistic scenarios may be selected, depending on who is performing the assessment.
Robust with scientific basis	3	The methodology was developed by the European Commission and is considered a robust and structured framework, grounded in widely accepted standards. It was created by the Joint Research Centre (JRC), which conducts independent, scientific research. The JRC's work is peer-reviewed, published in international scientific journals, and aligned with global standards, ensuring the credibility and reliability of the methodology.
Transparent assumptions and methodological parameters	1	The methodology assigns a circularity factor to different end-of-life scenarios outlined in the Waste Framework Directive. However, the circularity scores themselves have not been clearly explained therefore are considered subjective. The assumptions regarding the type of logic to be applied when selecting the most appropriate end-of-life outcome for each building element are based on literature and have been described within the method. Nonetheless, the application of the methodology remains a subjective decision.
Free to use	3	Both the template and the methodology are freely available to download and use.
Measurable results	3	The outcome is presented as a circularity score by both value and mass. Due to the use of coefficients, the various end-of-life scenarios are all quantified. This outcome could potentially be used to set circularity targets.
Outcome simple to comprehend	2	The outcome is presented in two forms: a circularity score by value and by mass. Both are expressed as percentages ranging from 0 to 100%, which makes the results relatively intuitive to interpret. However, there is currently no clear guidance on what constitutes a 'good' score or what targets should be aimed for. Additionally, it is unclear which of the two metrics—value or mass—should be prioritised, leading to potential ambiguity in decision-making.

Table F.19 Evaluation of metric with justification RAG scoring – OneClick Building Circularity Tool V2

Criteria	Score	Explanation
Objective input data	2	The software incorporates a database of Environmental Product Declarations (EPDs), along with pre-defined assumptions related to circular economy parameters such as recycled content, material wastage rates, and end-of-life scenarios. These features enhance the objectivity and consistency of user inputs. Nevertheless, in early design stages where specific material specifications are unavailable, users are required to select assumed or most likely materials. This introduces a degree of subjectivity.
Robust with scientific basis	2	The tool has been developed primarily to align with current policy and regulatory reporting requirements. As such, it serves more as a compliance mechanism than as a contribution to original methodological research. Its foundation is based on the application of established principles to facilitate policy-driven assessments, rather than the development of a novel scientific framework. Therefore, while it closely follows policy practices, it cannot be regarded as having a robust scientific basis.
Transparent assumptions and methodological parameters	1	No detailed methodology or development process has been disclosed. The calculation methods are not clearly explained, and it is unclear what assumptions have been made during the process.
Free to use	1	OneClick is a commercial software tool that requires a paid subscription. Access to the Circularity tool specifically requires an expert licence, which could pose a significant financial barrier.
Measurable results	3	The tool operates solely based on quantifiable data, producing results as percentages representing different material streams. This allows for a measurable and data-driven assessment of circularity outcomes.
Outcome simple to comprehend	2	The tool presents a breakdown of materials by percentage, based on their source and end-of-life scenario. The graphical output helps to visualise and understand circularity. However, there is no clear performance indicator or guidance on what constitutes a "good" result, which limits its usefulness for benchmarking or decision-making.

Table F.20 Evaluation of metric with justification RAG scoring – eTool Material Circularity Indicator

Criteria	Score	Explanation
Objective input data	2	The software includes a database of Environmental Product Declarations (EPDs), which increases objectivity in terms of assumptions for specific products. Nevertheless, in early design stages where specific material specifications are unavailable, users are required to select assumed or most likely materials. This introduces a degree of subjectivity.
Robust with scientific basis	2	The methodology has been developed based on the Ellen MacArthur Foundation's Material Circularity Indicator and adapted for use in buildings, which provides a robust and well-established foundation. However, the approach relies heavily on best practice principles and general assumptions. It is not clear whether the methodology has undergone peer review, nor is there detailed information on how it has been developed or validated.
Transparent assumptions and methodological parameters	2	The assumptions underpinning the methodology have been clearly stated. The methodology operates on a mathematical basis, with limited use of subjective factors or weighted scoring systems. However, materials are weighted according to their mass, a decision that has not been explicitly justified or supported by evidence.
Free to use	2	The methodology is publicly available and documented. However, access to the accompanying E-tool, which applies various assumptions and facilitates the calculations, requires a financial commitment. This limits full transparency and accessibility.
Measurable results	3	The assessment quantifies all the indicators, and the output is fully numerical and measurable. It could be used to develop targets and goals.
Outcome simple to comprehend	2	The outcome can be communicated and interpreted with some additional effort and explanation. It is presented as a single value between 0 and 1, with defined boundaries. However, in the absence of further studies or benchmarks, it is difficult to determine what constitutes good or poor performance.

Table F.21 Evaluation of metric with justification RAG scoring – Flex 4.0

Criteria	Score	Explanation
Objective input data	2	The scope of the assessment is clearly defined, and the methodology evaluates both individual materials and building layers by assigning assessment values to each. While this approach aims to provide objectivity, certain categories within the assessment may be subject to varying interpretations by different users. For instance, the classification of "large closed surfaces" in façades is assigned a poor assessment value, yet the term "large" is not explicitly defined. This lack of clarity introduces potential subjectivity in how elements are categorised, which may affect the consistency and reliability of the results.
Robust with scientific basis	3	The methodology is based on a research study conducted according to scientific standards and published in a peer-reviewed journal. The development of the criteria is well justified and follows a rigorous process.
Transparent assumptions and methodological parameters	2	The parameters used in the assessment are well justified, stemming from a thorough literature review and consultation with industry experts. However, the methodology quantifies an aspect of the circular economy—flexibility—that is not inherently justifiable. Without further testing and validation, it is not possible to determine whether the underlying assumptions are adequate to achieve the intended outcome of encouraging the construction of more flexible buildings.
Free to use	3	The methodology is open access and free to use.
Measurable results	3	A quantitative value is assigned to each of the assessment indicators, resulting in a numerical outcome that can be used to set clear targets.
Outcome simple to comprehend	3	The assessment provides flexibility classes along with descriptions of their meanings, making it very easy to understand how a building performs.

Table F.22 Evaluation of metric with justification RAG scoring – Circular Construction Evaluation Framework (CCEF)

Criteria	Score	Explanation
Objective input data	2	The building criteria are based on principles that are inherently qualitative. While the methodology provides some explanation and guidance on different levels of performance, its simplicity and generality mean it could be interpreted differently by various assessors. For example, descriptions such as "moderately complex design with variability in parts and sequential construction required" are difficult to interpret.
Robust with scientific basis	2	The methodology is based on a research study conducted according to scientific standards and published in a peer-reviewed journal. However, in comparison to other reviewed studies, some of the methodologies and processes lack robust justification.
Transparent assumptions and methodological parameters	1	The methodology is based on selecting different criteria, but there is a lack of clear connection between how the circular economy indicators have been chosen, how they have been balanced, and how the different scoring brackets have been developed. While there are some references to previous studies and standards, there is little explanation as to why these specific sources were selected. Therefore, the methodology appears to be largely subjective.
Free to use	3	The methodology is open access and free to use.
Measurable results	3	A quantitative value is assigned to each of the assessment indicators, resulting in a numerical outcome that can be used to set clear targets.
Outcome simple to comprehend	2	The methodology results in two percentage outcomes—one based on the average scores of different elements, and one reflecting the building's overall circularity. While the scores are intuitive, they represent criteria that are both inherently quantifiable and non-quantifiable. The methodology does test how increased reuse of materials influences the score; however, it still does not clearly define what a 'good' performance looks like.

Table F.23 Evaluation of metric with justification RAG scoring – Transformation Capacity (TC)

Criteria	Score	Explanation
Objective input data	2	The study aims to quantify the relationships between various building elements that influence a structure's potential for transformation. It involves evaluating different factors and assigning them scores. Notably, the study provides detailed analysis of connection types, which can serve as guidance for objective input data. However, the methodology lacks clearly defined scoping and categorisation of elements, which may limit consistency in its application.
Robust with scientific basis	3	This is a doctoral study conducted at TU Delft, and as such, it has been judged to meet standards of scientific rigour.
Transparent assumptions and methodological parameters	2	The parameters used in the assessment are well justified, stemming from thorough analysis of interdependence of building elements. However, the methodology quantifies an aspect of the circular economy—design for disassembly—that is not inherently justifiable. Without further testing and validation, it is not possible to determine whether the underlying assumptions are adequate to achieve the intended outcome of encouraging the construction of more flexible buildings.
Free to use	3	The methodology is open access and free to use.
Measurable results	3	The assessment quantifies all the indicators, and the output is fully numerical and measurable. It could be used to develop targets and goals.
Outcome simple to comprehend	3	The outcome of the study is numerical and normalised, allowing for comparison across different building elements. While the results can be communicated and interpreted, this may require some additional explanation and contextualisation. Section 6.1.1 of the study outlines categories that classify elements into high, medium, and low disassembly potential, providing a structured framework for interpretation.

Appendix G Metrics not shortlisted

Table G.24 below is an extension of Table 7 in Section 6 above, to provide full justification for the omission of longlisted metrics which were not progressed for further assessment following initial appraisal.

Table G.24 Metrics not shortlisted for further investigation, including justification for omission

Metric	Criterion score	Progressed as recommended metric?	What does it measure?	Brief Explanation
EU Level(s) Indicator 2.1 Bill of Quantities	2.50	No	Quantity of materials in the building	Although based on a robust, peer-reviewed methodology with clear, objective inputs and outputs, this assessment only sets up the bill of materials and does not directly evaluate circularity metrics. Similar functions are covered more comprehensively in current policies, and industry practice favours RICS element classification over this approach. This overlap and limited scope have prevented further progression.
VBCI	2.50	No	Resource efficiency, diversion of waste from landfill, design for disassembly, design for longevity	The methodology is scientifically grounded, well-structured, and openly accessible. However, since the Whole Building Circularity Indicator (WBCI) is based on the VBCI and addresses its previously identified limitations, a separate review of the VBCI was deemed unnecessary. A detailed assessment confirmed that reviewing the VBCI independently would not provide any additional insights beyond those already covered in the WBCI evaluation.
EU Level(s) Indicator 2.3 Design for adaptability use	2.33	No	Design for adaptability	The methodology is robust but hasn't progressed due to challenges with bespoke buildings, where classification can be unclear, and scores vary. Its scoring and weighting lack clear justification or empirical support, reducing confidence. Also, without performance benchmarks, it's hard to interpret the scores, limiting its practical use.

Metric	Criterion score	Progressed as recommended metric?	What does it measure?	Brief Explanation
EU Level(s) Indicator **2.4 Design for deconstruction**	2.33	No	Resource circularity at the end of life of the building	The methodology is well-structured but remains subjective, especially at Level 1 where assessments rely on personal judgment. Circularity scores lack clear explanation and standardisation, causing variability depending on the assessor. While results are intuitive, the absence of clear targets or guidance on prioritising value versus mass limits practical use and consistency.
eTool Material Circularity Indicator	2.17	No	Resource efficiency, diversion of waste from landfill	The methodology is based on a robust foundation but relies on general assumptions and lacks clear peer review or validation details. Material quantities use standard values, but guidance is missing for unspecified materials, causing inconsistent results. Weighting by mass is not fully justified, and access to the calculation tool requires payment, limiting transparency. While outputs are measurable and targetable, the lack of benchmarks makes performance interpretation difficult.
London Borough of Enfield's Circular Index	2.17	No	Resource efficiency, diversion of waste from landfill	The assessment uses generally objective material quantity data but lacks clear guidance on assumptions like recycled content and demolition waste. The methodology is not peer-reviewed, and its weighting factors and targets are unsupported and subjective. Though open access and fully quantifiable with intuitive percentage outputs, the rationale behind key elements remains unclear.
CCEF	2.17	No	Resource efficiency, design for disassembly, design for longevity	The methodology relies on qualitative criteria that can be interpreted inconsistently by assessors. Although based on peer-reviewed research, it lacks clear justification for indicator selection, weighting, and scoring, making it largely subjective. The method produces numerical scores useful for setting targets, but without clear benchmarks, it is hard to define what good performance is.

Metric	Criterion score	Progressed as recommended metric?	What does it measure?	Brief Explanation
OneClick LCA Circularity Tool	1.83	No	Resource efficiency, waste generation and diversion from landfill, design for adaptability, design for disassembly	The software uses a database with preset assumptions and standard material quantities but lacks guidance for unspecified materials and depends on user-entered costs, causing variability. Designed mainly for policy compliance, it is not based on original research and lacks transparency in methodology. The commercial tool requires a costly subscription. While outputs are quantifiable and visualised, no clear benchmarks or performance guidance limit its practical use.

Appendix H Equalities Impact Assessment

A review of the potential impacts of the findings and recommendations of the study on key protected characteristic groups.

<table>
<tr><th>Protected Characteristics</th><th>Impacts Identified</th><th>Mitigations / Justifications Considered</th></tr>
<tr><td>Age</td><td rowspan="11" colspan="2">This study is not anticipated to have a direct impact on any of the groups identified under equality considerations. Its focus is on developing a methodology to effectively measure the circular economy, rather than implementing circular economy practices that could affect members of the public or specific communities. Whilst availability of the methodology without payment has been considered, any future application of the methodology would be subject to separate impact assessments where equality considerations would be appropriately addressed.</td></tr>
<tr><td>Gender</td></tr>
<tr><td>Race</td></tr>
<tr><td>Disability</td></tr>
<tr><td>Religion and Belief (including non-belief)</td></tr>
<tr><td>Sexual Orientation</td></tr>
<tr><td>Gender Reassignment</td></tr>
<tr><td>Pregnancy and Maternity</td></tr>
<tr><td>Marriage and Civil Partnership</td></tr>
<tr><td>Does the evidence address socio-economic disadvantage (including those with lower income or carers, ex-offenders and armed forces veterans)?</td></tr>
<tr><td>Does the evidence address structural inequality?</td></tr>
</table>

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