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Level(s) test phase analysis: Identification of horizontal themes and technical updates

Draft publication

Draft consultation version

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1. Background

The aim of this report is to provide a summary of the key findings from the JRC's analysis of the Level(s) test phase. It has been drafted with the intention to provide a starting point for engaging with stakeholders on how to revise Level(s), starting with a stakeholder event in Brussels on the 20th February 2020 and a written consultation period that will run until the 20th March 2020.

The feedback from both the conference and the consultation will inform work by the JRC to develop a first publication version of Level(s) by summer 2020. In doing so, the JRC will draw upon the input of test phase stakeholders, as well as technical experts who have been involved in the development of Level(s).

The findings presented in this report are based on the analysis of approximately 80 test results and survey responses, together with detailed interviews (verifications) carried out with 10 test projects. The paper is organised in two parts:

- Identification of the **headline themes and associated horizontal issues** to have emerged from the test, each with a tentative first discussion of the way forward and initial proposals for discussion (in section 2), and
- Identification of **the main technical issues relating to each of the indicators and life cycle tools,** which call for updates of the background methodological guidance (in section 3).

The detailed background analysis of the test phase survey, verification interviews and results are, for the purpose of transparency, published as separate Annexes of this synthesis report.

2. Horizontal themes identified from the test phase

Three horizontal themes have been identified that relate to the overall design and way in which Level(s) is intended to be used. Each theme brings together and attempts to find a resolution for a number of recurring issues that have arisen from the test. These issues have been identified from the EU survey and verification interviews, as well as having also been cross-checked with the co-ordinated tests carried out in a number of countries – namely Denmark, Finland and France.

The three horizontal themes are as follows, under each of which a number of more specific issues that require a detailed response have been grouped:

Theme 1: <u>How Level(s) is designed and can be used</u>

- Ensure that 'level 1' works as a true entry level
- Reframe and clarify the use and purpose of different 'levels'
- Redefining the levels to track the typical project stages

Theme 2: <u>The underlying instructions and guidance provided to users</u>

- Ensure that the guidance is simpler and more instructive
- Ensure there is a clear framework for national use
- Making reporting more user friendly

Theme 3: <u>Supporting users to improve their knowledge and capacity</u>

- Promoting life cycle thinking
- Providing options to benchmark and evaluate sustainability
- Preparing Level(s) for digitalisation

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For each theme, a summary is provided of the feedback from testers followed by a preliminary discussion on the possible way forward, together with initial, outline proposals.

Theme 1: How Level(s) is designed and can be used

T1.1 Ensure that 'level 1' works as an entry level

Issues raised by testers:

A common theme to emerge is that testers found level 1 to be more detailed and to require more time and expertise to obtain a result than they expected. This appears to be due to a combination of factors:

- the lack of a clear set of step by step instructions on how to use the indicator and how to report
- the clarity of terms and definitions – the common language of sustainability that Level(s) aims to impart - which appears to have led, in part, to frustration and/or incomplete sets of results being submitted
- problems with the excel reporting tool, which was seen as being very rigid and not allowing for the flexibility of interpretation offered by level 1
- the complexity of the guidance, with the simple descriptions in the Part 2 document appearing to have been overlooked in favour of the larger, and more off-putting Part 3 document

The need has also been identified for a 'level' which can be used at the concept stage of a project and which can be used to define the sustainability goals for a project. It has been emphasised that, as an aid, the macro-objectives are powerful communication tool. They provide a way of understanding and learning about the strategic need for action, grounded in the EU and international policy context, and how this translates into the indicators and life cycle tools. Moreover, it is important to keep a focus on the framework as a common language and basis for action based on agreed priorities.

From the perspective of national test co-ordinators, it is important that Level 1 is accessible and works as an educational tool for all countries in EU, especially those where the use of LCA and sustainability assessments are less prevalent, so that each market can mature and progress through the 'levels'.

In respect of the sustainability goals of a project, the importance of providing a complete picture of the comfort aspects under Macro-objective 4 has also been emphasised by some testers and also at national test level. It is important therefore that, as a minimum, lighting and acoustics are included within the revised version of Level(s). Otherwise there is a risk that designers consider Level(s) to only provide a partial picture of building performance.

Preliminary discussion on the way forward:

There appears to be a general need for an entry point into levels that starts by facilitating a general understanding of the macro-objectives and, linked to these, the performance aspects that each indicator and tool addresses. This could be presented as 'level 1', or if there must always be a quantitative unit – as would be the case if Level(s) were to be adopted as a regulatory instrument - as a conceptual 'level 0'. It is important in all cases that Level(s) retains a performance based element.

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From a practical point of view, analysis of the result excel sheets suggests that the focus should firstly be on understanding the indicator itself and the unit of measurement. This entry level would then prompt users to report on whether they have addressed the performance aspect in their project and – potentially aided by checklists of key issues or design aspects to take into account – the extent to which they been taken into account. This would be rather like the checklists of aspects currently provided for level 3, and also for the 'potential future aspects', but simplified.

It should then be possible for a user to relate their use of the indicator to the relevant point in the project life cycle in which they are situated. More complex options for the disaggregation of the headline indicator results – for example, into different energy needs (indicator 1.1) or construction waste streams (indicator 2.3) – should only be revealed to more confident, advanced users as these have proved to be a significant source of confusion for less experienced users.

Overall, users said that they would benefit from being taken step-by-step through the process of using an indicator or life cycle tool. There were also many requests for examples as applied to real projects, with projects from the test phase potentially being a source.

Proposals for discussion

- Rethink the presentation of level 1 so that it is much more basic, focussed only on concepts such as the unit of measurement. The material currently provided in Part 2 could form the starting point.
- It is to be discussed whether as part of this rethink there is the need for a preceding more conceptual and qualitative 'level 0'.
- For each indicator and life cycle tool, develop a level 1 package including:
  - A basic description of what they each address and why
  - A quantitative dimension: the unit of measurement and the recommended calculation method (where appropriate)
  - A qualitative dimension: a checklist of critical aspects of performance to take into account (e.g. energy and water needs to address, LCA hot spots commonly identified in literature)
  - A simple stepwise introduction to using them with, if possible, examples of their application to building projects.
- For those indicators where the complexity is inherently higher, such as 2.4 LCA, clearer guidance on how:
  1. they can start by using proxy tools such as the life cycle scenarios, and
  2. Then move on, supported by guidance on how to select software tools that can help managing the complexity.
- Further development of the 'potential future aspects' of '*lighting and visual comfort*', '*acoustics and protection against noise'*, '*Increased risk of extreme weather events'* and '*Increased risk of flood events'* in order to provide, as a minimum in the frame of this revision, level 1 descriptions and checklists.

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T1.2 Reframe and clarify the use and purpose of the 'levels'

Issues raised by testers:

There were many comments in the survey about the lack of clarity on the purpose of the three levels. It was unclear whether they represent a progression in terms of expertise. In some cases, level 1 was felt to be more complex than level 2.

The original concept of comparability in the beta version (that by reporting the method used to generate a result this would establish an initial basis for comparability), does not appear to have been clear to all testers. The opportunity to choose the level at which they could work was, however, seen as being positive overall, but the concept needs further development.

Despite the issues raised, there is still support amongst national and public sector test co-ordinators to retain the logic of the three levels – in their words in order to 'assess, compare, improve'. These levels enable the framework to be adaptable to market maturity and should be retained in some form even if, for example, a project stage approach is contemplated (see T1.3).

Preliminary discussion on the way forward:

The current concept of the three levels does not appear to provide a clear narrative for a progression, as suggested by the staircase graphic in the guidance documents. Amongst the various suggestions made by different testers were that the levels should represent, separately or in combination:

- A progression in terms of project stages,
- An increment in the precision or scope of data being handled,
- A means of establishing minimum and advanced uses.

What appears to be important to potential users is that they can clearly relate the level at which it would be appropriate to work to the nature of their project and the resources they have available. As was discussed under theme 1, the issue of how level 1 works is critical to this.

The issue of comparability can be considered as a more general aspect of the underlying methods for each indicator, and could potentially be better addressed at different project stages rather than forming the basis for a specific 'level'. Moreover, national test co-ordinator considered that it should be Member States role to adapt the level 2 assumptions and rules to the national context so that it can then be used for benchmarking purposes. This approach would link well to points raised about criteria for equivalence and processes for adapting Level(s) to national standards and requirements (see T2.2).

Proposals for discussion

- Reframe the presentation of the levels so that they are aligned with a simplified schematic of the typical project stages (see T1.3 for more detail on how this could work).
- Provide rules and guidance at appropriate project stages for ensuring comparability (as per the original level 2) and reliability, as well as for optimising performance (as per the original level 3).
- Offer these as options together with clear explanations of the potential benefit of using them.

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T1.3 Redefining the levels to track the typical project stages

Issues raised by testers:

The combination of the choice of level with the different project stages does appear to have created confusion, particularly where the terms and definitions used were not clear to testers, but also in the case of indicators such as 4.1 where the progression is linked to the project stage.

The possibility to use Level(s) at different or even multiple project stages is valued, but testers need greater clarity on how it can be used at different stages. A focus on project stages also appears to have a more practical appeal than the three levels, being more closely related to the activities of different building professionals.

A further project related aspect emphasised by a number of testers is how refurbishments (also referred to as major renovations) and occupied buildings can use Level(s). The Beta version appears to be mainly directed at new buildings and there is limited guidance on how to apply it to the refurbishment of existing buildings. A stronger use phase perspective is therefore required, particularly from the point of view of modelling LCA stage B and the modules that this stage is made up of, as well as related life cycle costs.

Preliminary discussion on the way forward:

Based on the discussion under T1.2, project stages seem like a more natural basis for a progression in terms of levels of ambition and complexity. So, for example, the move from concept to detailed design requires bringing in more expertise and modelling capabilities. The subsequent post-completion testing of a building and then post-occupancy monitoring of performance, although important, are still not commonplace. As a result, there is the potential for levels to be reframed in a way that it is aligned with a generic sequence of project stages, indicatively as follows:

- Level 1: Concept (project definition)
- Level 2: Design (concept and detailed)
- Level 3: Optimisation (technical and as-built designs)
- Level 4: Implementation (construction and commissioning)
- Level 5: Monitoring (handover, post-completion and post-occupancy)

These stages are likely to be readily understood by clients and design teams and can be used to create different entry point into the use of levels.

It would also have to be considered to what extent all levels should be followed and/or in the sequential order. The distinction between some of the levels will, to some extent, be project specific. There would be a need for the Level(s) user to start with a project definition and to record a Level(s) plan from the inception.

Proposals for discussion

- Reframe the presentation of the levels so that they are aligned with a simplified schematic of the typical project stages.
- Encourage project teams to put together a Level(s) plan at the inception, identifying the project stages that they will aim to follow and report on.
- In this way, the further a user progresses with and can track use of an indicator towards implementation and monitoring of the real performance of the project, the further the level increases with each project stage.

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Theme 2: The underlying instructions and guidance provided to users

T2.1 Ensure that the guidance is simpler and more instructive

Issues raised by testers:

There was consistent feedback that the guidance was too technical and complex for the purpose. Reference was made to the structure and content of the Part 3 guidance, which was found to be difficult to navigate through in order to find the relevant information for any one indicator. Moreover, it was considered to need:

- A simpler, more stepwise approach,
- The use of more accessible and less technical language,
- Greater clarity on what is/is not up to the user to decide,
- A clearer distinction between requirements and background guidance/advice, which should include examples,
- Improve the links between the minimum requirements and the tools (either external or as provided by the JRC) that can be used to make calculations,
- Extracts from methodologies and standards referred to, so that additional time and resources are not needed.

Preliminary discussion on the way forward:

The guidance clearly needs to be improved in order to be more accessible and user friendly. This may in part relate to the format of the guidance documents and, as remarked by some testers, to the need for a way of presenting the material that is more visually appealing. A recommendation has been made to use communication specialists in the design of supporting material. It is also clear that it needs a more logical structure that is easier to navigate in order to find relevant information.

In respect of technical language in the guidance documents its use is, to some extent, unavoidable. Material dealing with introductory concepts could potentially be simplified, but at some point standardised technical terms are required to be used as they form a fundamental part of the common language of Level(s). Professional development almost always entails the learning of a new technical vocabulary. A balance therefore needs to be struck between more accessible introductory material and more advanced material that requires a degree of professional development.

Proposals for discussion

- Rethink the structure of the guidance so that it is much more instructive, with an initial focus on the minimum requirements for each indicator and life cycle tool.
- Decide whether the concept of a minimum scope and a more ambitious scope of indicators and life cycle tools, as was introduced during the test, should be retained.
- Make a general review of the language used throughout the guidance documents and its accessibility, making a distinction between introductory material and more advanced material that assumes a level of professional development.
- *See also T1.1 and T1.2 relating to Level 1 and clarifying how the levels work*

Draft for discussion

T2.2 Ensure there is a clear framework for national adaptation and adoption of Level(s)

Issues raised by testers:

A consistent message from testers was that Level(s) needs to be better adapted to local standards, regulations, practices and guidance. Moreover, it was commented that often EN or ISO standards have been adopted or interpreted by local standards and methods, and sometimes in different ways. As a result, the read across between them is not always clear.

A common question was whether a specific national methodology or standard could be used.There was an expectation that there would be some way of checking for compatibility between what Level(s) requires or expects and the local interpretation. Principles of equivalence should be applied. In other cases, local conventions such as, for example, the structuring of building element information in BIM was referred to, as well as underlying modelling assumptions such as a building's reference service life.

At a national level, some test co-ordinators have emphasised that Level(s) should also work as a bridge between top-down climate and resource policies (e.g. EU´s carbon neutrality 2050) and bottom-up requirements (e.g. the energy efficiency of buildings). It is important therefore that the results from Level(s) assessment are comparable to or contribute to national goals, to the extent that they are allocated to construction sector.

Preliminary discussion on the way forward:

There does appear to be a strong need to go further in supporting the national use of Level(s). This should be in such a way that users find it easy to understand which standards, guidance and conventions they should follow, but also in order to avoid the need for additional time and costs to be incurred in rerunning analyses or ordering new assessments in order to report according to Level(s).

This could imply a new role for national authorities in the implementation of Level(s), who would need to adapt the general frame of Level(s) to local conditions. The Commission should also examine the extent to which Level(s) could/should be further modified to provide the necessary instructions to national authorities.

It does not seem practical or feasible at this stage to contemplate a version of Level(s) that would contain (and maintain) a comprehensive read across of each indicator in each national context. Moreover EN and ISO standards often form the common reference point for national standards, meaning their adoption by national standards bodies is expected. In some cases, such as for indicator 3.1, the indicator has no current standardised basis, so any instructions would need to be standalone.

Proposals for discussion

- Ensure that the guidance is clear on when the results from national calculation methods or standards can be used.
- The Commission to establish some simplified guidance or principles for determining equivalence.
- Development of a checklist for each indicator and life cycle tool to be completed by national authorities identifying the equivalent basis for performance assessment in each Member State.

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T2.3 Develop a user friendly reporting tool

Issues raised by testers:

In general, the reporting tool was not considered to be user friendly and was a source of frustration for testers. There were several 'bugs' identified in the worksheets and macros that require fixing. Moreover, it does not appear to have been flexible enough from a user perspective, given the number of indicators and the complexity of the reporting options available.

The only standalone calculator tool that was provided to testers was the water calculator in support of indicator 3.1. This proved popular and some testers expressed frustration that the general reporting tool did not make calculations for other indicators. Similar tools were also requested for the other indicators and life cycle tools.

A further issue relates to the comprehensiveness of the reporting that is possible with the tool. In some cases, such as for indicator 2.3, this caused significant confusion in the correct reporting of results, in part compounded by the terminology used.

Linking to the discussion under T3.2 on the evaluation of the sustainability of a building project, there is a need for a more visual dashboard presentation of the results as a whole. This would provide an overall view on the different performance aspects of the building.

Preliminary discussion on the way forward:

The tool has, to some extent, defined the testers' experience with Level(s), rather than the method and guidance in itself. If a reporting tool is still to be provided to users, significant improvement is needed in order for it to meet testers' expectations of a modern online reporting platform. This may include considering more advanced web-based interfaces.

The reporting options made available to testers need to be tailored to their needs and the level/project stage at which they are working, with unnecessary and potentially confusing reporting fields kept hidden. More could be done to recommend and/or provide screening criteria for calculator tools that could be used for each indicator. Whilst the Commission cannot endorse commercial tools, it can lay down minimum criteria for tools that can be used (see also theme 7).

Under the proposal to align the 'levels' with project stages (see T1.3), the possibility to encourage users to complete a 'levels plan' at the outset of a project was discussed and proposed. From a reporting perspective, this could form the basis for a stage by stage reporting on performance across the whole 'dashboard' of indicators and tools, which would in turn also highlighting the comprehensiveness of reporting chosen for the project.

Proposals for discussion

- The question of whether a user reporting tool still needs to be provided, as well as the resourcing that would be needed to develop something suitable, is to be discussed further within the Commission and with stakeholders.
- The main role of such a reporting tool should be to collect, present and communicate assessment results, it is not a calculation tool. It should have text fields reporting the methods, tools and assumptions used to obtain the results.
- The potential to lay down criteria for the software tools that can be used to

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make calculations and obtain results should be explored for some indicators, particularly more complex ones such as 1.2 and 2.4
- Ensure that there is always a 'dashboard' reporting of the overall performance of a building for all of the indicators and tools, rather than separate sheets. This can help highlight gaps in the comprehensiveness of a performance assessment.

Theme 3: Supporting users to improve their knowledge and capacity

T3.1 Promoting life cycle thinking

Issues raised by testers:

In general, the overall concept of encouraging life cycle thinking have been welcomed by testers, with significant interest in indicators such as 2.1 and 1.2. More can however be done to help users get started, to make the guidance clearer and more consistent, and to help make calculations.

The life cycle tool 2.1 (Bill of Materials) appeared to have been a cause of some frustration for testers. Moreover, they identified that the link between 2.1 and the preparation of building data for calculations under indicator 1.2 requires more attention. Whilst there was interest in the life cycle scenario tools 2.2, they were in most cases tested late in the development of projects, reducing their potential value in informing design decisions.

Preliminary discussion on the way forward:

The concept of life cycle thinking and the linked indicators and life cycle tools that are intended to support the concept, require better communication. This could in part be achieved by ensuring the 'dashboard' approach to communicate on the overall performance of a building outlined in T2.3 and also project tracking (T1.3).

The ability to make calculations for indicators 1.2 and 2.4 relies on the use of calculator tools and data, hence the selection of tools and appropriate sources of data should be further supported. The potential to establish minimum criteria for selecting appropriate tools is proposed as the main means of doing this. Given the need for underlying compatibility with the EN 15804 and 15978, more focus could be put on hints and tips for how to start using software tools.

Proposals for discussion

- Encourage life cycle thinking at as early a stage as possible in the project process, particularly in seeking to encourage use of the life cycle tools 2.1 and 2.2.
- Establish minimum criterion for the functionality of LCA software tools that could be purchased or obtained by users of Level(s), as well as the quality of the databases that are available. These criteria would need to be supported by a dynamic directory of tools and databases.
- Ensure that the guidance material is accessible enough to users who are new to LCA. For these users background methodological issues are less important than being able to get started with the preparation and use of their building information for modelling.

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T3.2 Providing options to benchmark and evaluate sustainability

Issues raised by testers:

Although Level(s) is not intended to be a benchmarking tool at EU level, the test revealed that building professionals have an expectation of being able to set targets and objectives for their project based on some kind of benchmarks or reference values. Some testers also commented that it would have been useful to see how other projects perform.

A common complaint was that it did not tell testers about the relative sustainability of their building. This can be seen, for example, in the preference for level 2 when using the life cycle scenarios for adaptability and deconstruction, which specifies the option to use a semi-quantitative tool that generates a score, rather than simply referring to a check list. Facilitating the benchmarking of performance should, based on the feedback, be seen as an integral part of achieving widespread uptake of such a common indicator framework.

Some national test co-ordinators thought that Level(s) should evolve in order to be a decision-making tool in addition to an assessment tool. For instance, identifying 'hot spots' in LCA and trying to minimise the related impacts is an important process.

Preliminary discussion on the way forward:

Establishing benchmarks for each indicator is not yet considered feasible at EU level. Instead, some testers suggested that it could be possible to benchmark performance based on available reference points in a Member State. Options could include:

- As a % improvement between design options for the same building (internal)
- As a distance to a target (external)
- With respect to a bottom-line or baseline reference (external)

In this respect the development of a new ISO standard 21678 on 'Principles for the development and use of benchmarks' may be relevant.

To take an example of how this could work, for indicator 1.1 it could be relatively easy to determine a minimum (baseline) performance requirement for a new building. This is because in each Member State there exist 'Nearly Zero Energy Building' (NZEB) performance thresholds. Design simulations can then provide the basis for internal benchmarking of design options or in comparison with examples of best practice from front-runners. Developing this idea further, users of Level(s) could therefore be encouraged to make a simple benchmarking of their building's performance against the '*market minimum'* (baseline) and the '*leading practice*'.

Proposals for discussion

- The JRC could provide general benchmarking suggestions for each indicator, but not for every Member State.
- One possibility is to provide a generic benchmarking scale or reference point as a general orientation. This provide a generic way in which EU, national, local or even portfolio or project-specific data could be calibrated – for example, market minimum level of performance > market average practice > front runner best practice.
- Member States should play a lead role in determining benchmarks for performance, linked to the national use/adaptation of Level(s).

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T3.3 Preparing Level(s) for digitalisation

Issues raised by testers:

A number of testers, national test co-ordinators and stakeholders have emphasised the increasing importance of the digitalisation of design and construction data. The increasing use of BIM as a tool to manage and integrate building data can be advantageous to Level(s).

It should therefore support the new ways of working and sharing information. There is the possibility, for example, to prepare Level(s) reporting templates to directly accept outputs from commonly used design softwares such as ArchiCAD and Revit, as well as associated new plugins. The interchange of data from other sources, such as Environmental Product Declarations (EPDs), is also becoming increasingly important.

Preliminary discussion on the way forward:

This is an aspect that requires further input from stakeholders. This is because, at present, there is not the intention on the part of the Commission to develop any form of calculation tool which would require cross-platform data handling.

Proposals for discussion

- The JRC would welcome further input from stakeholders *on how Level(s) could be prepared for the digitalisation of design and construction data* as per the various requests arising from the test community.

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3. Technical issues identified for each indicator and life cycle tool

In this section, the JRC has compiled the main technical issues it has identified to date in relation to the underlying technical specifications of the indicators and life cycle tools.

For each indicator and life cycle tool the main technical issues are first identified and discussed. These issues have been grouped under the following broad headings that correspond to how the original part 2 and 3 guidance was organised:

- Terms and definitions
- Unit(s) of measurement
- Boundary and scope
- Calculation method and reference standards
- Supporting tools and data requirements
- The reporting format
- How the three levels work

A further reference is made, where relevant, to any background *technical and methodological advancements and/or regulatory changes* at EU level that have been made that should also be taken into account in a revised technical specification of the indicator.

There then follows for each indicator a tabular summary of the specific technical updates that are proposed to be made as a result of the test analysis. These updates represent the initial view by the JRC on the work that would need to be carried out in Spring 2020 to update the Beta version of Level(s).

3.1 The indicators and life cycle tools tested

The testers were asked in the EU Survey to confirm which indicators and life cycle tools they had tested. The overall results show that the most popular were those communicated to testers as the '*minimum requirements'* for carrying out a test (1.1, 2.3, 3.1, 4.1 and 4.2) together with those communicated as an extension of these minimum requirements (1.2 and 2.1). The number of testers ranged from 47 (2.1) to 80 (1.1).

The possibilities for optional additional reporting (2.2, 2.4, 5.1, 6.1 and 6.2) were subject to much less testing, with the number of testers ranging from 6 (5.1) to 31 (2.4).

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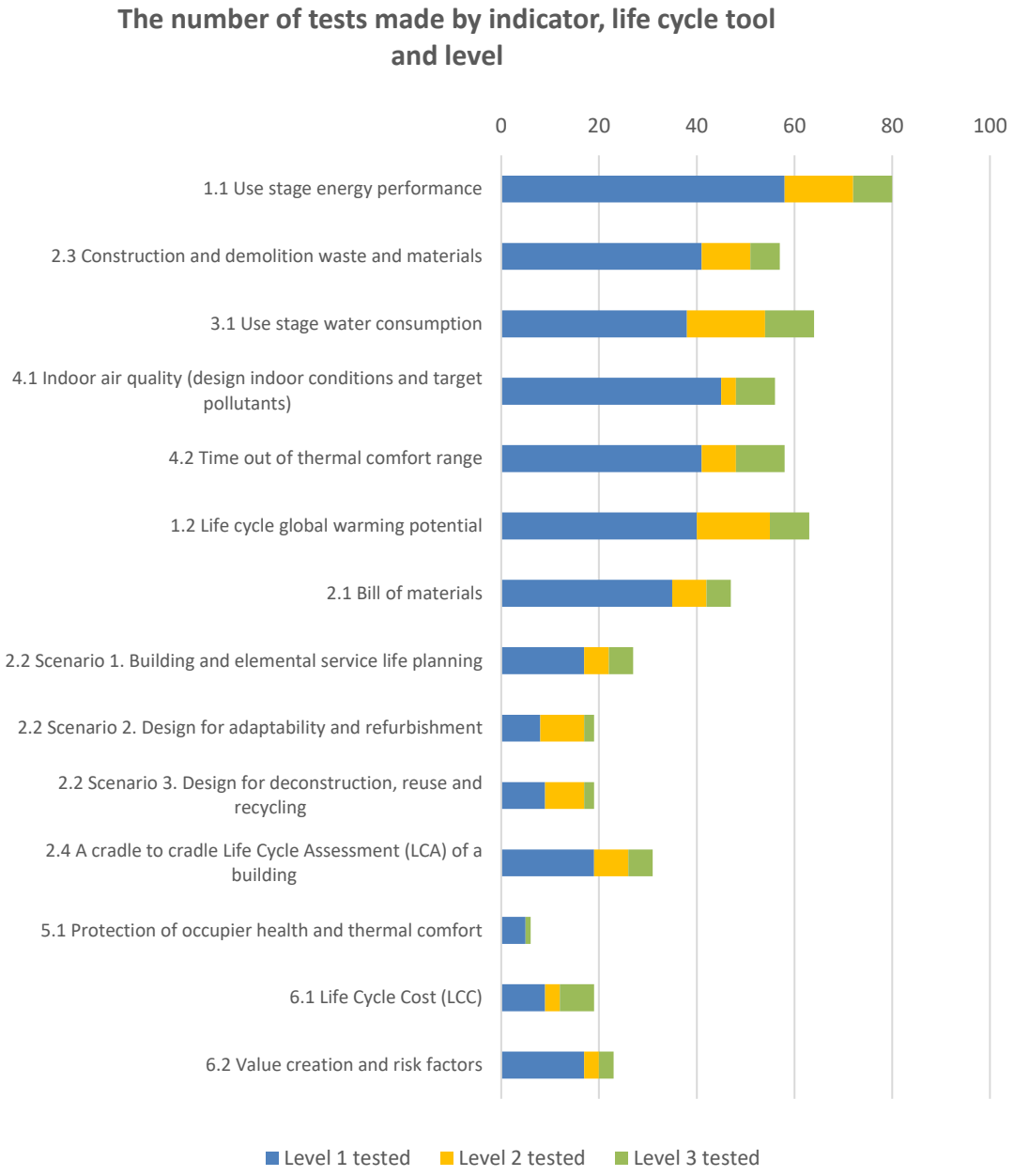
The number of tests made by indicator, life cycle tool and level
0
20
40
60
80
100
1.1 Use stage energy performance
2.3 Construction and demolition waste and materials
3.1 Use stage water consumption
4.1 Indoor air quality (design indoor conditions and target pollutants)
4.2 Time out of thermal comfort range
1.2 Life cycle global warming potential
2.1 Bill of materials
2.2 Scenario 1. Building and elemental service life planning
2.2 Scenario 2. Design for adaptability and refurbishment
2.2 Scenario 3. Design for deconstruction, reuse and recycling
2.4 A cradle to cradle Life Cycle Assessment (LCA) of a building
5.1 Protection of occupier health and thermal comfort
6.1 Life Cycle Cost (LCC)
6.2 Value creation and risk factors
Level 1 tested
Level 2 tested
Level 3 tested

3.2 Analysis of the issues identified for each indicator and life cycle tool

Indicator 1.1: Use phase energy consumption

A large number of testers worked with this indicator (79) and the majority succeeded in obtaining a plausible result for this indicator. Despite the familiarity of the unit of measurement to testers, there is still the need to make it easier and more logical to use. The main difficulties faced by testers related to:

- the sub-indicator 1.1.2,
- the net primary energy balance,
- disaggregation of energy needs and
- calculation methods that are accepted for use.

Terms and definitions

The definition of the heated floor area to be used raised a number of comments. Clarity was requested as to whether this should be the same area measurement as *useful internal floor area* of the property.

The reference standards for a *useful internal floor area* measurement using Level(s) are the IPMS office and residential measurement standards. In terms of the EPBD the IPMS standards are broadly equivalent to the reference area defined in EN 15603 and prEN ISO 52000-1, which is a measurement of the net internal area inclusive of shared circulation areas that are within the thermal envelope.

Unit(s) of measurement

The combination of the two sub-indicators with the potential to report on the different energy needs that they are composed made this indicator more complex to report on than it should have been and posed a number of difficulties for testers.

The sub-indicator of delivered energy was not consistently reported on for calculated results, if at all. Some testers were also unclear where it could be derived from – suggesting a lack of clarity on its definition as it is primary data from an energy simulation of a building's energy demand.

Whilst primary energy appeared to be a more familiar unit of measurement for testers, the different rows of the balance equation for renewable and non-renewable primary energy, as well as a lack of clarity on how to disaggregate or assign the totals for each row to different energy needs, resulted in reporting problems.

Boundary and scope

The boundary and scope did not appear to be a source of problems. The extension of the scope to include unregulated or 'non-EPBD' energy needs was clearly reported on each most cases.

Calculation method and reference standards

The calculation method was, based on the survey response, an issue of concern as well as the method for interpreting and using monitored (measured) data. There also appeared to be an assumption that a dynamic simulation should be carried out, which is not the case, so the options available to users therefore require clarification.

In relation to national calculation methods, Level(s) needs to be clearer in stating which methods can be used and which are compatible with the reference EN standards. The guidance does currently indicate that any national method developed

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according to the EN standard could be used, but such information about the method may not be apparent to users.

In relation to measured (monitored) data, users would appreciate further guidance on its collection and handling. Aspects of the EN standard which address monitored data could be brought together with some general guidance on the specification of monitoring. Guidance note 2 on *'The role of metering in Building Performance Evaluation'* from the part 2 documentation should be moved under this indicator, as well as 3.1.

Supporting tools and data requirements

In line with the feedback on calculation methods, the potential to use national calculation methods which have their own compliance tools should be clearly communicated. Their ready availability suggests the need to be flexible in what can be used to make the calculation, but with a background aim to raise awareness about the potential shortcomings of simplified methods.

The reporting format

The difficulties experienced reporting on the primary energy balance calculation and the disaggregation of the energy needs suggests that there should first be a simple reporting of the unit of measurement. Disaggregation should then be explained to users and the option provided to separately report on this.

How the three levels work

The overall feedback suggests that although in most cases the background data required to report at level 1 was readily already available, greater clarity is needed on the reporting process itself and the use of this data. Where levels 2 and 3 were used they were generally well understood and reported on, reflecting their use by advanced users.

Technical, methodological and/or regulatory advancements to take into account

No broader technical advancements or regulatory changes have been identified at this stage that should be taken into account at this stage.

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Table 3.1. Key technical issues and proposed updates for Indicator 1.1: Use phase energy consumption

Key technical issues to address	**Main proposed technical updates and solutions**
1.1.1 **Treated floor area** definition used for the energy simulation	- Short guidance on floor area measurement and normalisation to be added to 1.1 guidance and for each indicator.
1.1.2 Clarity on the difference between the **two sub-indicators**	- Improve the definitions and instructions for the two sub-indicators and where they can usually be found in amongst the information needed to comply with national/regional minimum requirements, or to put together EPCs - Start with only a simple reporting of the headline unit of measurement for each sub-indicator
1.1.3 How to derive and report on the **disaggregation of energy needs**	- 'Hide' the disaggregated energy uses, only revealing them to advanced users - Better instructions are needed on the balance equation for total and net primary energy, including the renewable energy contribution
1.1.4 Use of and acceptance of national and other **calculation methods**	- More implicit instructions on which calculation method that can be used - Greater clarity on the information that should be reported on the calculation method used and it's characteristics. Some simplified ways of identifying these characteristics could be considered e.g. time steps
1.1.5 Quality of and interpretation of **monitored energy consumption data**	- Reproduce the requirements for handling measured data from the reference EN standard - Provide some basic guidance on specifying monitoring and interpreting the metered data obtained.

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Indicator 1.2: Life Cycle Global Warming Potential

Although 56 testers worked with this indicator, only a limited number of them succeeded in adhering to the Level(s) guidance and reporting plausible results (xx%).

The main difficulties faced were in the following areas:

- the access to tools and data,
- the correct application/referencing to the Level(s) guidance document,
- the reporting of results and supplementary information.

Terms and definitions

Testers in general appeared to have a good understanding of terms and definition used. Nevertheless, there may be the need to further clarify the building floor area to be considered for the assessment and ensure it is harmonised between the indicators.

Unit(s) of measurement

Analysing the delivered results, it is possible that many testers were misled by the discrepancy between Level(s) guidance document (the official reference), according to which results had to be reported as kg $CO_{2,eq}$ per m^2 per year, and the reporting tool (provided to support the reporting of results), where kg $CO_{2,eq}$ was mentioned only.

Boundary and scope

Some testers required a better description of the rules to use for defining the scope of the analysis. It should be clarified which life cycle stages and sub-stages to cover in the analysis, and how to differentiate between embodied and operational emissions. In particular, it should be ensured that the scope covers emissions both Module A and Module B.

Benchmarks were also referred to by testers as an important element to introduce into Level(s) for enabling a comparative or improvement focussed analysis between different building project options. In this respect, it was highlighted the importance of quantifying this indicator:

- for the pre-design phase, since decisions made at this stage can have a significant effect in determining the environmental performance of a building;
- for the operational phase, since this allows a verification of the actual impacts associated to a building.

Calculation method and reference standards

The calculation method was, based on the survey response, an issue of concern. A stronger link with the EN 15804 and EN 15978 standards was requested. In particular, further clarifications have to be provided for biogenic carbon in wood, carbonisation in concrete, and how to handle district heating.

Many testers reported that the calculation method provided for this indicator is complicated, especially in the case LCA expertise and related tools are not available within the building team. The main issues related to the quantification of bills of materials (from building specifications and drawings – see also Life cycle tool 2.1), but also energy data in some projects. A number of testers also highlighted the potential of BIM to make the analysis easier.

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Some flexibility could be needed for the reference service life to consider for the assessment, due to variation of practices across Europe. 50 years is often used, whilst the life of structures may be much longer than 60 years.

As a separate item of feedback, it was reported that the link with indicator 1.1 is obvious but that it should be clarified that consumption energy data is needed for indicator 1.2.

Supporting tools and data requirements

The access to software tools and a comprehensive set of data was considered as the most critical factor for this indicator.

Another problem is that many existing tools and databases still do not allow an easy breakdown between biogenic CO_2, fossil CO_2 and CO_2 from land transformation. Some gaps were reported also for modules C and D.

Assumptions may be required due to data limitations in BIM, EPDs and LCI databases. Some testers requested either to avoid data which is not yet available broadly, or to improve the provision of default data, to use as proxies in the case of data gaps.

As a separate feedback, the importance of data quality indicators was remarked (covering also consistency aspects). A reference hierarchy could be provided to guide testers in the selection of data.

The reporting format

Testers reported the following difficulties with the reporting tool:

- The layout and user-friendliness of the tool should be improved, also to avoid that information is misplaced;
- The reporting unit was not aligned with the methodological guidance;
- Granularity in terms of sub-stages included/excluded in the assessment was not sufficient;
- The introduction of negative values was not straightforward/ possible;
- GWP results are duplicated in 1.2 and 2.4;
- The insertion of supporting information, relating to methodological assumptions and interpretation of results, should be made easier.

How the three levels work

Many testers requested to make simpler, or at least clearer, the description of how to handle the indicator for different Level(s). For example:

- Projects developed in accordance with some certification schemes only allow entering some Level(s);
- Text should be reduced and examples/web-trainings provided;
- Especially for Level 3 it is essential to double check design information with construction and operation stages.

For Level 2 it has also to be pointed out that elementary flows (necessary to carry out the calculation of indicator 1.2) could be not covered in a harmonised way in different databases, which can bias the comparison between different building projects.

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Amongst the testers who responded to the survey considered that Level(s) 2 and 3 were useful for the comparison between different building options. However, it was highlighted that variation in results can be higher than real differences among most common building options, and that carrying out a critical review of the results can require a significant budget.

As well as the differentiation between the levels, some testers also commented on the relationship between indicators 1.2 and 2.4. In order to avoid redundancy, some testers suggested either to handle indicator 1.2 as part of tool 2.4 "LCA", or to have the possibility to not report on GWP in 2.4.

Technical, methodological and/or regulatory advancements to take into account

The revised EN 15804:2012+A2 standard and the ongoing revision of the EN 15978 standard have been identified as key elements to take into account.

Table 3.2. Key technical issues and proposed updates for Indicator 1.2: Life Cycle Global Warming Potential

Key technical issues to address	**Main proposed technical updates and solutions**
1.2.1 **Floor area and unit of measurement**	− Harmonise between the indicators and make reference to the correct unit of measure in the reporting tool (kg $CO_{2,eq}$ per m^2 per year)
1.2.2 Definition of the **scope of the analysis**	− Provide a better description of how the scope of the analysis has to be defined for different Level(s) − Clarify the life cycle stages and sub-stages to cover in the analysis, to allow a comprehensive assessment and differentiate between embodied and operational emissions (both in terms of modules to consider and guidance for different building project stages)
1.2.3 Lack of **benchmarks**	− Introduce guidance for setting benchmarks and targets in order to enable a comparative/improvement analysis between different building project options
1.2.4 Calculation methods and **alignment with EN standards**	− Simplify and reduce the description of the calculation methods, making a stronger link with the revised versions of EN 15804 and EN 15978 standards − Explore the possibility to provide some flexibility for the reference service life to be used − Provide further clarification on carbonisation, biogenic, fossil and land-use emissions of $CO_{2,eq}$, as well as how to handle district heating − Promote the use of BIM as a means of facilitating building data − Clarify that consumption energy data is needed from indicator 1.1

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1.2.5 Availability of **LCA tools/data**	– Provide a neutral description of tools and databases that are available that can be used – Explore the possibility of establishing minimum criteria for their functionality and alignment with EN 15804/15978
1.2.6 Difficulties in understand **how different Level(s) works**	– Clarify how different Level(s) work, under which requirements, and provide further indications to make sense of the results
1.2.7 **Duplication of results**	– Avoid redundancy and overlap between 1.2 (GWP) and 2.4 (LCA)
1.2.8 Ease of **reporting results**	*Improve the following aspects of the reporting tool:* – The layout and user-friendliness of the tool should be improved. Colour codes and visual guides could be added, for example, to avoid that information is misplaced; – The reporting unit has to be aligned with the methodological guidance – and the reference service life time considered in the assessment has to be reported; – A sufficient level of granularity has to be provided and sub-stages which are included/excluded in the assessment have to be clearly highlighted; – A bug impeding the introduction of negative values has to be removed; – Indications about other indicators, scenarios, data sources linked to different life cycle stages could be provided, as well as typical value ranges; – A standard structure could be developed for the detailed insertion of supporting information (e.g. tools and data used, key methodological assumptions, interpretation of results) – Different tables should be automatically generated in case multiple scenarios are evaluated

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Life cycle tool 2.1: Building Bill of Materials

43 testers worked with this indicator, although only a limited number of them succeeded in adhering to the Level(s) guidance and reporting plausible results. Difficulties were faced in a number of areas relating to data collection and the quantification and reporting of the bill of quantities.

Terms and definitions

Testers in general appeared to have a good understanding of the terms and definition used. Nevertheless, there may be the need to further clarify what bill of materials and bill of quantities mean in the context of Level(s), as well as on what is covered in different categories of materials.

Unit(s) of measurement

More than half of testers considered that the unit of measurement was '*easy and logical to use'*. Results for the total materials were in general reported by weight as requested. However, many testers did not quantify the bill of quantities for different building elements using the right units of measurement (e.g. x wooden windows of y m^2 each).

Boundary and scope

Some testers questioned the added value of this tool reporting that the classification used in Level(s) causes extra work since it is not integrated in existing standards. Simplification was requested and it was suggested to link the material groups to those required for LCA or national/regional systems, instead of using Eurostat categories.

On the other hand, with respect the building elements/parts, it was requested to expand the existing list and to consider that some parts can consist of various layers and/or composite materials fulfilling different functions (e.g. load transfer, thermal insulation, sound insulation, protection from humidity, fire resistance, acoustic functions, and esthetical function). For example, some of the layers are shell and some are core within the same building component. The addition of one or two composite material categories could help.

Some testers requested to provide a full description of building components and related material information (e.g. material definition, material characteristic, material origin, characteristics of connection to neighbouring layers). This could be used for the creation of a list that includes a reference tab/number for each building element and that can then be used as a material bank information.

Calculation method and reference standards

Some testers reported a lack of clarity, in particular with respect to how to handle packaging, landscaping and ancillary materials used in the construction and replacement processes, as well as the replacement of materials in the building use phase. Examples and a check-box approach may also be beneficial.

Supporting tools and data requirements

A significant portion of testers raised a problem in terms of data gaps and/or the quality of data (11) and/or about the workload necessary for the use of this tool (8).

Using LCA software and/or BIM was reported useful practices to facilitate calculations. However, it was reported that some software solutions are not able to

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define single layers within one component, which could make it difficult to make use of BIM data.

The reporting format

Based on comments and results from testers, the following changes could be applied to improve the user-friendliness of the reporting format:

- Since the guidance was common to all levels, it was a bit misleading that you have to choose a level in the reporting tool;
- An additional column could be added to enter the specific name of materials (as the three first columns remain vague in this);
- Calculation of percentage contributions of each material could also be of help for users;
- Provide examples of the right units of measurement and allow to switch between units of measures (e.g. reporting per m2);
- Provide indications about possible data sources to quantify the indicator;
- Add typical ranges of values or default values for building projects;
- Provide clear instructions about how to provide additional information (e.g. background information).

How the three levels work

At a general level, it was asked to clarify the purpose of this indicator and the division into levels. A BoM is a fundamental element to carry out LCA calculations and could be moved so that it is presented before indicator 1.2 and considered as a kind of 'Level 1' LCA.

Technical, methodological and/or regulatory advancements to take into account

The revised EN 15804:2012+A2 standard and the ongoing revision of the EN 15978 standard must be taken into account.

Table 3.3. Key technical issues and proposed updates for tool 2.1: Building of Bill of Materials

Key technical issues to address	**Main proposed technical updates and solutions**
2.1.1 **Integration with indicators 1.2 and 2.4**	– Explore the possibility of moving BoM to before the life cycle GWP indicator and considering it as a kind of 'Level 1' LCA
2.1.2 **Building elements classification, LCA and BIM**	– Clarify further what is covered in different categories of materials – Check if the classification system used in Level(s) needs to be revised, *e.g. making reference to national/regional systems or allowing for more flexibility.* – Facilitate the link between LCA and BIM software and/or existing building element classifications
2.1.3 **BoQ/BoM quantification**	– Clarify further what BoQ and BoM mean in the context of Level(s) – Provide examples for the units of measurement to use – Expand the list of default elements/parts potentially for generic building examples

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	- Consider that some building elements or components can consist of various layers of materials and/or composite materials fulfilling different functions - Explain how to handle packaging, landscaping and ancillary materials used in the construction and replacement processes, as well as the replacement of materials in the building use phase. - Support further users to create a list that can be used as a material bank of information for other indicators (such as 2.3 and 2.2 - Scenario 3) and as the first step for LCA calculations - Include examples and introduce a more check-list type approach
2.1.4 **User friendliness** of the reporting tool	- Select Level only if there is a difference between Levels 1, 2 and 3 - Add a column to introduce the specific name/number of materials - Add the % of materials - Provide examples of the right units of measurement and allow to switch between units of measures (e.g. reporting per m2); - Provide indications about possible data sources to quantify the indicator; - Add typical ranges of values for building projects; - Provide clear instructions about how to provide additional information (e.g. background information).

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Life cycle tool 2.2: Scenario 1 – Building and elemental service life planning

28 testers worked with this indicator, and the majority of them succeeded in obtaining plausible results. It was recommended to provide further guidance on some aspects such as the operating life of materials and how to handle composite materials and maintenance/repair/refurbishment operations.

Terms and definitions

Testers in general appeared to have a good understanding of the terms and definition used. However, it should be clearly defined whether the '*theoretical lifespan'* or the '*actual operating life'* of building components is to be reported. The two definitions can lead to different results, with operating lives being more representative of reality. This is particularly relevant for an existing building, where it can be easier to report in terms of actual replacements rather than theoretical lifespans.

Unit(s) of measurement

More than half of testers considered that the unit of measurement was 'easy and logical to use'.

Boundary and scope

The main feedback received related to the need to align with national classifications of building components.

Calculation method and reference standards

A significant proportion of the testers considered that the quantification of this tool required a high workload. There is the need to clarify:

- Which lifetime to consider (theoretical v. actual – as already noted);
- How the lifespan of a building component should be assessed (it is not clear if the lifespan of a building component should be calculated as the lowest material lifespan in the component);
- How to quantify lifespans in case of renovations.

It was also suggested to refer to the numbers of replacements in a certain period (e.g. the reference service life) rather than reporting lifespans only.

Supporting tools and data requirements

Some testers referred to difficulties in finding typical lifespan estimates for building elements. Calculations could be eased by the provision of a reference catalogue for building parts, or by using LCA tools and data,

The reporting format

Testers provided the following comments on the reporting format:

- Allow for more detailed reporting which is better connected to practice (e.g. for elements made of sub-parts and for differentiating between maintenance and replacement);
- Further align with the guidance document and make clearer how the selection of options for parts/components works;

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- Add additional columns to enter the specific name of materials and highlight maintenance/refurbishment needs;
- Consider reporting also the frequency of replacement.

Moreover, the following broader aspects could be considered, on the basis of the feedback received:

- Consider merging indicator 2.1 with tool 2.2;
- Provide indications about possible data sources and reference lifespans to quantify the indicator, as well as typical ranges of values for building projects;
- Provide clear instructions about how to provide additional information (e.g. background information).

Technical, methodological and/or regulatory advancements to take into account

The ISO 15686 series could provide further standardised reference points for this life cycle scenario tool.

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Table 3.4. Key technical issues and proposed updates for Scenario 1 – Building and elemental service life planning

Key technical issues to address	**Main proposed technical updates and solutions**
S1.1 **Definitions**	- Clarify whether/when it is requested to quantify 'theoretical lifespans' or 'actual operative lives' for building components
S1.2 **Calculation methods**	- For an existing building, it may be easier to report 'actual' replacements - Explore the possibility to consider the number of replacements in a certain period instead of lifespans - Clarify how to account for the lifespan of a building component (sub-part), since it is not clear if the lifespan of a building component should be calculated as the lowest material lifespan in the component - Clarify how to cope with service lifespans for maintenance and renovation works
S1.3 **Tools and data**	- Provide access to reference catalogues or guidance where to find typical lifespan values for building parts - Align with national classifications for building components - Facilitate the link with LCA tools and data
S1.4 **Reporting tool**	− Consider merging indicator 2.1 with tool 2.2 − Allow for more detailed reporting (e.g. for elements made of sub-parts and for differentiating between maintenance and replacement); − Further align with the guidance document and make clearer how the selection of options for parts/components works; − Add additional columns to enter the specific name of materials and highlight maintenance/refurbishment needs; − Consider including reporting also for the <u>frequency of replacement;</u> − Provide indications about possible data sources and reference lifespan data to quantify the indicator, as well as typical ranges of values for building projects; − Provide clear instructions about how to provide additional information (e.g. background information).

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Life cycle tool 2.2: Scenario 2 - Design for adaptability and refurbishment

A smaller number of testers worked with this scenario (19) and the majority succeeded in reporting on level 1 design aspects and/or a semi-quantitative result obtained from an existing tool or standard.

Although no major difficulties were identified by testers, nonetheless suggestions for improvement related to:

- the accessibility (and cost) of third party tools and calculators,
- identification of sources of design information,
- flexibility in reporting as well as the appropriateness and
- complexity of some third party tools.

For some testers it was also a new design aspect, so more examples and precedents from other building projects would support these users.

More explanations of the benefits of focussing on adaptability and for the choice of the aspects could be provided, to aid learning. This should include an emphasis on use early in the design process.

Terms and definitions

No significant issues were raised in relation to the terms and definitions used, although greater clarity on the design aspects covered by the third party tools and standards identified in the guidance would be welcomed. There may also be scope to review the terms and definitions in order to ensure alignment with the new ISO 20887.

Unit(s) of measurement

Testers were interested in using the (level 2) option to report on a semi-quantitative basis using a tool or standard, so this option should be further emphasised. However, the values generated are dimensionless and the calibration of the values generated is specific to each tool or standard.

Boundary and scope

The boundary and scope did not appear to be a source of problems. The testers either identified the building elements that they had checked or addressed the aspects that they could in order to obtain a semi-quantitative score.

Calculation method and reference standards

The checklist approach did not appear to pose any significant problems, nor the most commonly used semi-quantitative method, which is contained within the DGNB certification criteria.

Supporting tools and data requirements

Testers asked that tools such as the DGNB calculator should be made readily available and/or a similar tool integrated into Level(s). The applicability of the Life Time Homes standard to all residential scenarios was questioned, so it should be checked whether this still standard remains unique as a reference for residential adaptability.

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The cost of access to the tools suggested for use at level 2 was considered a barrier. Testers did not appear to require much additional training to understand and use the scenario checklists and/or third party tools.

The reporting format

The checklist format appeared to have worked for most testers, although flexibility to enter new aspects was requested.

How the three levels work

As has already been commented upon, the level 2 option to use a semi-quantitative tool was welcomed as a better option than the level 1 checklists.

Technical, methodological and/or regulatory advancements to take into account

This scenario represents a new aspect of sustainability for which, at the time of publication of the Beta version of Level(s), there was no clear standardised basis. Two areas of activity were noted at the time as having the potential to inform future revisions:

- A new ISO standard 20887 on 'Design for disassembly and adaptability' was under development. This would have provided a standardised reference point for the scenario and potentially also the design aspects. The standard is now in the process of being published and so should be further reviewed for the content addressing the concept of adaptability.
- The Horizon 2020 funded project Buildings as Material Banks (BAMB) was under way and included work tasks addressing both adaptability and deconstruction. These were to include a focus on methodological development of assessments for building designs. The project has now drawn to a close, and so the learning from the pilot work should now be reviewed.

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Table 3.5. Key technical issues and proposed updates for Life cycle tool 2.2: Scenario 2 - Design for adaptability and refurbishment

Key technical issues to address	**Main proposed technical updates and solutions**
S2.1 Use of the scenario tool late in **the design process**	– Identify with examples how the checklists and tools can be used as a design aid. – Identify at which stages in the design and appraisal process the scenario can be used to improve outcomes. – A more visible disclosure of whether the checklists have been taken into account in the building design should be introduced.
S2.2 More **knowledge about the tools** that are available and how to use them	– Improve information on the concept of adaptability and the potential benefits and the reason for the choice of design aspects should be provided as a learning aid. – Check the read across or consider minimum criteria for the design aspects and terminology used in third party tools highlighted in Level(s).
S2.3 **Accessibility** of semi-qualitative scoring tools	– Explore the potential to improve access to existing tools into Level(s) *e.g. from DGNB or BREEAM Netherlands*.
S2.4 Requests to **embed a tool** that generates a score in Level(s)	– Explore the potential to integrate an existing tool into Level(s) *e.g. from DGNB or BREEAM Netherlands*.
S2.5 The need to further **adapt the residential checklists** so they apply to all cases	– Review the state of the art in residential checklists, which in comparison with the Lifetime Homes scheme.
S2.6 Improve the **standardised basis for the scenario**	– The new ISO 20887 Design for disassembly and adaptability of buildings and civil engineering works shall be reviewed as the basis for the scenario tool.

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Life cycle tool 2.2: Scenario 3 - Design for deconstruction, reuse and recycling

A smaller number of testers worked with this scenario (19) and the majority succeeded in reporting fully or partially on level 1 design aspects and/or a semi-quantitative result obtained from an existing tool or standard.

Although no major difficulties were identified by testers, nonetheless this scenario was considered slightly less user friendly than scenario 2 on adaptability. Suggestions for improvement related to the accessibility, cost and complexity of third party tools and calculators, a closer link to an LCA approach and flexibility in reporting. For some testers it was also a new design aspect, so more examples and precedents from other building projects would support these users.

Terms and definitions

No significant issues were raised in relation to the terms and definitions used, although greater clarity on the compatibility with the third party tools and standards identified in the guidance would be welcomed. There may also be scope to review the terms and definitions in order to ensure alignment with the new ISO 20887.

Unit(s) of measurement

Testers were interested in using the (level 2) option to report on a semi-quantitative basis using a tool or standard, so this option should be further emphasised. However, the values generated are dimensionless and the calibration of the values generated is specific to each tool or standard – sometimes allowing for reporting on multiple different aspects of performance.

The multiple aspects of the scenario caused some confusion, in part related to their potential overlap between them. Some degree of interpretation of how and to what extent the aspects should be addressed appeared to be needed.

Boundary and scope

The boundary and scope did not appear to be a source of problems. The testers either identified the building elements that they had checked or addressed the aspects that they could in order to obtain a semi-quantitative score.

Some testers commented on the difference between a focus on the design aspects and an LCA approach based on scenarios for end of life recycling and reuse rates – with the latter being focussed more on the material bank rather than elements and component interactions.

Calculation method and reference standards

The checklist approach did not appear to pose any significant problems, however, the most commonly used semi-quantitative method, which is contained within the DGNB certification criteria. did raise some issues. Some experienced users obtained one of the suggested tools and found it to be too complex. Others asked for greater clarity on which sub-criterion or method should be used, highlighting in the process that several different values could be obtained.

Supporting tools and data requirements

Testers asked that tools such as the DGNB calculator should be made readily available and/or a similar tool integrated into Level(s).

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The cost of access to the tools suggested for use at level 2 was considered a barrier. Testers did not appear to require much additional training to understand and use the scenario checklists and/or third party tools.

The reporting format

The checklist format appeared to have worked for most testers, although there was some confusion about the difference between the different design aspects and, moreover, flexibility to enter new aspects was requested.

How the three levels work

As has already been commented upon, the level 2 option to use a semi-quantitative tool was welcomed as a better option than the level 1 checklists. Greater clarity is needed as to whether reporting on the checklists is still needed if at a level 2 a semi-quantitative assessment has been made.

Technical, methodological and/or regulatory advancements to take into account

This scenario represents a new aspect of sustainability for which, at the time of publication of the Beta version of Level(s), there was no clear standardised basis. Two areas of activity were noted at the time as having the potential to inform future revisions:

- A new ISO standard 20887 on 'Design for disassembly and adaptability' was under development. This would have provided a standardised reference point for the scenario and potentially also the design aspects. The standard is now in the process of being published and so should be further reviewed for the content addressing the concept of design for deconstruction, reuse and recycling.
- The Horizon 2020 funded project Buildings as Material Banks (BAMB) was under way and included tasks addressing deconstruction (referred to as 'reversible building'). These were to include a focus on methodological development of assessments for building designs. The project has now drawn to a close, and so the learning from the pilot work should now be reviewed.

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Table 3.6. Key technical issues and proposed updates for Life cycle tool 2.2: Scenario 3 - Design for deconstruction, reuse and recycling

Key technical issues to address	**Main proposed technical updates and solutions**
S3.1 Use of the scenario tool late in **the design process**	– Identify with examples how the checklists and tools can be used as a design aid. – Identify at which stages in the design and appraisal process the scenario can be used to improve outcomes. – A more visible disclosure of whether the checklists have been taken into account in the building design should be introduced.
S3.2 More **knowledge about the tools** that are available and how to use them	– Improve information on the concept of adaptability and the potential benefits and the reason for the choice of design aspects should be provided as a learning aid. – Check the read across or consider minimum criteria for the design aspects and terminology used in third party tools highlighted in Level(s).
S3.3 **Accessibility** of semi-qualitative scoring tools	– Explore the potential to improve access to existing tools into Level(s) *e.g. from DGNB or BREEAM Netherlands*.
S3.4 Requests to **embed a tool** that generates a score in Level(s)	– Explore the potential to integrate an existing tool into Level(s) *e.g. from DGNB or BREEAM Netherlands*.
S3.5 Improve the **standardised basis for the scenario**	– The new ISO 20887 Design for disassembly and adaptability of buildings and civil engineering works shall be reviewed as the basis for the scenario tool.

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Indicator 2.3: Construction and demolition waste

Although a large number of testers worked with this indicator (77) only 65% correctly reported a plausible result. Despite the basic nature of the unit of measurement to testers, many testers did not appear to be familiar with reporting real data. The main difficulties faced by testers related to:

- A lack of experience in gathering and reporting real data;
- A lack of experience in tracking the fate of Construction and Demolition Waste (CDW) once it leaves site (i.e. landfill disposal, recycling applications or recovery applications);
- The lack of tools and general assumptions for making estimates of waste generation, and
- The format of the reporting excel, which was not intuitive enough.

Terms and definitions

Testers did not raise any queries about the definitions laid down in the guidance.

Unit(s) of measurement

Data is reported in kg and normalised to the m^2 of useful floor area. In order to align with other indicators, it would be ideal to have a consistent approach for considering the floor area (i.e. indoor floor area only or to include patios, terraces and forecourts as well). Even if a consistent approach is not possible, each approach should be defined as clearly as possible.

Some testers only reported numbers in terms of kg (omitting the step to divide the number by the m^2 of useful floor area). This led to some extremely high results that were several orders of magnitude greater than typical ranges for normalised results.

Boundary and scope

The boundary and scope did not seem to be an issue based on tester feedback. One issued that was flagged up related to Module D estimates and if these should be applied to an old building to be demolished or the new building, when it would eventually be demolished in the future. This can be easily clarified with reference to EN 15978.

Another potential issue is whether or not testers were counting CDW that never left the site (i.e. reused, recycled or recovered onsite as part of the construction activity). According to the methodology on site reuse should be counted unless it is as backfill, but perhaps in some projects, the only records referred to are shipment notes of CDW leaving the site, since this would be associated with invoices that would be archived. Especially the use of CDW in landscaping or backfill on site would be at risk of not being counted. The counting of CDW that never leaves the site could therefore be made more explicit in the reporting excel.

Calculation method and reference standards

The calculation method was very simple in principle but a high proportion of testers (45%) filled out the reporting excel incorrectly in one way or another. The extent of incorrect reporting appeared to be directly linked to the format of the reporting, which is discussed in more detail in the relevant sub-section to follow.

Testers also expressed the need for more practical guidance supported by estimates, with reference to some general rules of thumb and typical rates for certain types of

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construction product or activity. Some testers provided references that they had used for their own estimation purposes.

When reporting actual data, a number of testers highlighted the difficulty of obtaining real site data. In some cases this was cited as being linked to a general lack of any requirement to gather such data in normal building projects in certain regions.

Supporting tools and data requirements

According to the Level(s) guidance, demolition data is to be estimated from a pre-demolition audit and construction waste data from a design-stage BoM or BoQ. A general impression from tester feedback was that the it would have been appreciated to have more guidance on how to do a demolition audit and to have some possibility to input data from a pre-demolition audit and a BoM or BoQ into the reporting excel. This would allow for an automatic first estimate to be made, based on certain default assumptions and rules of thumb (e.g. kg of hazardous and non-hazardous CDW generated per m^3 of reinforced concrete or per m^2 of plasterboard) for a building to be demolished.

It would be necessary to carefully review the current assumptions and rules of thumb that are applied throughout Europe before any such tool or functionality might be included in Level(s). Such a tool would only generate a total estimate of a specific fraction of potential CDW. The quantity of earthworks would remain an unknown, since this is highly site-dependent. The *potential* for recycling or recovery could also be indicated as a default for each waste material with an input to such a tool. The option to make a link with indicator 2.1 might be beneficial as well.

The reporting format

Some testers complained about the fact that indicator 2.3 could be reported on at all project stages. For example, the reporting excel kept the fields for e.g. design pre-estimate of CDW open when a user selected the project stage as 'occupation', which clearly did not make sense.

Based on the high proportion of testers who made mistakes and the variety of mistakes made, it was clear that the reporting format was not sufficiently intuitive and could be improved significantly. Based on the feedback following changes are recommended as a minimum:

- to request that CDW data only be inserted in kg;
- to have a separate cell where the useful floor area is entered – allowing all CDW data to be automatically converted into kg/m^2;
- to have a cell for "total CDW" irrespective of where it goes;
- to insert formulas to automatically calculate percentages by CDW fate;
- to move the columns related to Module D to the end (right hand side) of the cells, and
- to have cells for reuse split into "onsite" and "offsite", likewise for recycling and recovery.

How the three levels work

Level 2 and level 3 for indicator 2.3 did not appear to offer much added value to testers. Indicator 2.3 would probably benefit more than other indicators from a shift in the level(s) approach towards one that matches project stages (which are currently all included in level 1 only).

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Technical, methodological and/or regulatory advancements to take into account

No broader technical advancements or regulatory changes have been identified at this stage that should be taken into account at this stage.

If any estimation tool or similar functionality is to be incorporated into the reporting excel, then a review of the literature to provide reasonable assumptions would be necessary.

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Table 3.7. Key technical issues and proposed updates for Indicator 2.3: Construction and demolition waste

Key technical issues to address	**Main proposed technical updates and solutions**
2.3.1 **Automatic normalisation** of data	− To agree on what floor area should apply (internal floor or also including external floors). − To insert a cell into the reporting excel, together with linked formulas to the raw CDW data entries to convert results from kg to kg/m^2.
2.3.2 Better **estimations of CDW**	− Provide guidance on demolition audits and BoM/BoQ and general rules of thumb and assumptions commonly used. − Add cells for the manual or automatic (possibke link to indicator 2.1 for BoM) entry of raw data to generate estimates of CDW. − Add calculations that apply to rules of thumb to raw data to generate the estimates automatically.
2.3.3 Making the reporting excel **more intuitive**	− Insert cells for total values. − Automatically generate the percentage splits based on raw data entered. − Place Module D data at the end, since it would come last in time for a particular building project.
2.3.4 Reconsider the **split between the levels**	− Depends on broader discussion, but if level(s) approach changed to project stages, the reporting format could be adapted accordingly.

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Life cycle tool 2.4: Cradle to cradle Life Cycle Assessment (LCA)

20 testers worked with this tool, but only a limited number of them succeeded in adhering to the Level(s) guidance and reporting plausible results. Difficulties were faced in a number of areas, including:

- the access to tools and data,
- the correct application/referencing to the Level(s) guidance document,
- quantification of indicators related to material scarcity/type, and
- the reporting of results and supplementary information.

Terms and definitions

Testers in general appeared to have a good understanding of the terms and definition used. Nevertheless, there may be the need to further clarify on the building floor area to be used for the assessment and to ensure it is harmonised between indicators.

Moreover, it was recommended to avoid the use of the term 'Cradle to Cradle' since it is also used for a globally registered certification scheme. The terms 'full LCA', 'Comprehensive LCA' or 'Cradle-to-grave'-LCA would prevent any confusion and better reflect terms used in EN standards.

Unit(s) of measurement

About half of testers considered that the unit of measurement was 'easy and logical to use'. The LCA impact categories are, for the most part, already pre-determined by both the EN standards and the software tools used to generate results.

Boundary and scope

Benchmarks were referred to by testers as an important element to introduce into Level(s) so as to enable a comparative/improvement-based analysis between different building project options. Encouraging users to make a hot spot analysis was also proposed.

In this respect, the importance was highlighted of quantifying this indicator in the design phase and of then verifying the 'as-built' results obtained in the construction and operational phase (see also indicator 1.2). A comprehensive approach should be pursued already at Level 1 in order to obtain meaningful results.

Some testers also pointed out that important life cycle stages should not be neglected, since the revised version of the EN 15804 standard encourages a whole life cycle, cradle to grave approach. Some testers considered that components that are not fully known at the design stage (e.g. external works) have little influence on the LCA results. Other testers reported that their inclusion could lead to impaired comparability of results at building level.

Clearer guidance should be provided for handling repair, refurbishment and maintenance and for differentiating between new and existing buildings (already at Level 1).

Bearing in mind the overall objective to make robust calculations, it was suggested to focus on the development of a comprehensive and accurate BoM that includes a very detailed list of all materials installed in a building. In separate written feedback from testers it was also suggested to explore the possibility to set cut-off and normalisation rules based on cost considerations (i.e. contribution to overall construction costs).

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Calculation method and reference standards

The calculation method was, based on the survey response, an issue of concern. A stronger link with EN 15804 and EN 15978 standards and existing LCA tools and databases was requested. Some testers also called for more consideration of PEF methods and data.

Many testers reported that the calculation method provided for this indicator is complicated, especially in cases where LCA expertise and related tools are not available in the building project team. It was pointed out that a multi-disciplinary knowledge and the involvement of the whole team are needed. It was suggested that linking BIM with LCA calculation software could make the analysis easier.

Some flexibility should be given in defining the reference service life to consider for the assessment, due to variation of practices across Europe. 50 years is often used, whilst the life of structures may be much longer than 60 years.

As separate feedback it was remarked that the guidance regarding ADP (Abiotic Depletion Potential) calculations is not clear, as well as if and how to consider other indicators referring to material use.

There is a link back to life cycle tool 2.1, as quantification of the bill of materials (from building specifications and drawings) was a challenge for many testers.

Supporting tools and data requirements

Access to software tools and a comprehensive set of data was considered as the most critical factor for this indicator.

Another important aspect is the reliability of information. Testers would welcome additional information about the availability and robustness of tools and databases (e.g. compliance with EN 15804 to ensure consistent modelling).

Data quality evaluation was mentioned as requiring a significant effort and to depend on several factors such as:

- The quality of background datasets,
- The representativeness of background datasets,
- The precision and accuracy of the data collection process,
- Uncertainty related to the environmental indicator addressed.

Moreover, the data quality rating included within Level(s) was considered to be a relatively subjective valuation which also depends on the expertise of the user.

The reporting format

Testers reported the following difficulties with using the reporting tool:

- The layout and user-friendliness of the tool is not aligned with or comparable with that of existing LCA tools;
- The reporting unit and the numbering of the tool was not aligned with the methodological guidance;
- Life cycle GWP results are duplicated between 1.2 and 2.4;
- The granularity in terms of sub-stages of the EN modules included/excluded in the assessment was not sufficient;

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- The insertion of supporting information, relating to methodological assumptions and interpretation of results, should be made easier.

How the three levels work

In order to avoid redundancy, some testers suggested either to handle indicator 1.2 as part of tool 2.4 'LCA', or to have the possibility to not report on GWP in 2.4.

The testers who responded to the survey considered that Level(s) 2 and 3 were useful for the comparison between different building options. However, many testers requested to make simpler, or at least clearer, the description of how to use the indicator at different Level(s).

In particular, comparison with benchmarks or results for different design options is necessary to make the assessment meaningful, even at Level 1

For Level 2 it was also pointed out that elementary flows could be not covered in a harmonised way in different databases, which can bias the comparison between different building projects (this also applies to indicator 1.2).

Technical, methodological and/or regulatory advancements to take into account

The revised EN 15804:2012+A2 standard and the ongoing revision of the EN 15978 standard have been identified as key elements to take into account.

Table 3.8. Key technical issues and proposed updates for tool 2.4: Life Cycle Assessment

Key technical issues to address	Main proposed technical updates and solutions
2.4.1 Floor area and unit of measurement	– Harmonise between indicators and make reference to the correct unit of measure in the reporting tool (kg $CO_{2,eq}$ per m^2 per year)
2.4.2 Definition of the **scope of the analysis**	– Do not refer to "Cradle-to-Cradle" LCA – Provide better description of how the scope of the analysis has to be defined for different Level(s) – Clarify the life cycle stages and sub-stages to cover in the analysis, in order to allow for a comprehensive assessment and to differentiate between embodied and operational emissions (both in terms of modules to consider and guidance for different building project stages) – Support the compilation by users of a detailed list of materials used in buildings – Explore the possibility to set cut-off and normalisation rules based on the cost contribution of building elements – Provide clearer guidance for repair, refurbishment, maintenance and how to work with new and existing buildings (also at Level 1)

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2.4.3 Lack of **benchmarks and hot spot analysis**	- Introduce guidance for setting benchmarks and targets in order to enable a comparative/improvement analysis between different building project options - Introduce guidance on how to identify and analyse hot spots and options for improvement
2.4.4 Complexity of the **calculation methods and alignment with EN standards**	- Simplify and reduce the description of the calculation methods, making a stronger link with the revised versions of EN 15804 and EN 15978 standards - Promote the use of BIM - Explore the possibility to provide some flexibility for the reference service life - Clarify guidance on ADP and if/how to consider other indicators referring to materials
2.4.5 Availability of **LCA tools/data**	- Provide a neutral description of tools and databases that are available that can be used - Explore the possibility of establishing minimum criteria for their functionality and alignment with EN 15804/15978
2.4.6 **Reliability** of results	- Explore possibilities to simplify the data reliability/quality assessment - Strengthen the importance of reporting results transparently and interpreting them critically
2.4.7 Ease of **reporting of results**	*Improve the reporting tool in the following ways:* - The layout and user-friendliness of the tool should be improved. Colour codes and visual guides could be added, for example, to avoid that information is misplaced; - The reporting unit has to be aligned with the methodological guidance – and the service life time considered in the assessment has to be reported; - Allow the possibility of avoiding reporting on GWP again, if both indicator 1.2 and tool 2.4 are used - A sufficient level of granularity has to be provided and sub-stages of the modules which are included/excluded in the assessment have to be clearly highlighted; - Indications about the other indicators, scenarios, data sources linked to different life cycle stages could be provided, as well as typical value ranges; - A standard structure could be developed for the detailed insertion of supporting information (e.g. tools and data used, key methodological assumptions, interpretation of results); - Different results tables should be automatically generated in case multiple scenarios are evaluated.

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2.4.8 Difficulties in understand **how different Level(s) works**	– Clarify how different Level(s) work, under which requirements, and provide further indications to make sense of the results. – For Level 2 it was in particular highlighted the importance of referring to harmonised databases to avoid possible biases in the comparison between different building projects

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Indicator 3.1: Use stage water consumption

A large number of testers worked with this indicator (77) and the majority of these succeeded in obtaining a plausible result.

This indicator is distinct in that unlike the others, a bespoke calculation method is provided for reporting in level(s) using an excel-based calculator that was published prior to the testing period. Overall, the feedback was positive about the calculator tool, although several comments were received about bugs or other aspects that could be reported or additional functionalities that could be incorporated.

Terms and definitions

Definitions were provided in the level(s) guidance (part 3 document) for the following terms: blackwater; freshwater; greywater; groundwater; operational water use; potable water; rainwater harvesting; water exploitation index (WEI) and water withdrawal/abstraction. None of the definitions were queried by testers and no requests were made for additional definitions.

Unit(s) of measurement

The output of the water calculator is a final result in units of m^3/occupant/annum (or m^3/o/a). This result is generated by a series of values that are entered into the calculator for usage factors (e.g. flushes/o/d) and specific consumption rates (e.g. L/flush). In case the tester does not have all these values, default values are suggested in the calculator. Depending on the level, it is also allowed to vary the assumed days per year when the building is occupied, which has a directly proportional influence on the final result.

All testers appeared to have used the correct units, except perhaps one result which was very high (1380 compared to normal range of 4-8 m^3/o/a) suggesting that a mistake had been made in the assumptions in input units.

Boundary and scope

The boundary and scope did not seem to be an issue based on tester feedback. Only very few testers actually used the functionality of the calculator to look at non-core elements of use phase water consumption (e.g. floor and window cleaning in offices, irrigation of vegetated areas, substitution of potable water by greywater/rainwater).

One aspect that was considered as overlooked in the calculator was hot water consumption. Since this is directly related to use phase energy consumption, a link to indicator 1.1 could perhaps be made. However, some well justified assumptions about the average share of hot water (i.e. water at 60 °C) in the total consumption of water in showers, baths and kitchen taps would need to be justified. For residential buildings, it would also need to be checked how common is it to have direct feed of hot water into washing machines and dishwashers.

Calculation method and reference standards

The calculation method was very simple in principle due to the fact that a bespoke excel calculator was provided with embedded instructions and comments. Testers were directed to only fill out the cells shaded in green.

Some testers were confused by the appearance and disappearance of the cells relating to greywater reuse and rainwater harvesting in level 1. They thought it was a bug when in fact it was a deliberate conditional formatting. The aim was for the cells to

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only appear if the river basin where the building is located suffered from summer water scarcity (e.g. WEI+ > 20). While there is a certain logic in this approach, it does not align with real practice, where ironically rainwater harvesting and greywater reuse appears more popular in countries with fewer water scarcity problems than in countries with very serious water scarcity problems.

In order to avoid the problem of uncertainties in the result caused by uncertainties in the occupation rate, the core water using activities are user specific (i.e. usage rates are reported on a per person per day basis). So if occupation rate doubles, the total result would double and the per occupant result would remain the same as before.

With certain non-core activities (e.g. irrigation and cleaning of windows) the consumption rate is independent of the number of occupants, so the more occupants in a given building, the lower the per occupant consumption.

The default consumption rates and usage factors were 'middle of the range' values based on defaults used in the main Green Building Assessment schemes (e.g. BREAAM, HQE, LEED, DGNB, VERDE) and part G of the UK building regulations.

Supporting tools and data requirements

From feedback, the most complex aspect was to estimate irrigation water requirements because meteorological data and the water demand of the vegetation is needed to have an idea of the water deficit. A large dataset of the EEA, set at the level of EU river basins has been consulted for evaporation rates and rainfall (the latter is also useful for rainwater harvesting systems). All the tester has, in theory, to do is select the EU river basin and relevant numbers appear in the required cells automatically.

Since the calculator provides default values for all core water uses, it is possible to generate a result simply using default values. This was noticed by some testers with residential buildings, where final results were identical (to 2 decimal places) to the result if only default values were used.

The reporting format

There were some queries about which project stages can be reported on. It seemed to some testers that indicator 3.1 can only be estimated at the post-completion or occupation stages of projects. But this is not the case as estimates can be made even at the design stage when choices are being made about the types of water consuming devices and fittings to install. So it still seems justifiable that reporting sheets can be generated for all project stages, but that this need a clearer explanation.

Feedback overall from testers suggested the following improvements:

- A better alignment of the level 3 format with that of levels 1 and 2;
- Not to confuse users by making greywater/rainwater calculation cells appear or disappear in level 1 depending on the WEI of the river basin;
- To allow for reporting on hot water consumption and, in the occupation stage at least, on actual metered consumption, and
- To fix a number of bugs identified in the water calculator.

It is worth commenting that if actual data is to be entered into the reporting format (at occupation stage only) it would also be necessary for the tester to define the

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occupation rate of the building, so that actual results can be expressed in the common unit of m^3/o/a.

Technical, methodological and/or regulatory advancements to take into account

Apart from an update to the meteorological data and WEI+ estimates in the EEA database, no broader technical advancements or regulatory changes have been identified at this that should be taken into account at this stage.

If hot water consumption is to be reported, then further research would be needed to ensure that default shares of hot water flow in showers etc. are well justified.

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Table 3.9 Key technical issues and proposed updates for Indicator 3.1: Use stage water consumption

Key technical issues to address	**Main proposed technical updates and solutions**
3.1.1 **Harmonise the reporting format** between levels 1, 2 and 3	– (*Exactly what to do here will be influenced by the horizontal discussions on whether the levels should continue in the same manner or be aligned with project stages instead*). – If continuing in the same way, the cells for level 3 should be exactly the same as levels 1 and 2, with some extra cells below to provide extra detail (e.g. on irrigation and window cleaning or other defined uses).
3.1.2 More consistent approach to **greywater/rainwater harvesting in level 1**	– Currently the calculator only allows greywater/rainwater calculations to be possible at level 1 if the WEI+ value is >20. – Either remove the rainwater/greywater calculation functionality from level 1 altogether (to keep as a simpler-looking entry level method), or – Allow the cells to appear always, independent of the WEI+.
3.1.3 Inserting a result for estimated **hot water consumption**	– Review the literature to find reasonable estimates of the shares of hot water in the main flows of relevance (i.e. showerheads, bath-tubs, kitchen taps and bathroom taps) – Link result to indicator 1.1 – Perhaps have a dedicated hot water value in the reporting excel as well.
3.1.4 **Fix the bugs** in the water calculator	– To follow up on specific comments and to recheck calculations, especially for those parts not commonly used by testers.

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Indicator 4.1: Indoor air quality

A large number of testers intended to work with this indicator (77) and the majority were able to report meaningful information. Indicator 4.1 has a number of different facets which may be considered independently or together and this was reflected in the types of reporting observed. In some cases it was very comprehensive and in others only focussing on one aspect or even just part of one aspect.

The main difficulties faced by testers in using indicator 4.1 related to:

- A lack of experience in gathering real data;
- A lack of awareness of the EN 16798 and EN 13779 definitions of air quality categories;
- The need for specialists and the cost associated with in-situ Indoor Air Quality (IAQ) monitoring, and
- Inconsistent approaches to labelling and defining the performance of low VOC emission products on the market.

Terms and definitions

The definitions of 'lowest concentration of interest (LCI) value' and 'ventilation rate' were provided in the level(s) guidance. Although testers seemed to understand well what was meant by the ventilation rate, some specifically commented that they did not know what was meant by LCI. A general lack of awareness about LCI values is supported by the fact that only 1 out of 53 testers actually entered a response in the relevant cells that corresponded to LCI.

Unit(s) of measurement

The input data and associated units depend on which aspect of air quality is being reported on.

At design stage 1, categories are selected from drop-down menus for: ventilation rate, CO_2, relative humidity (RH); benzene and particulates. The measurement units associated with each category are in line with the respective standards. Some testers stated that it would have been very helpful for the threshold values for each category to be incorporated into the reporting excel. Another input is also required for radon (standard units of Bq/m^3), although no drop-down menu is provided.

At design stage 2, the focus is on source control of certain VOCs of concern (carcinogenic VOCs, in units of $\mu g/m^3$, a separate limit for formaldehyde in $\mu g/m^3$ and a limit for LCI). It was clear from feedback that many testers confused the reporting for carcinogenic VOCs with that of total VOCs, although the units reported were consistent.

At level 3 only, it is possible to report on the design and commissioning stage ventilation rates (in standard units of $l/s/m^2$) although the cells relating to post-completion and occupation stage ventilation rates are greyed out. Also at level 3, it is possible to report on air pollutants, this time with specific concentrations and not just categories.

Boundary and scope

The boundary and scope was questioned on some specific points by testers. Some testers wondered why radon was in the scope since this was already addressed by broader local planning constraints. With respect to source pollutants from VOC

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emission testing, several testers questioned why LCI was included and felt that it was not clear what was being asked for. Several testers also responded to the source control data input simply by stating what type of low VOC emission scheme the products were or would be certified by.

In terms of actual in-situ testing, a test for TVOC was considered as much more practical and as a possible warning to indicate when it would be relevant to test for specific VOCs of concern (such as formaldehyde). Some criticism was received about the recommendation for the in-situ testing of benzene since it was an expensive test and difficult to find suitable testing bodies able to carry out this measurement.

Calculation method and reference standards

The methods associated with reporting on indicator 4.1 are all linked to EN standards. The categories for design-stage ventilation rate calculations follow EN 16798 (in particular part 7). EN 16798-7:2017 provides two methods:

i. to estimate air flow rates based on detailed building characteristics and
ii. use rules to apply a statistical approach for the determination of air flow rates.

The second method may be based on method 1 data or real data and the statistical approach can be defined at national level. However, several testers made reference to EN 15251 (now withdrawn as an EN standard), which has recommended methods in Annex B. National versions or variations on these standards were also referred to by some testers.

During the testing period a number of testers requested that the threshold values for EN 16798 and associated categories be made available for reference. The JRC did seek permission to upload a series of tables from the standard on the JRC website during the testing period. However, this did not prevent this point being brought up in survey feedback after the testing period. Access to standards (or the lack thereof) was definitely an important issue for testers with indicator 4.1 – as highlighted in the survey response.

Supporting tools and data requirements

Reporting on indicator 4.1 requires specialists and relevant software to estimate ventilation rates, which in turn will have an impact on IAQ parameters. A major parameter affecting the specification of the ventilation system is the outdoor air quality (ODA), which most testers were sufficiently informed about to be able to report on.

When asked to provide data to inform source control (i.e. VOC emissions from construction materials, paints etc.) testers did not insert any data about the LCI values because they were not familiar with the concept and/or because they did not see any link between low VOC emission labels and the LCI values.

There was a clear misunderstanding regarding total carcinogenic VOCs, with testers instead reporting limits for total VOCs (i.e. carcinogenic + non-carcinogenic), the latter tending to be a much higher number and associated with higher limits in labelling standards. It would perhaps be useful to provide a short guide to the different relevant VOC labels on the market and what they currently measure and report on in terms of VOC emissions.

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The reporting format

In general, the reporting format for indicator 4.1 did not seem to be an issue for testers. Some testers appeared to want to insert quantitative data at the level 1 as well as to choose the categories from the drop down menus. Perhaps cells could be provided for both options.

Based on feedback received, it is recommended to directly provide the EN 16798 thresholds for the different categories of relevance in the reporting excel for level 1.

In respect of source control aspects, an additional column could be beneficial to allow users to specify the VOC emission criteria that they are complying with (e.g. Blue Angel, EU Ecolabel, IAQ Gold etc.).

How the three levels work

Most reporting occurred at level 1, which seemed to be very user friendly, with dropdown menus to choose from for design stage estimations. Level 2 reporting was not relevant for this indicator because it simply defines parameters that must be reported in order to ensure that IAQ in one building or design could be compared with another.

Level 3 reporting was more limited and, when it was reported, data was far from complete. Amongst the reasons cited for the limited reporting at level 3 were the cost and the need for external experts to obtain the data.

Technical, methodological and/or regulatory advancements to take into account

Approaches to indoor air quality have been evolving towards a harmonised approach in EN 16798 (e.g. EN 13779 is now incorporated into EN 16798-3 and 4).

In terms of source control, the chamber-test method for measuring VOC emissions from different materials still varies in different regions. The EN 16516 standard is the newest and most relevant approach in Europe (it equates to a more tightly defined version of the ISO 16000 standard series). Several labelling schemes exist on the market for low VOC emission products (e.g. EU Ecolabel, Blue Angel, Nordic Ecolabel, EMICODE, the Finnish M1 and M2 ratings, IAQ Gold and the French VOC label were mentioned by testers) and these may target more or less individual VOCs and set different limits for the same VOC. Moreover, the Commission has been pursuing an ongoing initiative to develop a harmonised emissions classification system – the outcomes of which should also be taken into account.

In terms of in-situ monitoring, the current measurements recommended in level(s) are generally considered as expensive to carry out and requiring specialist expertise and equipment. Ideally, in-situ monitoring should align with parameters that are direct in-line measurements (e.g. CO_2) or indirect measurements in a laboratory (e.g. total VOCs). Sampling should be possible by non-experts with hand held equipment or via automatic sampling at fixed monitoring points in order to provide real time data.

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Table 3.10 Key technical issues and proposed updates for Indicator 4.1: Indoor Air Quality

Key technical issues to address	**Main proposed technical updates and solutions**
4.1.1 Inclusion of more **information in the reporting excel**	− To provide the EN 16798 reference tables with limits for different categories directly in the guidance and in the reporting excel. − To add a column for low VOC emission labels that can be specified as part of the reporting. − Potentially to add references to recommended test methods for in-situ monitoring in the level 3 reporting parts.
4.1.2 **Explanation** of the different relevant **VOC emission labelling schemes** on the market	− Provide a review of the main labels on the market in Europe, with information on: i. The type of products they cover. ii. The emission methodology used. iii. The specific VOCs that are addressed and the associated threshold values.
4.1.3 Reconsider the most appropriate **in-situ tests to report on**	− Re-review current best practice on the market (e.g. the approach of the WELL standard and DGNB, in which in-situ testing is mandatory) − Consider the level of external expertise that is needed and if results can be generated in-situ via handheld devices. − Consider the potential monitoring cost.

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Indicator 4.2: Time out of thermal comfort range

A large number of testers worked with this indicator (58) and the majority succeeded in reporting fully or partially on level 1 design aspects and with plausible results.

Despite the familiarity of the unit(s) of measurement and the related standards to many testers, there is however still the need to address aspects of the calculations requested and the reporting that are more difficult to derive from existing calculation methods and simulation software.

It may be necessary to explore whether there are any more simplified or semi-quantified risk assessment methods that could be used as a starting point by users who do not work yet with dynamic simulations.

Terms and definitions

No significant issues were raised in relation to the terms and definitions used, although greater clarity on the compatibility with existing compliance methods and simulation tools would be welcomed.

Unit(s) of measurement

The testers appeared to generally be familiar with the concept of the temperature ranges but the main unit of measurement - the 'time of out of range' - appeared to introduce a new concept for many.

The main unit of measurement appears to require better explanation given that testers also felt that the indicator did not tell them how the building performed, when in reality the time out of range enables a comparison to be made with established comfort ranges or EN classes (covered in the part 3 reporting).

Moreover, it was not clear to some testers why parts 1 and 3 of the reporting do not follow the same standards. The need to switch to reporting on the EN 16798 comfort classes, in order to allow for comparison between a design estimate and occupier survey results also appeared to create some confusion. In fact, some expert testers did ask that:

1. The 'adaptive approach' to the definition of internal comfort conditions linked to outside temperatures be highlighted, and
2. that in case that calculations cannot be performed the indicator can later be assessed with questionnaires directed to the users of the building

Boundary and scope

The main issue identified related to the inclusion of both heating and cooling. The extent to which they were considered relevant, or there was the possibility to modify the calculations or simulations (e.g. by omitting a heating or cooling system), varies by Member State and by climate zone.

Calculation method and reference standards

There was a perception amongst testers that some form of dynamic simulation should be used in all cases. The compatibility of a dynamic approach with National Calculation Methods was cited as being an issue.

Although it is not the case that a dynamic approach is always asked for, as in the case of indicator 1.1 greater clarity is needed on which calculation methods can be used, including simpler quasi-steady state methods of the kind used in many Member States for overheating calculations.

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The need to simulate a building with and without heating/cooling was considered problematic and not something that users had had to do previously. In fact, in some Member States it is not possible to calculate performance without a technical building system included.

Supporting tools and data requirements

Linking to the previous point, the more demanding requirements of dynamic modelling and a general lack of knowledge and/or possession of relevant software or calculator tools were cited in the survey response.

Problems were also identified in deriving the necessary data to report on the time out of range from some calculation methods and energy simulation softwares. National compliance methods and some methods developed by industry associations (e.g. CIBSE) do not always provide the necessary data. In some cases a more qualitative, risk assessment approach is adopted alongside simplified calculation methods.

The reporting format

The multiple aspects of the reporting caused some confusion, particularly the distinction in part 2 of the reporting between results with and without mechanical cooling and then in part 3 reporting in terms of EN 16798 categories.

How the three levels work

The option to work at level 3 appeared to work well and to be familiar to those who used dynamic modelling to obtain results.

An advanced user asked that the precision and accuracy be improved by offering a more granular approach - allowing for a full breakdown of building zones or asking for percentage of zones which are within the range for a percentage of the time.

Technical, methodological and/or regulatory advancements to take into account

No broader technical advancements or regulatory changes have been identified at this stage that should be taken into account at this stage.

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Table 3.11. Key technical issues and proposed updates for Indicator 4.2: Time out of thermal comfort range

Key technical issues to address	**Main proposed technical updates and solutions**
4.2.1 Need for clarity on the link between the **part 1, 2 and 3 reporting**	– The level 1 guidance should be reviewed in order to ensure that communication of the basic concept behind the indicator is clear. – This should include reference to how comfort range temperatures are set and the concept of adaptive comfort, which is adopted in the current EN standards – *The proposed move to project stage-based 'levels' may help in explaining to users the relevance of the part 3 reporting option.*
4.2.2 **Dynamic modelling** is not generally used in the residential sector so a coarser risk assessment may only be possible	– Provide instructions giving a number of options for how the comfort conditions could be assessed, – At the most basic level a risk assessment should be an option. A checklist would need to be provided accordingly. – At the most advanced level dynamic modelling without heating/cooling systems would still be encouraged (recognising that this may not be possible in all cases)
4.2.3 Simulating the performance of a building without heating/cooling may be **restricted by the national calculation method**	– The guidance should clarify how overheating compliance methods can be used to report on this indicator. *See also the proposed soluton for issue 4.2.1*
4.2.4 Thermal comfort is normally assessed for **specific rooms or sub-zones**	– Allow for a more granular approach with full breakdown of building zones or percentage of zones which are within the range for 95% of the time (in line with the approach of the EN standard).

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Indicator 6.1 Life Cycle Cost (LCC)

A smaller number of testers worked with this indicator (19) and the majority succeeded in reporting fully or partially on level 1 design aspects and with plausible results.

Despite the familiarity of the unit(s) of measurement to many testers, there is still the need to address aspects of the guidance and calculation method that were considered to lack the clarity and instructions necessary to ensure comparable results.

Terms and definitions

There did not appear to be any major issues with the terms and definitions used, which in part reflect those used in the ISO 15686 standard series.

Upon using some national tools there were some definitions identified that would need to be improved in order to ensure there is compatibility – particularly the life cycle stages and cost centres.

Unit(s) of measurement

The testers appeared to generally be familiar with the concept of the indicator and its unit of measurement. The normalisation to an area-based annual expenditure was carried out correctly.

Boundary and scope

Some life cycle stages were difficult to establish robust cost estimates for. Refurbishment and end of life costs were highlighted. This is understandable given the longer time horizon and forecasting required to put together estimates.

Calculation method and reference standards

The assumptions and default values to be use in making the calculations need to be clearer, according to the survey response. In particular relating to inflation, exchange rates and the reference service life of the building – with the latter requested to be aligned with the value stipulated for indicator 2.4.

It was not possible to check some of the underlying operations that can affect the result substantially – for example, the discounting of future costs.

Supporting tools and data requirements

Those who reported on results for the most part obtained them either from a prior certification (mainly DGNB) or a national calculator tool. This highlights the importance of ensuring there is the flexibility to accommodate results from various sources. Amongst those who did not use an existing calculation there appear to have been no major problems obtaining the relevant cost data from for a project and categorising it accordingly. Notably '*Access to and handling of data sets'* followed by '*calculation and modelling tool software use'* was highlighted as a key area of training to support the use of this indicator.

The reporting format

In general the reporting format appeared not to pose any problem for testers, although there some requested greater flexibility to report on '*other types of costs'*.

How the three levels work

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No specific feedback was received relating to use of the levels. The level 3 aspects had been checked in a small number of tests, but no feedback was provided in relation to testers valuation of them.

Technical, methodological and/or regulatory advancements to take into account

No broader technical advancements, methodological updates or regulatory changes have been identified at this stage that should be taken into account at this stage.

The ISO 15686 series should be reviewed again to see if it could provide further standardised reference points for this indicator.

Table 3.12. Key technical issues and proposed updates for Indicator 6.1: Life cycle costs

Key technical issues to address	**Main proposed technical updates and solutions**
6.1.1 Lack of clarity/consistency in the **key reference assumptions** to be used, including between LCC and LCA	- The reference service life value shall be fixed at 50 years in line with the proposed revision of the guidance for indicator 2.4 and reflecting the general convention for LCA in various Member States
6.1.2 **Reference values** need to be provided for inflation and exchange rates	- The reference assumptions and parameters should be reviewed, with the Commission's cost optimality guidance as a main reference point. - Other institutional reference points such as the European Central Bank could be used to provide sources of reference values.
6.1.3 Improve the potential to report using **existing LCC calculator tools**	- Like LCA, the potential to establish minimum functional criteria for LCC calculator tools could be considered.
6.1.4 Provide clearer definitions in order to support **compatibility with national calculators**	- Clearer definitions of the cost centres to be provided, to be cross-checked with how costs are reported in a sample of other calculator tools.

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Indicator 6.2: Value creation and risk factors

A smaller number of testers provided a survey response for this indicator (21). In reality the majority of testers were involved in reporting fully or partially using the two components of this indicator – the market influence checklists and the reliability rating. This is because it is linked to and integrated with all the other indicators and life cycle tools.

The majority of testers used and successfully completed the reliability ratings included as part of each indicator and life cycle tool. Nonetheless, there were many queries about how objective the rating scales were, which in turn casts some doubt on how meaningful the rating is or how it could be used to make comparisons.

However, in nearly all tests the opportunity to make the link between sustainability aspects and the property's value was not well used – with the fields either left blank or completed incorrectly - suggesting that it was not well understood. was and how this important link can be fostered by Level(s).

Given the importance of developing the potential link between sustainability performance and property value, further attention is therefore needed on how the market influence component is designed. This should be with the intention of achieving the original aims of this indicator, which were are to:

- Focus attention on those aspects of a more sustainable building performance that have the potential to create financial value or to expose owners and investors to risks and liabilities in the future, and
- Provide information on the reliability of the underlying data and calculation methods on which a reported performance is based, to those involved in the appraisal of a buildings value.

The reporting format

Because the reliability rating aspects and the Level 3 aspects were, for the most part, one and the same this created some confusion and duplication in the reporting format. The two could be merged as, in reality, the rating measures the level of optimisation of the performance assessment. Moreover, precision is needed on the conditions for assigning a score, for example, whether under independent verification a building that has a certification should be assigned 2 or 3.

The fields relating to the valuation method used were, in the small number of cases where they were completed, not well understood. In most of these cases they were completed with information about a performance assessment method related to an indicator instead of a property valuation method. Some users stated they needed clearer information on the valuation aspects or that they did not have the expertise to complete the fields. It appears this was the outcome because professional valuers were not involved in the test and were therefore not available to identify a method and/or the possible influences on the property's value.

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Table 3.13. Key technical issues and proposed updates for Indicator 6.2: Value creation and risk factors

Key technical issues to address	**Main proposed technical updates and solutions**
6.2.1 The **reliability rating scales** is considered to be too subjective	– Fully merge the reliability rating aspects with the Level 3 'aspects' in order to create one detailed reference list which can also optionally be scored, if users want to make use of this criteria. – Provide more detailed scoring descriptions for the *technical capability of the personnel making an assessment* and the *independent verification of the assessment*.
6.2.2 Limited **understanding and familiarity with property valuation methods**	– Make a clearer reference to the property valuation methods and criteria that may be used in different parts of the EU. – Provide instructions that make it clearer that either the design team has to check with a property valuer or that the valuer has to complete the *evaluation of potentially positive influences on the market performance*.
6.2.3 Create a **dedicated reporting format for the indicator**	– Create a dedicated reporting format for the indicator which asks that the user confirms the involvement of a property valuer and the method used. This would provide more context for completing the checklists assessing the potential influence of sustainability aspects on the value. – At Level 1 the design team could be prompted with a checklist of aspects of the design that may have an influence on the property's financial value. In this way indicator 6.2 would be the starting point for checking the influence derived from the Level(s) performance assessments instead of vice versa.

Draft for Revision

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