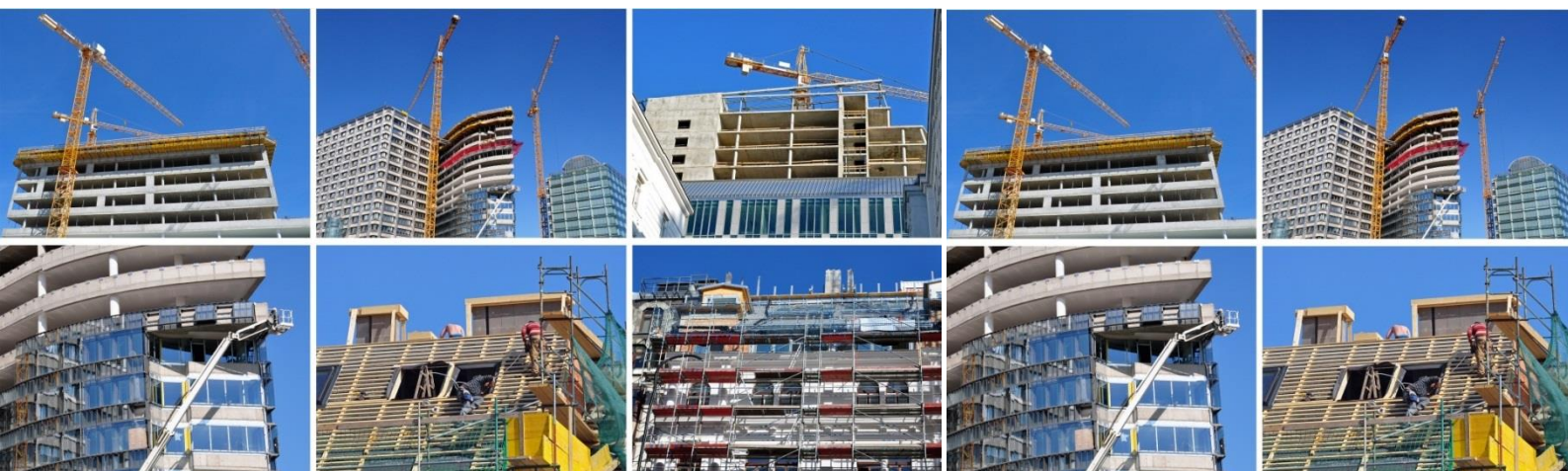European Commission

JRC TECHNICAL REPORTS

Level(s) test phase analysis
Annex 1: Results of the EU survey

Draft consultation version

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1. The survey as part of the Level(s) test phase

1.1. The survey from the tester's perspective

The Level(s) test survey was made available to testers via the EU Survey platform. It was launched at the beginning of October 2018 and ran until the end of September 2019. The survey was designed to complement the results of Level(s) performance assessments by gathering feedback from testers on their overall experience of using Level(s). It also included specific technical questions relating to the use of each indicator or life cycle tool.

The general introduction and instructions provided to survey respondent on the EU Survey platform is provided in the box below.

Introduction to the survey

Thank you for taking part in the Level(s) test phase. The involvement of your test building is important to the future development of Level(s).

As well as the results of your test, the Commission is interested in your experience using Level(s). The aim of this survey is therefore to obtain feedback on testers' experience of using Level(s). Your response to the questions will form part of the Commission's evaluation of the success of the test.

The Commission wishes to obtain feedback on three key aspects of your project´s test of Level(s):

- How useful was Level(s) for assessing the buildings performance?
- How did the design of Level(s) support the process of making the assessment?
- How user friendly were the selected indicators and life cycle tools, together with their supporting guidance?

Before completing the survey it is recommended that the questions are reviewed with all those in the project team who have been involved in the test in order to capture the experience and feedback of the team as a whole.

1.2. Design of the survey to measure RACER KPIs

As well as being designed to gather feedback that could be used to make improvements to the Level(s) framework and documentation, it was also designed to evaluate whether the Beta version of Level(s) has been a success when measured against a RACER framework of Key Performance Indicators (KPIs). These KPIs are based on the original aims and objectives of Level(s) as set out in the European Commission's 2014 Communication on Resource Efficiency Opportunities in the Building Sector.

The complete list of KPIs is provided in the box below. To allow for a semi-quantitative assessment of the KPIs to later be made, the majority of the questions in the survey were based on rankings of opinions or the selection of options complemented by a smaller number of open questions. The latter have been analysed in detail and prioritised in order to provide input to the formulation of proposals to improve Level(s) by the JRC.

RACER framework for evaluating the performance of the Level(s) framework

1. Relevance

- KPI 1.1: More efficient use of resources by new and renovated commercial, residential and public buildings and a reduction in their overall environmental impacts throughout the full life cycle.
- KPI 1.2 Enabling the setting of clear objectives and targets, including system boundaries, for building performance, complementing already existing European legislation on building
- KPI 1.3 Provides public authorities with access to core indicators and to a critical mass of relevant data on which to base their policy initiatives, including Green Public Procurement

2. Accessibility

- KPI 2.1 Accessibility of reliable, comparable and affordable data, methods and tools on which the operators in the supply chain can analyse and benchmark the environmental performance of different solutions.
- KPI 2.2 Can be incorporated as a module in assessment schemes next to their larger sets of indicators or can be used on its own.
- KPI 2.3 Allows for translation of technical indicators into information useful for the financial community wherever necessary

3. Credibility

- KPI 3.1 Provides reliable and comparable data to be used in decision-making covering the entire life-cycle of buildings
- KPI 3.2 Presents guidance concerning its implementation, in particular requirements for data quality and reliability

4. Engagement

- KPI 4.1 Increases awareness of the benefits of sustainable buildings among actors engaged in providing buildings, as well as private and public clients, including users of buildings
- KPI 4.2 Widens the market for sustainable buildings to a broader part of the building stock and property market than current trends indicate
- KPI 4.3 Reduces the cost to communicate the environmental performance of buildings

5. Robustness of the underlying methodologies

- KPI 5.1 The entire life-cycle of a building must be considered if the environmental impacts are to tackled effectively. Otherwise, impacts may be overlooked or additional problems created in other parts of the life cycle.
- KPI 5.2 Provides reliable and comparable data to be used in decision-making covering the entire life-cycle of buildings

2. The profile of the testers and their building projects

A total of 82 responses were submitted using the EU Survey tool. This represents a 60% response rate, based on those stakeholders who registered to take part in the test, and close to a 100% response rate from those testers who finally also submitted results using the excel reporting tool.

2.1. The indicators and life cycle tools tested

The testers were asked 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 number of tests made by indicator, life cycle tool and level

- Level 1 tested
- Level 2 tested
- Level 3 tested
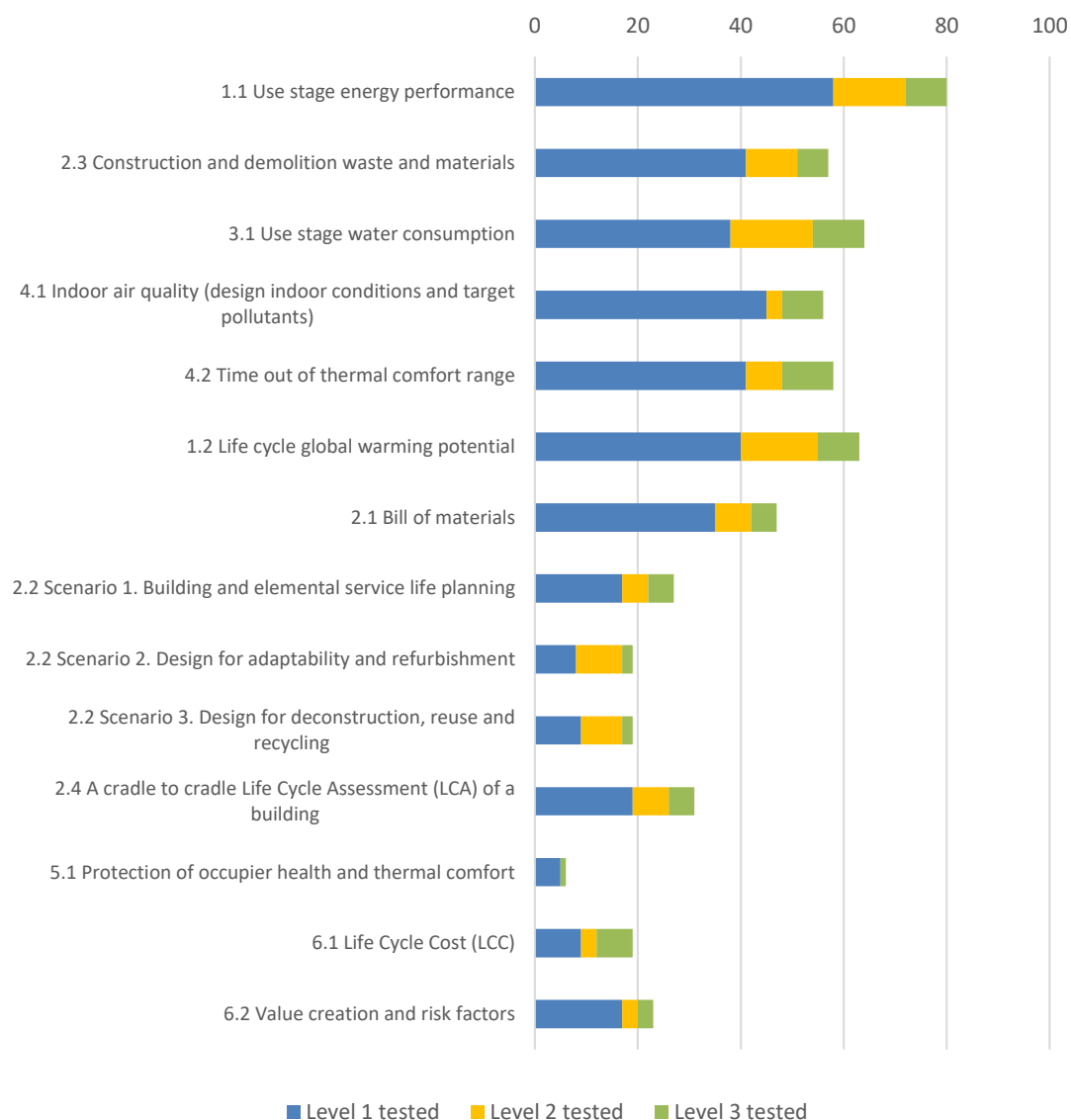
The possibilities for optional additional reporting (2.2, 2.4, 5.1, 6.1 and 6.2) were subject to much less testing, with the number of testers ranging from 6 (5.1) to 31 (2.4).

Based on the respondents choice of indicators and tools the EU Survey then automatically generated a generic set of questions for each individual indicator and life cycle tool tested, the results of which are presented in section 3.4 of this report.

2.2.   *Background of the test respondents*

Questions were asked in order to obtain a profile of the respondents to the survey and the building projects they have tested – the type of building, the professionals involved in the test, the involvement of specific types of stakeholders and the project stages at which they have tested Level(s).

Below the responses to the relevant questions 1.2, 1.5, 1.6 and 1.8 from the introductory part of the survey are briefly presented and analysed.

Q1.2 In which country is the project on which Level(s) has been tested?

The distribution of testers by both country and by broad geographical region are presented in the figures below. The majority of the tests took place in five countries – Finland, Denmark, France, Italy and Spain – accounting for just over 75% of the tests that were successful in delivering results and a survey response. The Western EU countries can be seen to be significantly under-represented.

Geographical distribution of testers by EU region
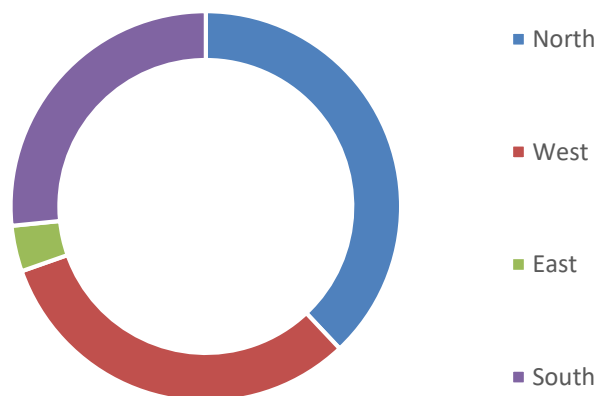
- North
- West
- East
- South

Q1.2 In which country is the project on which Level(s) has been tested?

Country	Value
Finland	22
Denmark	17
France	10
Italy	8
Spain	5
United Kingdom	3
Belgium	3
Austria	3
Slovenia	2
Malta	2
Germany	2
Sweden	1
Portugal	1
Netherlands	1
Greece	1
Croatia	1
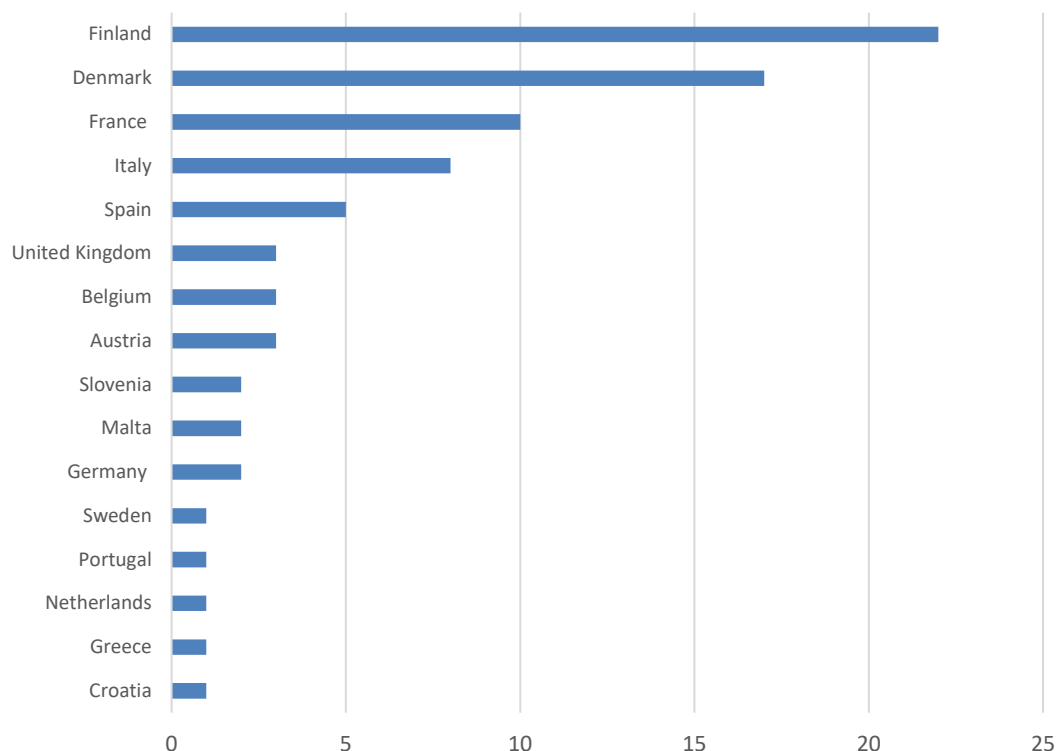
Q1.6 Which building professions have been involved in the Level(s) test?

Respondents identified a wide range of professionals that had been involved in their test, highlighting the multi-disciplinary nature of making a performance assessment using Level(s). The professionals cited have been grouped using the most common terminology that they used in their response.

Amongst the range of building professions identified as having been involved in each test projects, architects, engineers (from a range of disciplines), energy consultants, environmental advisors and LCA specialist were of particular importance to the test projects.

Q1.6 Which building professions have been involved in the Level(s) test?
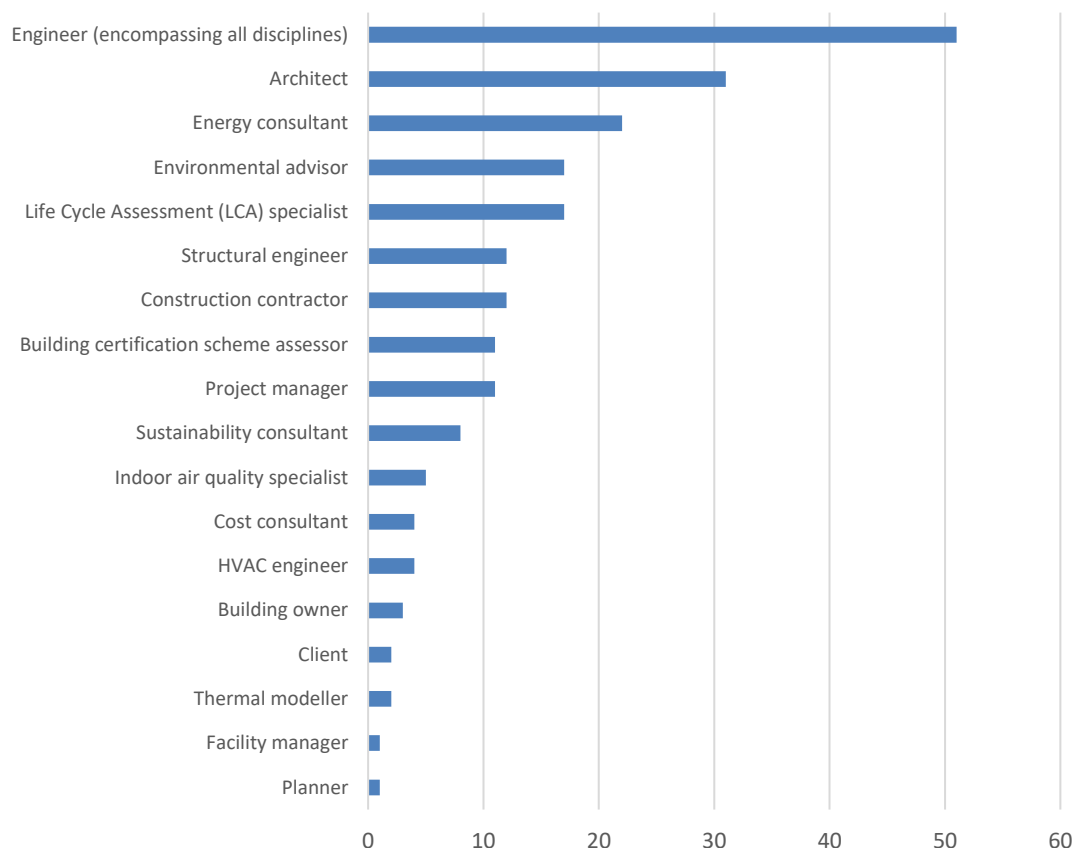
Q1.8 Please indicate which of the following stakeholders have been involved in the test

This question was designed to then be linked to sets of questions addressing the value of Level(s) for three target groups of building stakeholders – namely those directly involved in building design and construction, private investors and owners, as well as public authorities.

As can be seen from the response, the majority of the testers (66%) involved building design and construction stakeholders. 17% of the tests involved in some way a private investor or owner and 21% a public authority.

Q1.8 Please indicate which of the following stakeholders have been involved in the test
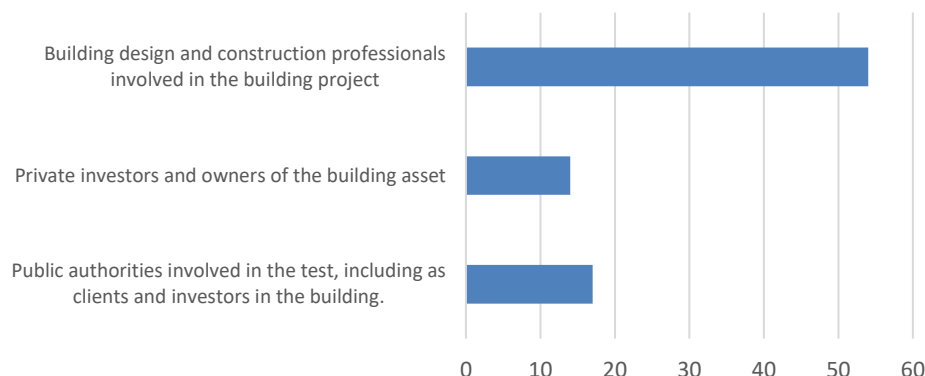
2.3. The building projects on which Level(s) was tested

Here responses relating to the building type and project stage at which Level(s) was tested are presented and analysed.

Q1.5 _What building type have you tested Level(s) on?_

The majority of the respondents had tested a residential building (46%), followed narrowly by an office building (35%). Around 15% had tested another building type, with those identified including schools, health care centres and training centres.

Q1.5 What building type have you tested Level(s) on?
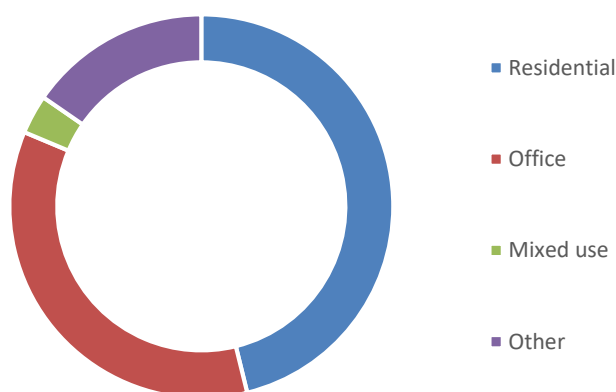
Q1.9 At which project stage have you tested Level(s)?

The response to this question provides an overall picture of the project stage at which Level(s) was tested. It can be seen that nearly half of all the test assessments were made at the design stage, or based on design stage information. The remaining tests were evenly split between the other project stages that could be selected.

Q1.9 At which project stage have you tested Level(s)?

- Design stage
- Construction
- Completion and handover
- Occupation
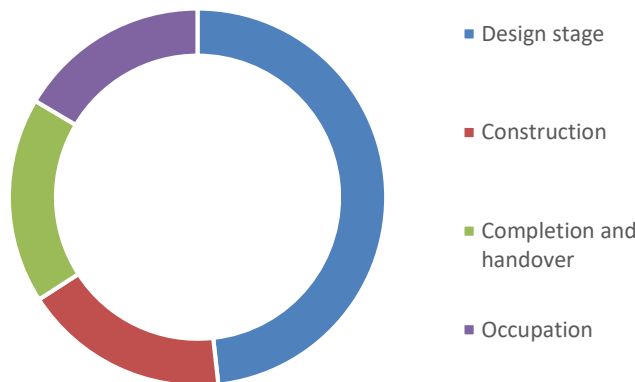
3. The Level(s) test survey

The test survey was split into four main sections, dealing firstly with the testers' experience and their evaluation of Level(s) as a whole, before moving on to their use of the indicators and life cycle tools themselves. This report is therefore structured to replicate the exact sections as presented in the EU Survey online, which were as follows:

- Expectations and previous experience
- How Level(s) is designed
- The value of Level(s) to key stakeholders
- Using the test indicators and life cycle tools

Under each section, the questions are replicated in their wording, together with a brief analysis of both the multiple choice and open questions.

3.1. Expectations and previous experience

In this section, testers were asked about their expectations and motivations for using Level(s) and for taking part in the test. Previous experience of making sustainability performance assessments was asked for.

Q2.1 When joining the test phase, what were the general expectations that motivated the use of Level(s)?
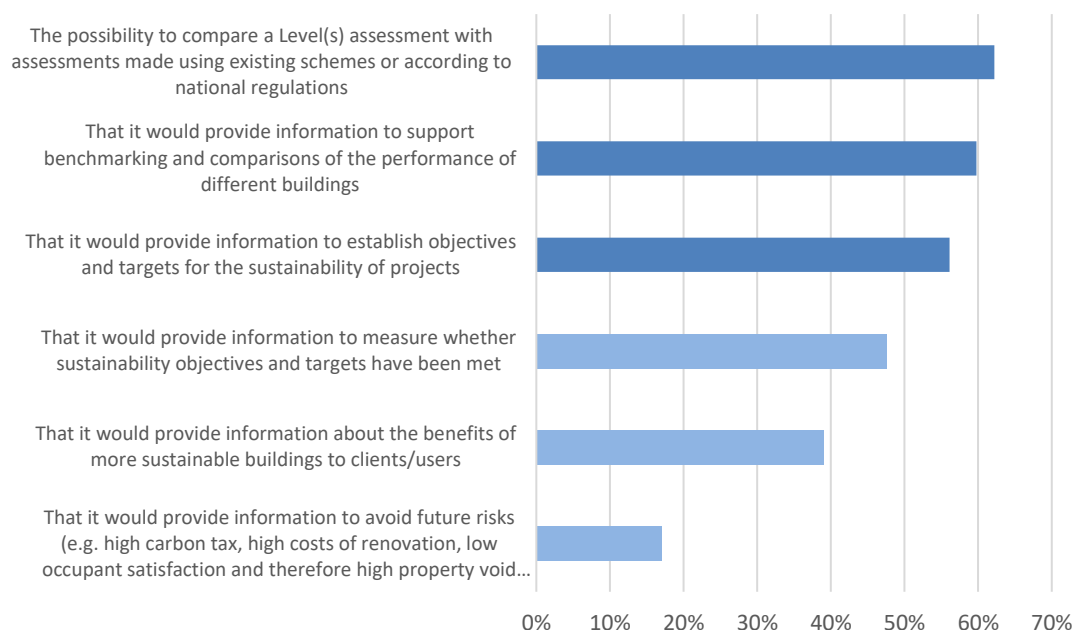
In total 28 of the testers responded and for this question several responses could be selected. It can be seen that the majority of testers were interested in either making a comparison with the outcomes of other assessments they had carried out, obtaining information to support comparisons of the performance of buildings and/or as the basis for establishing objectives and

targets   for   projects.

Please elaborate further on any other expectations and motivations

In total, 28 of the testers chose to elaborate on their expectations and motivations for taking part in the test. Their responses have been clustered under the main themes that could be identified, together with mostly verbatum quotes from their specific expectations and motivations, in Table 1.

The response was fairly evenly split between five main themes – developing project learning and know-how, aspects of life cycle assessment, getting to know how Level(s) works, Level(s) as an EU framework and a future tool for industry and the market – and two further themes were of lesser importance.

The first three of these themes reflects a focus on developing the capabilities of the test team, both in terms of using Level(s) as a new tool and in terms of new ways of assessing the sustainability of a building.

The last two of these five themes reflects expectations that Level(s) will become a driver for new policies. Reference was made to an EU wide framework and working between countries and approaches. Some testers were curious about its potential future role.

Table 1 Clustering of testers' expectations and motivations

Theme that could be identified	Number of views cited	Testers' expectations and motivations
Develop project learning and know how	5	That we could increase the knowledge of the project team
		That it would educate personnel on sustainability, and on the required information to obtain results.
		To develop "knowhow" of the project personnel
		To learn about sustainability measures
		To understand how sustainable was the building and what could be improved.

Aspects of life cycle assessment	5	To obtain familiarity with useful Life Cycle parameters
		To have an overview of the EPDs available at local geographical location of Finland (2)
		They wanted to take part in developing carbon footprint
		To take part of developing carbon footprint
Getting to know how Level(s) works	4	Testing Level(s) within an existing building, getting Level(s) system knowledge
		[it was] a chance to get to now Levels and a chance to participate in the development of Levels
		[They could] Join the others who are involved in the Level(s) project and have the opportunity to build a network to continue applying the level(s) project results.
		[they could] get to know Level(s) and to actually work with it...and perhaps have influence on the final Level(s) handbook.
Level(s) as a European framework	4	Level(s) is the first European framework that...embraces wider aspects of environmental performance of building projects and goes beyond the simple building codes
		...a European harmonized alternative/complement to existing detailed rating schemes... an interesting option for building owners using their buildings on their own who do not need a "real" rating label...
		A tool that could be used for comparison between countries
		Learning about Level(s) and experience different approaches from the different countries.
		Bringing a Danish touch to the test-phase and evaluation.
A future tool for industry and the market	4	Because we believe Level(s) is a valuable tool for the market and that it will become an important sustainability assessment tool.
		We want to be at the forefront of the industry and are curious to understand how Level(s) may influence the current market....
		That our Company would be ready to act when/if leve(s) is some day obligatory.
		To test the feasibility of the methodologies...compared to what is actually done in my company and analyse what should be done to be "compliant".
A sustainable construction dashboard or tool	3	The idea of having a sustainability dashboard for the building industry....going beyond energy performance assessments.
		To understand the meaning of different construction materials in different modules and....the meaning of CO_2-flows through LCA.
		...a tool that would be able to test the sustainability of the building in various degrees, and.....to what extent certain goals had been met.
Future European regulations and methods	2	...to sensitise the Slovenian government to Building sustainability Assessments....[and] to help the deployment of a standardised method in Europe...
		That it would give us valuable information on future-coming regulations.

Q2.2 _**How would you describe the test team's overall previous experience in making environmental or sustainability performance assessments of buildings?**_

In total 80 of the testers responded. Their response to this question contrasts markedly with the initial profile of team experience provided by the registrations in 2018, in which there appeared to be a balanced representation of testers with extensive, intermediate and limited/no experience. This may be because during the process the make-up of project teams changed, with additional expertise having been obtained in order to make some of the performance assessments.

Q2.2 How would you describe the test team's overall previous experience in making environmental or sustainability performance assessments of buildings?
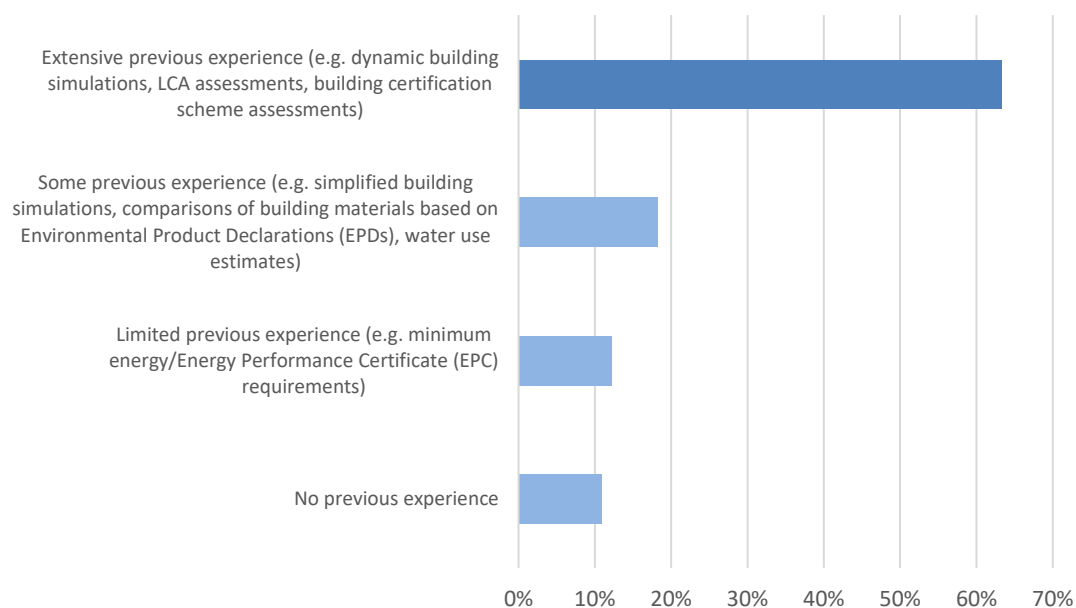
Q2.3 _**If your team has previous experience of making environmental or sustainability performance assessments, please identify the specific performance assessment schemes and methods that they have used**_

In total 70 of the testers responded, echoing the response to the previous question 2.2. Perhaps further reflecting the response to Q2.2, the majority of test teams included experience using an LCA tool at building level, followed by around a third who had experience making assessments according to LEED, DGNB or BREEAM.

Q2.3 If your team has previous experience of making environmental or sustainability performance assessments, please identify the specific performance assessment schemes and methods that they have used

Scheme	Percentage
LCA tool (various)	53%
LEED	34%
DGNB	30%
BREEAM	29%
LCC tool (various)	17%
Dynamic energy simulation tool (various)	13%
E+C framework (France)	11%
EPD schemes	7%
HQE	7%
GRESB	6%
WELL	6%
VERDE (Spain)	4%
klimaactiv (Austria)	4%
OGNI (Austria)	4%
ITACA (Italy)	3%
Miljöbyggnad (Sweden)	3%
GBC Italia schemes	3%
CESBA	3%
SB Tool (Portugal)	1%
CEEQUAL	1%
ASHRAE 189 (USA)	1%
NABERS (Australia)	1%
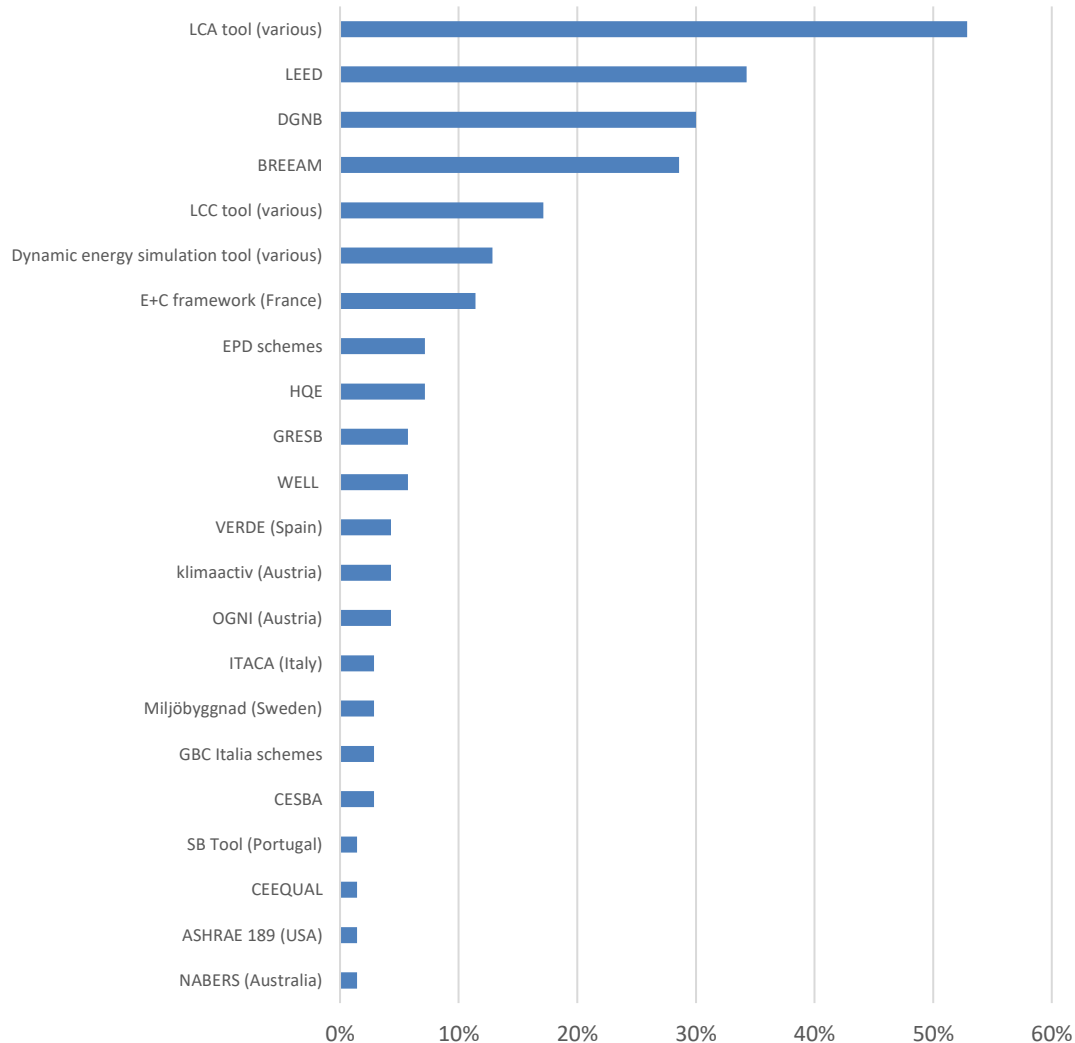
Q2.4 *Please briefly explain what would have encouraged additional testing*

In total, 47 of the testers chose to explain what would have encouraged them to make additional testing using more indicators or at a more advanced level. Their responses have been clustered under the main themes that could be identified, together with quotes from their explanations and suggestions, in Table 2.

The most cited form of encouragement was to have had more accessible methods and materials. Issues with the ease of use, complexity and instructions were cited, amongst others. The available time and resources was the next theme that could be discerned, highlighting the need to take this into account from a user perspective.

Knowledge and training was the next theme, with training to carry out LCA and LCC assessments as well as better knowledge about the benefits and value of using the framework were cited in particular.

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A number of issues were also cited that were project-related in some way. In particular, a dependency on a client's demands and expectations was noted. This could suggest that it will be important that Level(s) is/can be communicated to clients, so that they can learn about the potential benefits.

Table 2. Clustering of testers' views on what would have encouraged them to carry out additional testing and to do more

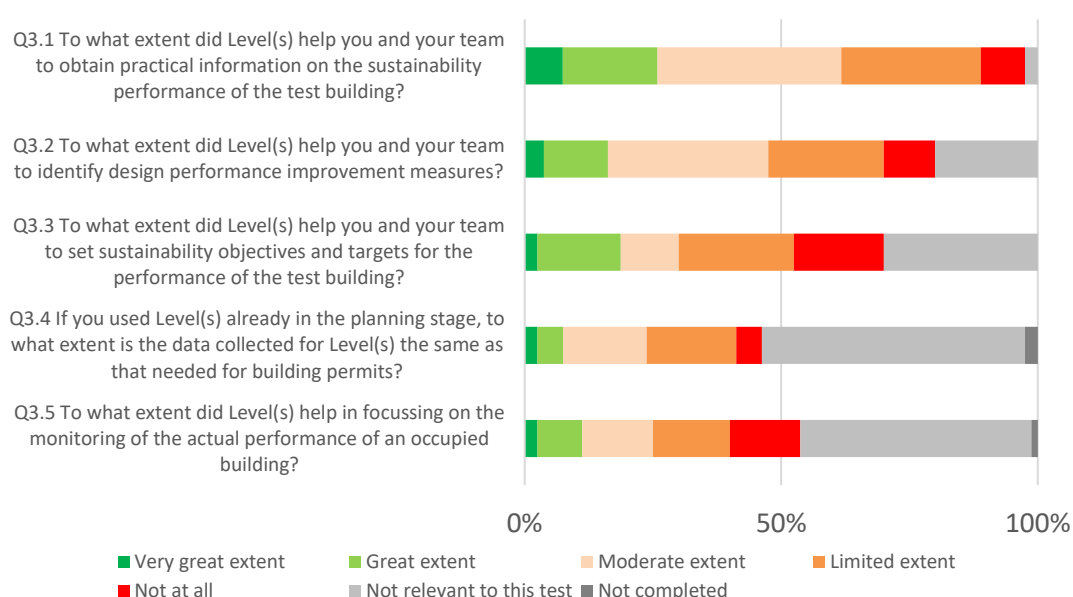| Theme that could be identified	Number of views cited	What would have encouraged testers to do more (number of testers)
More accessible materials and methods	18	Should be easier to use (5) Reduce the complexity (3) Clearer, shorter instructions (2) Material in their own language (2) Flexibility to adapt to local standards Simpler method Simpler reporting Language too technical LCA explanation and simplification Tool providing a score and information about the benefits
More time and resources	12	Available time and resources (4) Funding (3) Cost and knowledge required to use whole framework (2) Value to building owner/investor (2) Minimum scope too demanding
Knowledge and training	9	LCA/LCC training required (3) Information on the benefits and value of sustainability (2) Free access to LCA tools Need for specific skills More general insight needed Information at a national level Information on the benefits and value of sustainability
Project-related issues	8	Dependant on client demands and expectations (4) More preparation before the design phase It was not used earlier in the design process It was tested too early in the design process Time had passed since handover, data collection more difficult

3.2. How Level(s) is designed

In this section, testers were asked about the added value of using Level(s), including the different 'levels' and reporting options. In the first set of five multiple choice questions Q3.1-3.5 testers were asked for their views on a number of different aspects relating to the added value of using Level(s).

Q3.1 and 3.2 received the highest response, with Level(s) considered by most testers to a moderate or greater extent to have supported obtaining practical information on sustainability performance and/or to have helped identify improvement measures. It is not clear the extent to which the second response was less positive due to testers having already made design decisions.

In relation to Q3.3 on sustainability objectives and targets, the response was rather more mixed, with a greater proportion of testers selecting '*not at all*'.

The mixed response continued with Q3.4 and Q3.5, in relation to the use of existing data from building permitting and the monitoring of actual performance. In the case of Q3.5 a small but significant proportion selected '*not at all*'.
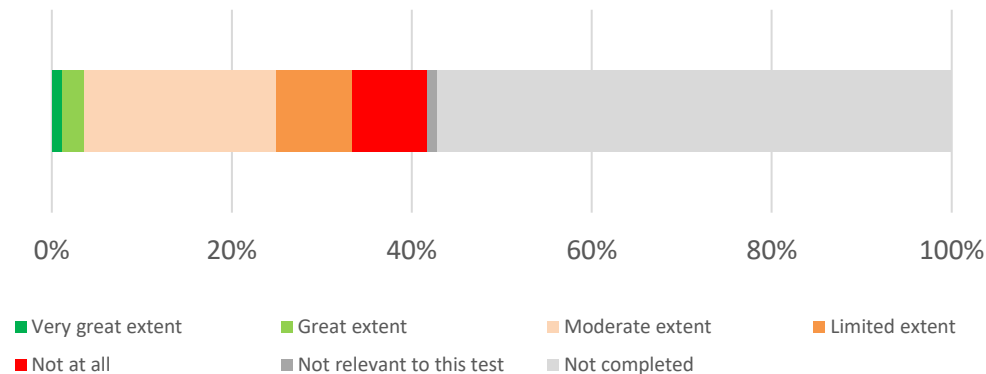
The added value of using Level(s), including the different 'levels' and reporting options

Q3.1 To what extent did Level(s) help you and your team to obtain practical information on the sustainability performance of the test building?

Q3.2 To what extent did Level(s) help you and your team to identify design performance improvement measures?

Q3.3 To what extent did Level(s) help you and your team to set sustainability objectives and targets for the performance of the test building?

Q3.4 If you used Level(s) already in the planning stage, to what extent is the data collected for Level(s) the same as that needed for building permits?

Q3.5 To what extent did Level(s) help in focussing on the monitoring of the actual performance of an occupied building?

■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent
■ Not at all ■ Not relevant to this test ■ Not completed

Q3.6 If in question 2.2 you said the test team had limited previous experience making sustainability assessments, to what extent has the use of Level(s) helped in getting started?

In total 36 of the testers responded. The relatively low response to this question reflected the increased proportion of test teams with greater experience seen in Q2.2. Approximately half of those with limited previous experience consider Level(s) to have helped them get started to a '*moderate extent*', followed evenly by a '*limited extent*' and '*not at all*'. This raises a concern as to why Level(s) was not able to support them. The analysis of the 35 open responses to the question in **Error! Reference source not found.** providing some insight.

Q3.6 If in question 2.2 you said the test team had limited previous experience making sustainability assessments, to what extent has the use of Level(s) helped in getting started?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not relevant to this test
- ■ Not completed

Please briefly elaborate on the reasons for your response

Whilst there were many positive comments, there were also a range of negative views relating to the complexity and the lack of an overview on the sustainability of a project. Whilst Level(s) was considered by some to have value in improving the building teams' knowledge and supporting the inclusion of sustainability in a project, for some they considered that a focus on team development was lacking and that it was not so intuitive. The need for simplicity and brevity in the instructions was also highlighted.

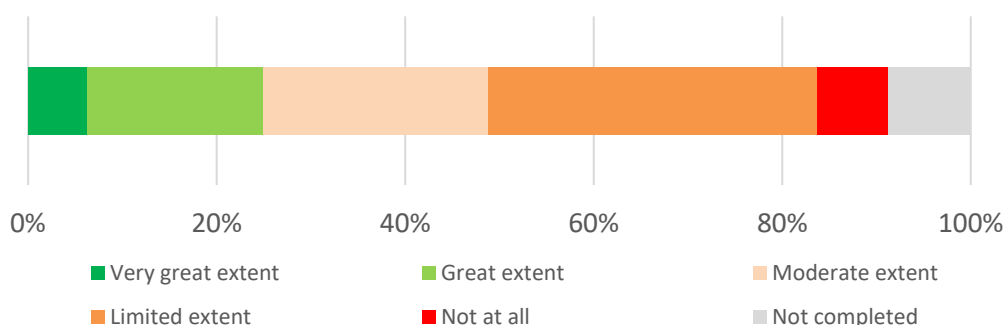*Table 3. Clustering of testers' views on how Level(s) can provide help in 'getting started'*

Theme that could be identified	Number of views cited	How Level(s) can help in 'getting started'
Support in reporting	**7**	*Positive* – Allowed us to establish a baseline performance – Useful in providing a starting point *Negative* – It was too complicated (2) – It was too difficult and complicated (2) – Misses an overview of the sustainability of a project
Improving team knowledge	**7**	*Positive* – It's value is in increasing understanding of project team – Supported inclusion of sustainability into project processes and responsibilities – Overlap with existing assessment schemes helped – Prior experience with assessment schemes meant it didn't require much additional expertise *Negative* – The team lacked the know how to collect data in the form needed – Too much focus on answers and not development – It is not very intuitive

Motivating it's use	4	*Positive* – Filled gap to address life cycle processes *Negative* – For users links to national legislation would provide better support – Guidelines and instructions too long – It should be simpler for new users
The scope it offers for improvement	4	*Positive* – Has an expanded focus beyond just energy performance *Negative* – It is very comprehensive but a simpler method would help with use (3)
As a learning process	3	– We learned a lot during the process – We learnt to use life cycle software tool and calculation methods – It provided a new way of solving problems
As a starting point	3	– Good for non-experienced practitioners to understand what to focus on (2) – Calculations and reports required are already familiar

Q3.7 Based on the Levels at which you chose to test, to what extent did the test team find the option to work at the three distinct Levels to be useful?

There were split views on the usefulness of the 'levels', with just under half considering it to be useful to a moderate or greater extent, whilst a significant proportion of respondents felt that they were only of limited value. The analysis of the 56 open responses in Table provides some more detailed insight.

Q3.7 Based on the Level at which you chose to test, to what extent did the test team find the option to work at the three distinct Levels to be useful?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

Please briefly tell explain your views on the usefulness of the levels

There were a diversity of different views on the usefulness of the 'levels'. The mostly commonly discernible theme related to how the levels are designed and work. There were on balance rather negative views and proposals for improvement. Amongst the views cited, clarity on their

use and intent, the difference between them and too many options and requirements were the most common.

Some proposals were made, relating to their use to manage an increment in data, to support building improvement linked to project stages and the possibility of defining minimum and advanced levels.

The second most commonly discernible theme related to the use of levels 2 and 3. Whilst there were positive comments that they brought value, allowed for adaption to the market and provided insight on the credibility of the assessments, there were also comments that they were difficult to understand, that the difference between levels 2 and 3 was not clear and that they required more comprehensive methods than current national requirements.

Level 1 received, on balance, positive views as a starting point, albeit with some negative views that it was more difficult than expected to use.

Table 4. Clustering of testers' views on the usefulness of the levels.

Theme that could be identified	Number of views cited	Views on the usefulness of the levels
How the Levels are designed and work	**19**	*Positive views* - Useful that you can choose the level of testing - Useful as an indication of what additional data/modelling is needed - Useful as a framework for project development *Mixed views* - The concept is good but the content too advanced - The concept is good but needs more testing - Is it really necessary to have the 3 levels? *Negative views* - Use and intent are unclear (2) - Purpose and definition are unclear - The concept was not useful - The difference between them is not clear - Too many options and requirements - They don't provide an overview of project sustainability *Proposals made for improvement* - Would be more useful if it were related to an incremental degree of data (2) - Set it up to provide comparability and support building improvement linked to project stages - Proposes further refining the definitions of the levels - Proposes minimum and advanced levels
Use of Levels 2 and 3	**15**	*Positive views* - Useful to understand to what extend the assessment is credible (2) - Useful to bring value on top of the basic issues - Provided motivation to improve the design - Enables adaptation to market maturity - Different levels can be worked on in parallel *Mixed views* - Useful once you have improved the team's capabilities

		- Levels 2 and 3 need more time, and have to be planned at an early stage. - Require more comprehensive methods than current national requirements - Requires more experience with LCA and LCC calculations Negative view - Difficult to understand how to use them - Basis for making comparisons is not clear - Not clear how level 2 is different - Even at level 2 some aspects can be freely selected - Specific skills would be needed, which is problematic for a public agency *Proposals made for improvement* - Ensure better comparability without fixing the tools/databases required
Use of Level 1	**13**	*Positive views* - Good to have a starting point with limited information requirements (2) - Good to have easy starting point (2) - Good to have a stripped down version in the early phase - Good to do something instead of nothing - Provides an easy starting point for most indicators *Mixed views* - Only useful if used at a stage before decisions made - The benefit is unclear because comparability is not assured - Benefits at design stage are not clear *Negative views* - It is more difficult than expected and as an entry level - It is too difficult for most users and as an entry level The Level and difficulty don't correlate - it should have been much simpler
Relationship to project stages	**2**	- Assessing a building at the different stages is very relevant. - Link the levels to project stages
How they support benchmarking	**2**	- There is a lack of benchmarks in order to optimise a building - A reference building for comparing a design with is not defined
Relationship to the national context	**1**	- It is complicated to translate the requirements into a national context.

Q3.8 If Level(s) was tested on a residential building, to what extent was it technically suitable for assessing this type of building?

In total 45 of the testers responded, accounting for all those who tested a residential or mixed use building. The majority were split between it being suitable to a '*great extent*' or a '*moderate extent*'. Further insight was provided by the 23 respondents to the open question, the analysis of which is presented in Table 5.

Q3.8 If Level(s) was tested on a residential building, to what extent was it technically suitable for assessing this type of building?

■ Very great extent   ■ Great extent   ■ Moderate extent
■ Limited extent   ■ Not at all   ■ Not completed
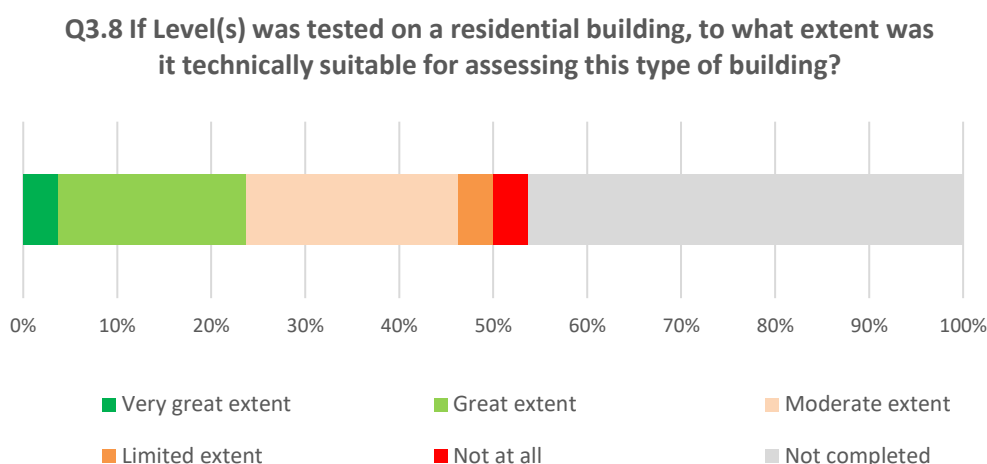
Please briefly explain the reasoning for your response

The majority of the comments and views were clustered around its 'general suitability' can be seen to complement the response to Q3.8, with a range of positive views presented. There were only some mixed views relating to being more suitable for more complex projects and that some indicators/methods would not be required for residential projects.

A range of more negative comments have been clustered under the heading 'data collection'. Here Level(s) was considered to have requirements that are too exhaustive and that in particular for indicators 4.1 and 4.2 it was not easy to make an assessment.

Table 5. Clustering of testers' views on the suitability for assessing residential buildings.

Theme that could be identified	Number of views cited	Views on the suitability for assessing residential buildings
General suitability	**14**	- It is suitable (3) - It is suitable but LCA requires expertise and tools - It is suitable to address several areas of building sustainability - It is suitable with the exception of some parameters e.g. CO_2, humidity - It met all expectations - It was logical and accessible - The tools were aimed towards residential buildings - It support the planning for a sustainable project - Options were given for residential in the building description *Mixed views on suitability* - Too intense to be a design tool - More appropriate in the short term for larger more complex residential developments - At national level some aspects are not always required for residential buildings e.*g. dynamic simulation*

Data collection	8	- Data requirements are too exhaustive e.g. 1.1 energy uses (3) - Indicators 4.1 and 4.2 is not easy to assess (2) - Indicator 4.2 is not easy to assess - If you know what to look for it is feasible to collect the data - It was possible for the MO1 indicators
Non specific response	2	- It has been applied to an innovative residential project
Specific typologies	2	- Conditions of use need to be flexible to specific residential building typologies e.g. residences - Allow for reporting on assessment aspects relating to specific rooms
Comparability	1	- Propose to fix this by country e.g. floor area and energy calculation methods
Guidance	1	- It seemed to be adjusted for residential buildings
Project stage	1	- The difficulty of obtaining data varies by project stage

Q3.9. Now that you have tested Level(s), please make any suggestions for improvements that would make it easier to use

This open question was designed to elicit a very broad response on views and suggestions to have emerged from the tests. 56 testers responded and their suggestions for improvement, which touched on a very broad range of issues, are clustered in Table 6.

The greatest number of comments have been clustered under the general heading of '*the guidance*'. Here there were clear views expressed that it is too complex and should be easier to understand. A range of suggestions were made, touching upon its user-friendliness, the need to be visually appealing, the need to simplify the technical language and possibility to include worked examples. The guidance should guide users more than it currently does on how to obtain results. The text should be more accurate and specific, providing an incremental or step wise process, a single procedure for each indicator and a differentiation between requirements and advice.

Attention needs to be focussed overall on the accessibility of '*Level(s) as a whole'*. It should be available in a range of languages and simpler/more intuitive to use. The objectives and use of the levels need greater clarity and the concept of the levels needs to be clearer and more consistent.

The compatibility of Level(s) with local '*standards and methods'* is a major challenge. In particular, there should be the potential to use local conventions for building element categorisations as well as calculation methods. Moreover, it should be more consistent in communicating which standards or methods should be used as a basis. Extracts, references and tables from standards should be provided so as to reduce the barriers to using the indicators.

The excel '*reporting tool'* was specifically identified as needing improvement. A more user friendly interface was considered to be needed. More supporting calculator tools, like the water calculator provided, would be useful.

In relation to the 'assessment result', there was a request for support in benchmarking. A weakness of Level(s) was that it was felt that it did not provide a sense of a building's relative sustainability. Benchmarks provided could be defaults for the market or a specific country.

Table 6. Clustering of testers' views on the suitability of Level(s) for assessing residential buildings.

Theme that could be identified	Number of testers	Views on the suitability for assessing residential buildings
The guidance	**39**	It is too complex and should be easier to understand (10) - The guide should be more user-friendly - A better overview is needed - It needs to be more visually appealing (2) - The guidebook requires work to make it more easily understandable to design teams. - The technical language is difficult to understand (3) - Examples should be provided (3) Guide users on how to obtain results - Restructure to provide an incremental process (2) - More accurate and specific text with examples (2) - Single methodological procedure for each indicator (2) - The structure and link between parts 2 and 3 needs attention - A better link is needed between the guidance and tools - Separate and shorter manual explaining requirements is needed - A simpler more stepwise approach is needed - More help is needed to fill in 'standard' values - It needs to be more accurate and explicit - Ensure there are clear requirements for calculating at each level - Clearly differentiate between requirements and advice is not clear - Clearly differentiate between requirements and guidance - Clarify what is/is not up to the user A national interpretation or translation of the manual would be a great help
Levels as a whole	**17**	*Accessibility* - It should be translated in each country's language (3) - It needs to be simpler and more intuitive to use (2) - It should be adapted to each country - It needs to be more accessible to design teams *How it works* - The objective and use of the levels needs greater clarity (3) - Clarification and consistency is needed on the 3 levels (2) - The differences between the levels should be made clearer - The 3 levels introduces unnecessary complexity - Sometimes 2 and 3 are easier than 1 e.g. 4.1 - Better explanation is needed as to why different aspects are covered - Further consideration is needed as to which are mandatory and optional indicators

Standards and methods	17	*National standards*
		- Allow for use local building elements categorisation methods (3) - Specify European regulations and verify, case-by-case, whether to use national regulations (2) - It should be more focused on national methods (2) - Are results obtained according to national/local policies accepted? - Improve compatibility with national standards *Use of existing standards* - Improve compatibility and consistency with existing standards (2) - Level(s) should tell you which method to use - Only well defined standards and parameters should be used - Concrete extracts from the methodologies should be included - References or tables from standards should be provided - Standards references should be more specific
Reporting tool	16	- A more user friendly interface is needed (8) - The tool requires improvement (2) - Embed some of guidance in the tool - It should be possible in each country's language *Information requirements* - Define more clearly what information is required in the reporting tool (2) *Supporting tools* - More standalone tools (like the water calculator) should be provided (3)
Assessment result	14	*Request for benchmarking* - It provides no assessment of a buildings sustainability (4) - Benchmarks and scales for the assessment need to be included (2) - Benchmark results against defaults for the market (2) - Benchmark results against defaults for the specific country (2) - Benchmarking against other users would be useful - Reference values should be provided *How results are presented* - More visuals would make it easier to compare results
Level 1	5	- Level 1 is quite difficult for beginners to use and needs simplification (3) - Better definitions and guidelines for users are needed - The guidelines need to be simpler

Input data	3	- Further specification required of which inputs are needed - Ensure that building input data from other schemes is supported (2)
Project stage	3	- Requires further adaptation to apply to in-use (occupied) assets (3)
Supporting tools	2	- Supporting access to databases is needed for some indicators e.g. 1.2 - Supporting calculation tools should be provided for some indicators *e.g. 4.2*

Encouraging life cycle thinking

A number of questions were asked about how Level(s) aims to encourage users to think about the whole life cycle of a building and how Level(s) is designed to encourage users to start to learn about the different necessary steps to conduct a Life Cycle Assessment (LCA).

The questions made reference not just to the indicator 1.2 but also to the set of what are referred to in the Level(s) framework as 'life cycle tools', which consist of:

- o 2.1 Building Bill of Materials,
- o 2.2 Life cycle scenarios 1-3,
- o 2.4 Cradle to cradle LCA,
- o 5.1 Future scenarios for climate change.

Q3.10 To what extent did use of indicator 1.2 and/or 'life cycle tools' help provide a better understanding of the life cycle of the test building?

In total 64 of the testers responded to this question. Of those that responded, just over half considered that indicator 1.2 and/or the life cycle tools had provided a better understanding to a moderate or greater extent. However, it is also notable that a significant proportion of testers considered that they had only helped to a limited extent. The open responses provide further insight and are analysed below.

Q3.10 To what extent did use of indicator 1.2 and/or 'life cycle tools' help provide a better understanding of the life cycle of the test building?

■ Very great extent   ■ Great extent   ■ Moderate extent
■ Limited extent   ■ Not at all   ■ Not completed
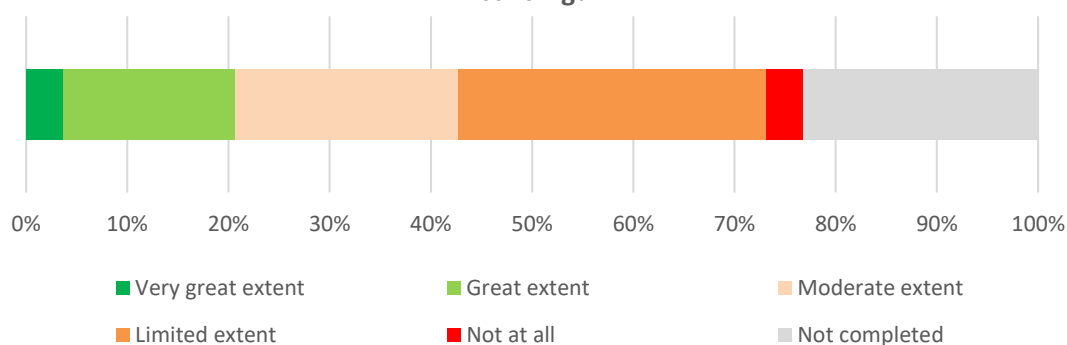
If the help was moderate or higher, please identify how it helped their understanding

26 testers went on to provide open comments following on from Q3.10. Their viewpoints are clustered in Table 7. A generally positive response was provided on how the tools helped provide a life cycle perspective as well as further visibility and knowledge on the impacts of a building project. Examples cited included: the act of recording and reporting the results having improved the visibility of different impacts; that it was possible to understand how decisions at

an early stage in a project could be effective; and that the team looked more on specific material choices and on new concepts such as circularity and the end of life stage.

Table 7. Clustering of testers' views on on how the indicators and tools helped testers understanding.
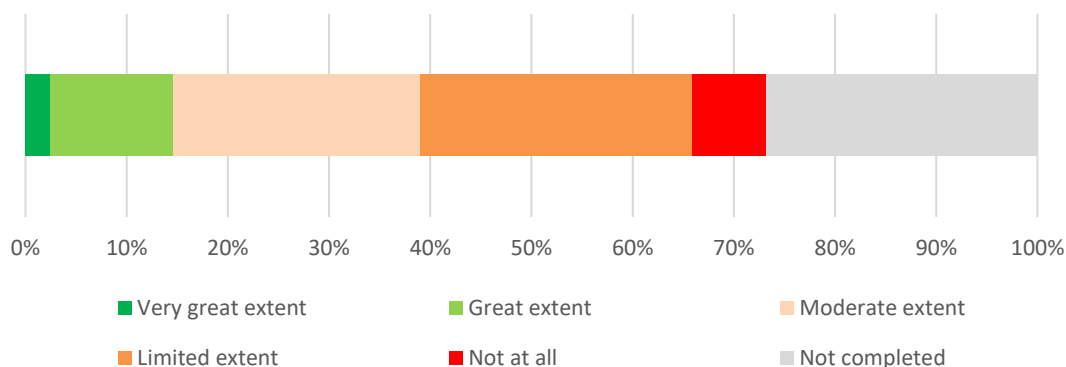
Theme that could be identified	Number of views cited	Views on how the indicators and tools helped testers understanding
Ability to measure impacts	7	- In general LCA is a good tool for understanding the sustainability aspects of a building project - The life cycle perspective is key to understanding the impacts - The indicators provide a better understanding when data can be compared to other buildings. *Specific technical points:* - A mass-based cut-off will often underestimate the environmental impacts (2) - BOM (mass) and waste impacts could be seen in context of the life cycle impacts - We learned that the external concrete pavement dominates the BoM while not being relevant for LCA.
Visibility and knowledge of impacts	6	- By collecting and summarising the data on BoM, GWP etc. the user can get an overview of the impact of the building - It aided an understanding that the most effective decisions are made in early phases of the project - Writing down and recording life cycle aspects improved their visibility e.g. maintenance, stages with biggest impact - It was useful to recognise the materials that stand out most in a building and also to know its useful life - It is not just about the construction phase but also about the materials used and design features that can improve circularity. - Reporting on end of life phase made the design team think about addressing these issues better.
Creating a starting point	5	- It was seen as the basis for the rest of the test and indicators (2) - It helps to identify what information is needed - It provides opportunity for interested parties to decide how to take advantage of the information *Specific technical points:* - Bill of material (BOM) is a useful approach (as LCA precursor) but lacks the granularity (e.g. "non-metallic")
Use of software tools	3	- The indicator was not fully complete because a dedicated software was necessary to perform a full calculation. - Use of a dedicated software was necessary to obtain/compile the data - Use of a calculator [software] tool helped the teams understanding
Geographical specificity	2	- Tested the impact using EPDs from different countries (2)

Training and expertise	1	- We don't have the expertise to understand the impact in a meaningful way.
Material and product selection	1	- Software didn't allow for product specific characteristics to be entered
Scenarios and assumptions	1	- It helped preparing in a systematic way the scenario definitions/assumptions

Q3.11 *To what extent has use of indicator 1.2 and/or the 'life cycle tools' encouraged the team to analyse the life cycle of buildings in more depth?*

In total 63 of the testers responded to this question. Those that responded were divided between a small majority that considered that indicator 1.2 and/or the life cycle tools had encouraged the team to a moderate of greater extent, and the remaining testers that considered this only to a limited extent or not at all.

Q3.11 To what extent has use of indicator 1.2 and/or the 'life cycle tools' has encouraged the team to analyse the life cycle of buildings in more depth?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

If the encouragement was moderate or higher, *please identify how it encouraged them*

26 testers went on to provide open comments following on from Q3.11. The comments are clustered in Table 8. They provided a generally positive response. Amongst the views they cited: the effects of the different life cycle stages; the contribution of materials in different stages; the development of a longer term approach; and progress to address embodied impacts. For a small number of testers, the test represented the first time they had studied the life cycle of a building.

Table 8. Clustering of testers' views on how testers were encouraged to analyse the life cycle of buildings in more depth.

Theme that could be identified	Number of views cited	Views on how testers were encouraged to analyse the life cycle of buildings in more depth
Greater understanding and awareness	7	- Helps to understand the effects of different stages of the life cycle (2) - Awareness on the contribution of the different construction materials in each of the life cycle modules - Develop longer-term approach based on better material/system choices - Supports progress to address embodied impacts, compared to energy use

28

|		
		- Understanding creates interest *Mixed views* - It would have been more of a motivation in the design phase
It formed a starting point	5	- Opportunity to study life cycle for the first time (2) - Development of material calculations and degree of material use - Thinking about how much material is needed for certain parts of the building and its environmental effect - Works as the basis for the other indicators
Supports comparability	2	- Allows for comparison with other buildings and material choices (2)
Supports in-depth analysis	2	- Potential for a more detailed LCA analysis (2)
Provided a basis for decisions	1	- For new solutions building owners want robust life cycle information on costs and impacts

The influence of sustainability on property market valuations

A question was asked about the use of indicator 6.2, which is intended 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.

Q3.12 If you made assessments of value and reliability for your test indicators and life cycle tools, *to what extent did the assessments provide useful information?*

In total 62 of the testers responded, of which 19 had not made an assessment of their test indicators and/or life cycle tools. Of those that responded as having made assessments, there were mixed views on their usefulness, with the number of respondents considering them to have been useful to a moderate or greater extent equaled by those who consider them useful to only a limited extent.

Q3.12 If you made assessments of value and reliability for your test indicators and life cycle tools, to what extent did the assessments provide useful information?

- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- No assessments were made
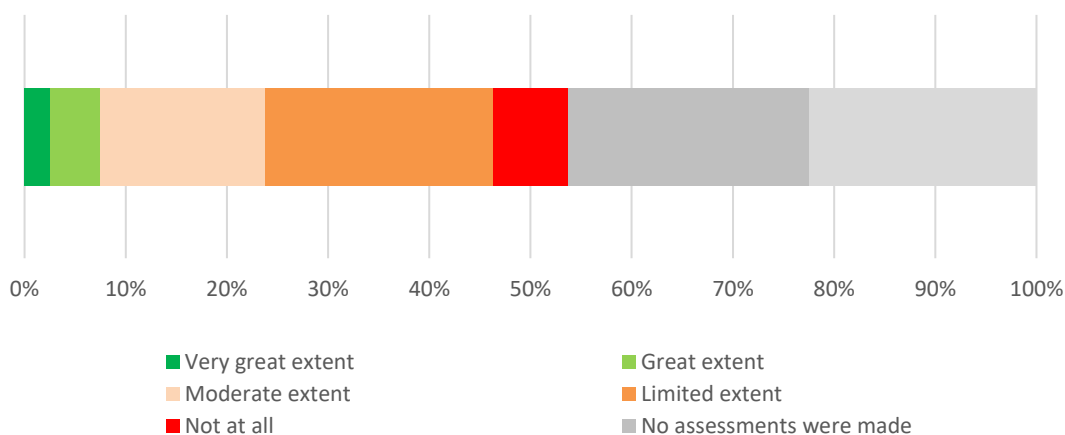
If you rated their usefulness moderate or higher, please identify how it was useful

There were 24 responses to the open question that accompanied Q3.12. There were a number of positive comments that it provided a useful '*overall quality assessment*' and a view on the global quality of a project's sustainability performance assessment.

Some respondents considered that the assessments can provide that they referred to as '*knowledge of exposure*' of a project to issues of data reliability and risk, as well as providing a means of knowing more about the comprehensiveness of underlying data used and the possible limitations.

In contrast, it was also identified that at the moment the rating method and scale are too subjective. The results may as a result be too abstract and ambiguous. The means of making the rating should be less subjective and more precisely defined.

Table 9. Clustering of testers' views on how value and reliability assessments were considered useful

Theme that could be identified	*Number of testers*	*Views on how value and reliability assessments were considered useful*
Overall quality assessment	**5**	- Provides a quick overview on the quality of analysis but not a comparable indicator and is too subjective (2) - The reliability rating gives a good overview and will help increase awareness on data quality. - It is a way to have an overview of the global quality of the assessment of the project - It helped recognise the strengths and weaknesses
Provides knowledge of exposure	**3**	- Provides knowledge of the exposure to reliability, risks and areas of improvement for each indicator and the project - Comprehensiveness of data and relevant environmental data are useful to make a list of the limitations of the studies. - Highlighted the lack of independent verification and technical capability
Approach not understandable or misleading	**3**	- The reliability indicators are not quite clear and flexible for each level, so it is not always easy to understand their value. - The end result may become a rather abstract and ambiguous number - Separating these elements into separate numbers or drivers within a building's evaluation is impractical at best, and potentially misleading at worst
Problems with comparability and subjectivity	**3**	- Provides a quick overview on the quality of analysis but not a comparable indicator and is too subjective (2) - Choosing the level of expertise of the professionals is not clear
Property expertise is needed	**1**	- A Real Property expert is needed to perform this kind of assessment
Potential at right project stages	**1**	- It was considered to have potential but the building had already been completed
External verification of reliability	**1**	- In other cited schemes reliability is externally verified *e.g. DGNB*

Critical approach	1	- A critical view and evaluation of the indicators used revealed the strengths and weaknesses of some aspects and increases sensitivity.
Data quality assessment	1	- It was quite useful to analyse the quality of LCI data used.

3.3. The value of Level(s) to key stakeholders

In this section, specific stakeholders were asked, based on their test experience, about the value of Level(s). The questions were targeted at three broad types of stakeholder:
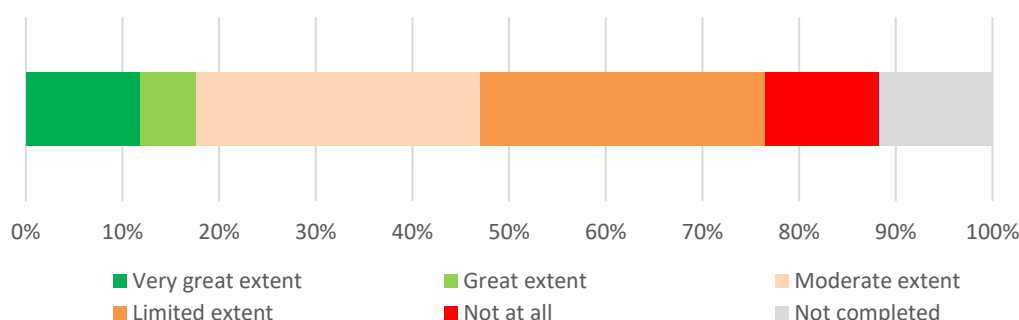
- o public sector authorities;
- o investors and owners of property assets;
- o design and construction professionals.

The Public Sector

Q4.1 Based on the test experience, to what extent could Level(s) be of future value in developing new procurement requirements?

15 of the 17 public authorities taking part in a test responded to this question. Just over half of respondents considered Level(s) to be of future value to a moderate or greater extent, whilst only a small proportion of respondents considered it to have no value at all.

Q4.1 Based on the test experience, to what extent could Level(s) be of future value in developing new procurement requirements?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

■ Very great extent   ■ Great extent   ■ Moderate extent
■ Limited extent   ■ Not at all   ■ Not completed

Please specify which features in particular have been of value, or what was missing that could make it more valuable
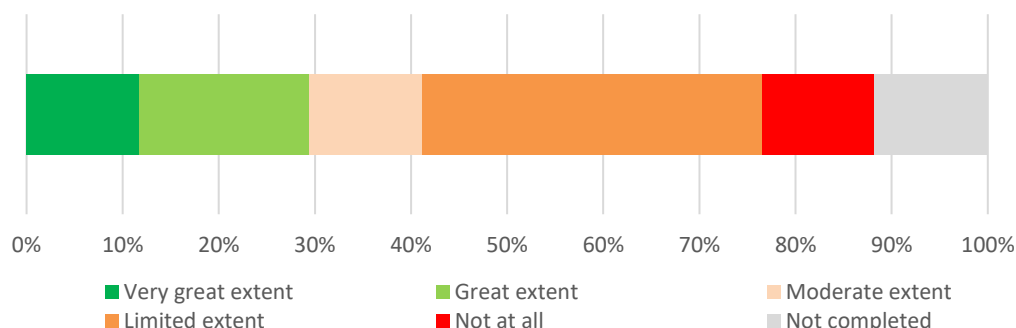
10 of the 17 public authorities taking part in a test responded to this question. In general, the respondents considered Level(s) to be a method rather than a means of setting performance level targets. In this respect, it currently lacks a benchmarking against accepted values, although one respondent noted that it did provide measurable indicators. This would allow clear goals to be established for a project – for example, LCA impact category thresholds were referred to. For Level(s) to be used in public procurement it would need to be made easier and more user-friendly to use. A visual representation of the results would be of value to public authorities.

Q4.2 Based on the test experience, to what extent could Level(s) be of future value in supporting other public policy initiatives?

15 of the 17 public authorities taking part in a test responded to this question. Just over half of respondents considered Level(s) to be of future value to a moderate or greater extent, whilst only a small proportion of respondents considered it to have no value at all. A significant

proportion of respondents considered, however, that Level(s) currently only had a limited future value in supporting public policy initiatives.

Q4.2 Based on the test experience, to what extent could Level(s) be of future value in supporting other public policy initiatives?


Please identify specific initiatives and the features of Level(s) that could be of value, or what was missing that could make it more valuable

9 of the 17 public authorities taking part in a test responded to this question. In general they considered that education regarding whole life cycle of buildings for public policy makers was valuable but Level(s) would have to be simplified in order to fulfil this role. Its use could be linked to regional EU funding as part of operational funding. It should be a basic requirement to apply the Level(s) framework in order to release funds for building projects. One respondent considered that a complementary tool would be needed to support this role.

Q4.3 _In terms of how Level(s) could be used in the future, to what extent could the test experience be applied to the improvement of other public buildings?_

14 of the 17 public authorities taking part in a test responded to this question. More than half of respondents considered to a moderate or greater extent that Level(s) could be applied to the improvement of other public buildings, whilst only a small proportion of respondents considered it to have no value at all. A smaller but notable proportion of respondents considered this to a lesser extent.

Q4.3 In terms of how Level(s) could be used in the future, to what extent could the test experience be applied to the improvement of other public buildings?
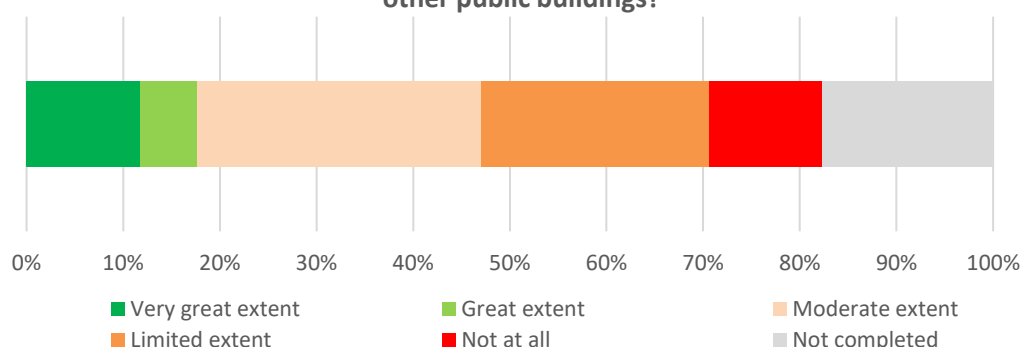
Please elaborate on the reason for your response

8 of the 17 public authorities that took part in a test provided a response. There was some concern that using Level(s) supposed professional skills, resources and tools. Guidelines should
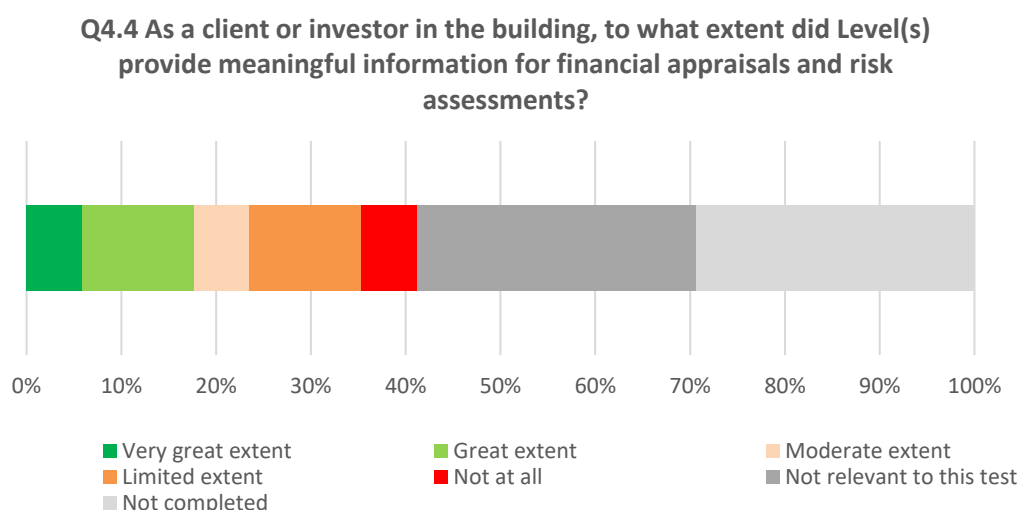
be provided as to who should be responsible for carrying out an LCA. It was considered difficult to retrospectively obtain data about a completed building.

In some countries, many aspects of the framework are already being applied to public buildings, but more focus is needed from a life cycle point of view. In other countries, the lack of current consciousness was cited as being an issue. One respondent considered the possibility to make it mandatory for public buildings but, to do this, performance comparisons and benchmarks would need to be developed.

Some tests had been carried out on schools, and it was considered possible to apply it to this building type.

Q4.4 *As a client or investor in the building, to what extent did Level(s) provide meaningful information for financial appraisals and risk assessments?*

12 of the 17 public authorities taking part in a test responded to this question. A notable proportion (5) did not consider this question relevant to the test. Of the 7 that considered it relevant to answer, more than half considered to a moderate or greater extent that Level(s) could provide meaningful information, whilst only a small proportion selected '*not at all*'.

Q4.4 As a client or investor in the building, to what extent did Level(s) provide meaningful information for financial appraisals and risk assessments?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not relevant to this test
- Not completed

Please specify what information was useful, or what information was missing that could have made it more useful

8 of the 17 public authorities that tested a building provided a response with views.

The life cycle cost aspects was considered of value by several respondents. In one instance, the project already had a budget but only a limited allowance was made for basic maintenance, with longer term costs not being accounted for. In the next project, they therefore planned to ask for more information.

The parts of Level(s) referring to finance and risk were difficult to understand for testers without a financial background. Explanations therefore need to be improved. It was, however, considered that Level(s) could help in providing information on life cycle costs.

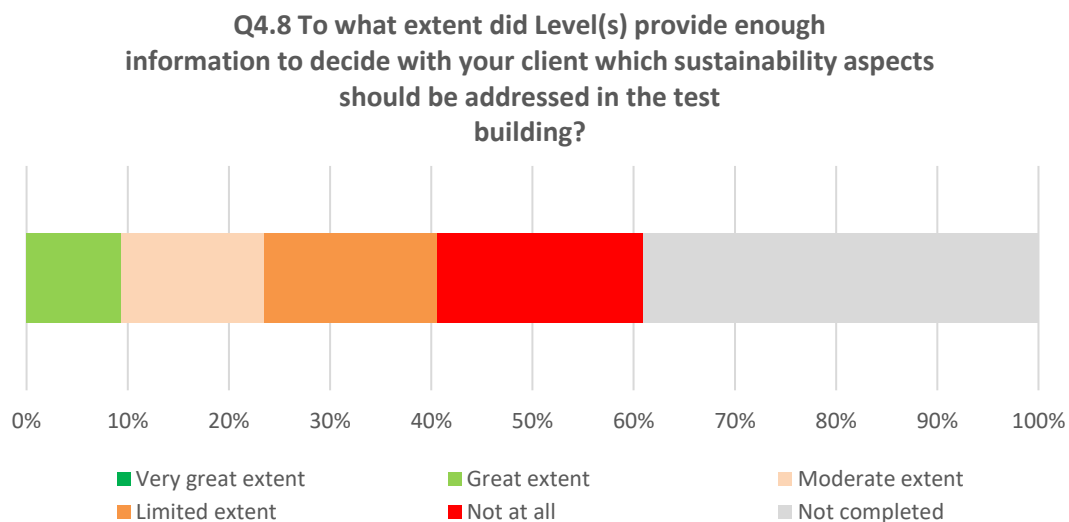### Investors and owners of property assets

Of the relatively low response overall to this section (12 testers) for at least 5 the lead testers primary activity is not property investment/ownership. The response is therefore not considered to be valid.

Building design and construction professionals

This set of questions was directed at the designers and construction contractor(s) responsible for the test building. Up to 48 testers completed this question set, although the response varied by question.

Q4.8 Taking into account the minimum scope for a test, to what extent did Level(s) provide enough information to decide with your client which sustainability aspects should be addressed in the test building?

Amongst the 40 testers that responded to this question, the response was mixed, with most considering to a moderate or lesser extent that it had provided enough information. A notable proportion did not think that it had provided enough information. Some of the views presented in the analysis of the open question that follows suggest that this may have been due to decisions having already been made about the building design and specification, with the test then coming ex-ante. They also suggest that it could relate to the expectation of some form of benchmarking of the sustainability of a project.

Q4.8 To what extent did Level(s) provide enough information to decide with your client which sustainability aspects should be addressed in the test building?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

Please specify what information was the most useful, or what information was missing that could have made it more useful

24 of the 40 building design and construction testers provided a response to this open question and the responses are clustered in Table 10.

Several respondents felt that while they liked the concept and that it had great potential, fundamental decisions on the project had already been made before the test commenced. It could therefore be of value for future projects. In one case, decisions had already been made, albeit using a version of DGNB that incorporates Level(s).

The comments were broad ranging, with views that it provided useful headline information for distinct areas of sustainability performance whilst it was considered that aspects missing included some form of analysis of hot spots, more specification for renovations and more specifications for scenarios.

Several comments concentrated on the idea of needing some form of reference point for benchmarking performance, as well as some form of visual representation of results to compare scenarios or to communicate to clients.

Table 10. Clustering of design and construction professional testers' views on useful information it provided and what was considered to be missing
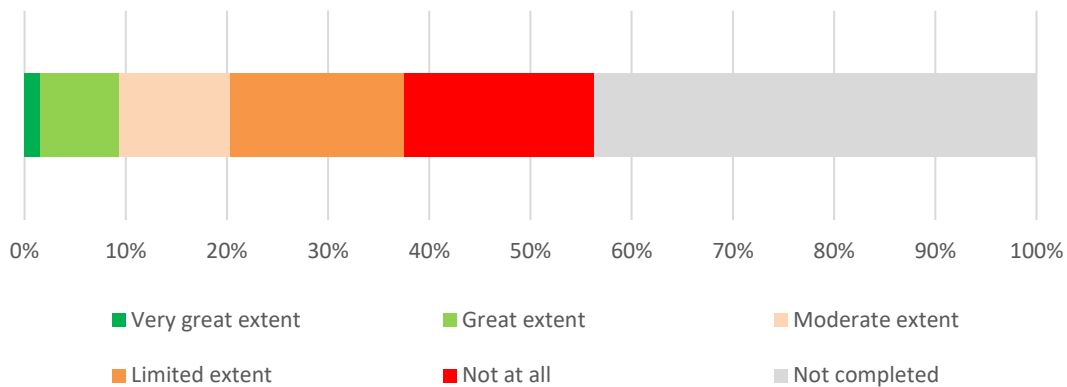
Theme that could be identified	Number of views cited	Views on useful information it provided and what was considered to be missing
Most useful information	**4**	- Energy performance and water consumption (2) - Distinction into energy, water, waste, and indoor air quality - Adaptability, LCA, LCC
Further information that was missing	**4**	- A hot spot analysis to highlight building elements to improve - Specification of which indicators are more relevant for a major renovation - Application of the scenarios [in the minimum scope] would have added additional value and we recommend to promote them further - More specific information and requirements relating to life cycle scenarios *e.g. end of life*
As a decision making tool	**4**	- The mandatory indicators provide an overview of the parameter needed to determine a buildings' sustainability (2) - The tool doesn't provide results so can't be as basis for decisions (2)
For comparisons of options	**4**	- Benchmarks of average material CO_2 emissions for the sector were missing (2) - Misses the possibility to benchmark performance *e.g. as in DGNB* - A diagram or visual to compare scenarios is missing
As a design tool	**3**	- Possibility to incorporate it into the early stage of projects - It is missing the possibility to benchmark on an 'absolute' sustainability basis - Acoustic and visual are important aspects that are missing
For project evaluations	**2**	- An integrated project planning process is missing and should be emphasised - Both the indicators and reliability rating lack benchmark levels
For communication to clients	**2**	- It will need to be easier to communicate to clients - Other schemes have a clearer structure to relate to a client'ss triple bottom line

Q4.9 To what extent did Level(s) provide meaningful information to support design and specification decisions?

Amongst the 48 testers that responded to this question, the response was mixed, with most considering to a moderate or lesser extent that it had provided enough information to support decisions. A notable proportion did not think that it had provided enough information.

As already noted in relation to the tester's response to Q4.8, there is evidence from some open responses that this was due to decisions having already been made about the building design and specification, with the test then coming ex-ante.

Q4.9 To what extent did Level(s) provide meaningful information to support design and specification decisions?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

Please specify what information was useful, or what information was missing that could have made it more useful

26 testers provided a response to this open question and the responses are clustered in Table 11.

The most clearly discernible themes to emerge from the views cited related to the usefulness of Level(s) to some form of design and options analysis, as well as the indicator results themselves. In terms of a design and options analysis, the most commonly cited information that was missing was reference values or benchmarks. It was felt that without reference points there can be no 'real' result from making an assessment using Level(s).

Table 11. Clustering of design and construction professional testers' views on useful information it provided and what was considered to be missing

Theme that could be identified	Number of views cited	Views on useful information it provided and what was considered to be missing
Design and options analysis	9	*Useful information it provided* - As a design stage planning tool *Information that was missing* - A reference value or benchmark to compare with (2) - Lacks benchmarks or a baseline to actually measure what was good and what wasn't. - Lacks benchmarks or a baseline to actually measure sustainable solutions - Lacks benchmarking tools as a source of information - A reference value or benchmark to compare with - More detailed reporting for LCA, LCC (including hotspot analysis) would support the design process - Defined targets

The indicator results	8	*Useful information it provided* - Life cycle GWP - Energy performance, water consumption and service life planning - Overview of a building's sustainability *Information that was missing* - Assessment of building sustainability (2) - Lacks benchmarks or a baseline to actually measure sustainable solutions - Information on how to interpret the results - No 'real' result as a baseline reference building is missing.
The indicator framework	5	*Useful information it provided* - Overview of building sustainability (2) - A scenarios based approach can improve design and specification decisions - Provides key performance indicators - Provides possibilities and material to discuss with our clients.
Building or project type	3	*Useful information it provided* - At occupation stage to set requirements - At design stage to set requirements *Information that was missing* - how to use Level(s) in the case of a major renovation.
Specific aspect	1	*Information that was missing* - Distance from common standards e.g. 4.1 and WELL building standard

3.4. Using the test indicators and life cycle tools: *minimum requirements*

In this section, testers were asked about the team's experience of using each of the indicators and life cycle tools selected for testing. This first batch of indicators and tools represent what were communicated to testers as the 'minimum requirements' or scope for carrying out a test. They comprise:

- 1.1 Use stage energy consumption (primary and delivered energy)
- 2.3 Construction and demolition waste and materials
- 3.1 Use stage water consumption
- 4.1 Indoor air quality (at Level 1)
- 4.2 Time out of thermal comfort range (at Level 1)

Indicator 1.1: Use stage energy consumption

Q1. *To what extent was the indicator or life cycle tool easy and logical to use?*

Overall, 79 testers reported that they had tested indicator 1.1. In general, the majority of testers considered that to a moderate or greater extent the guidance, method and reporting format were 'easy and logical to use'. Although a notable proportion of testers considered this to a limited extent. The unit of measurement received the most positive response.

The response rate to questions 1.6 and 1.7 on Levels 2 and 3 was lower reflecting the fact that less testers worked at these levels. Of those that responded, the majority selected a moderate or greater extent for both levels.
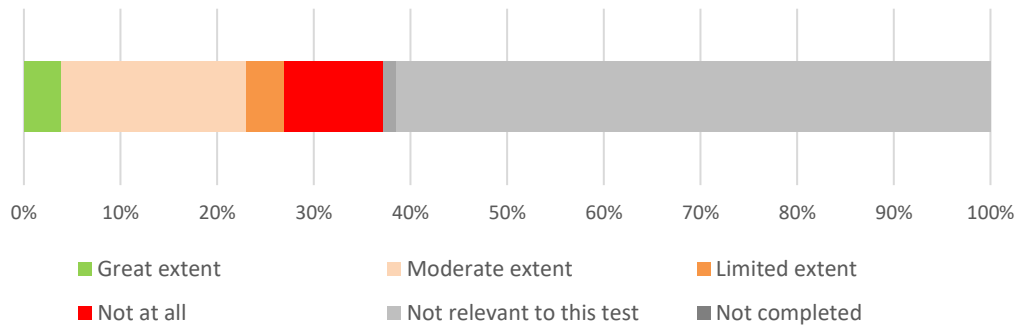
Q1. To what extent was indicator 1.1 easy and logical to use?
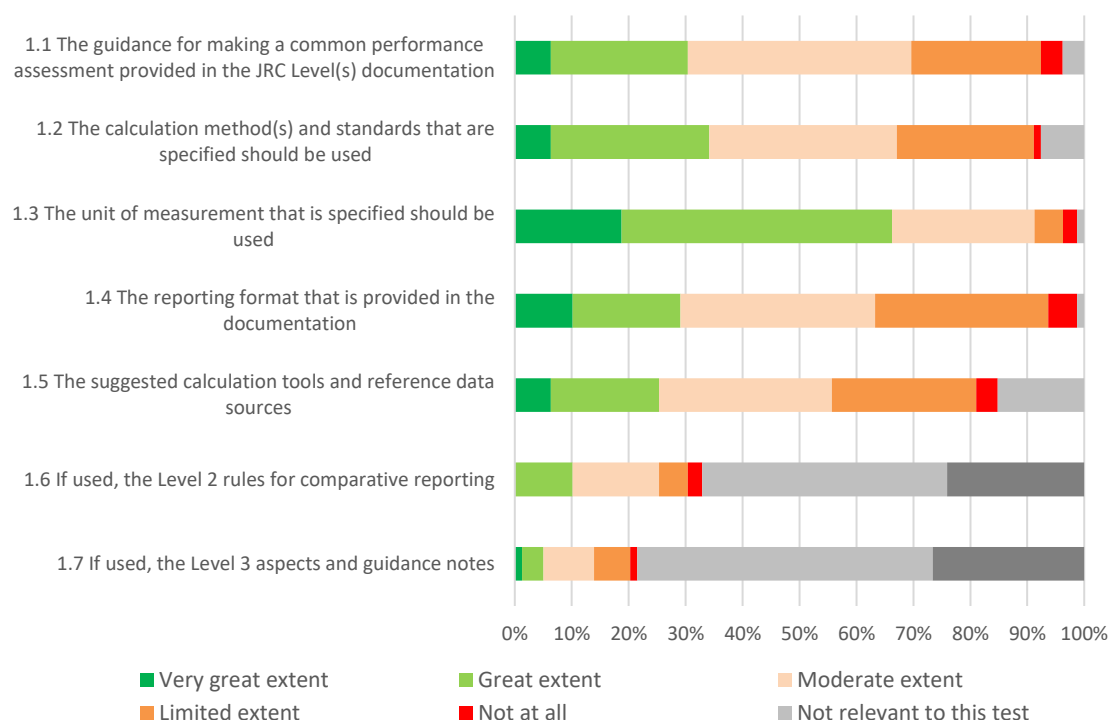
Q2. *If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?*

Of the 32 testers that responded, the majority considered that it helped to a moderate or greater extent. A notable proportion considered that it did not help.

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Great extent | Moderate extent | Limited extent
Not at all | Not relevant to this test | Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 71 testers that responded, the majority only encountered problems to a limited extent or not at all. However, just under a third had encountered problems to a moderate extent.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Very great extent | Great extent | Moderate extent
Limited extent | Not at all | Not completed
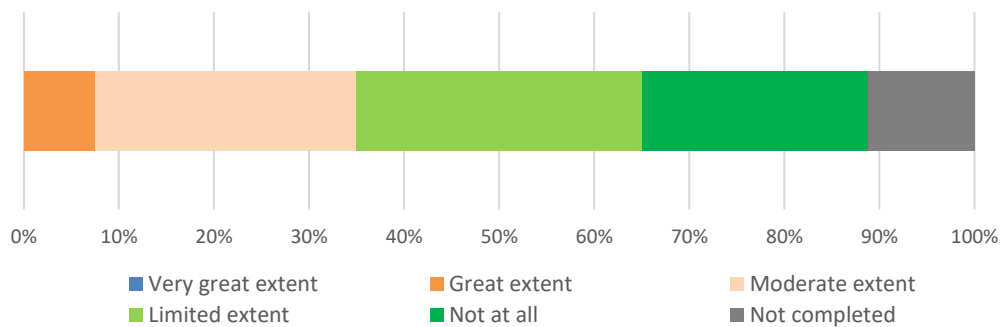
Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

In total 43 testers identified the problems they had encountered. Their responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward by testers, in Table .

It can be seen that the reference standards and methods (11 testers) posed particular problems, including both the floor area measurement and the possibility to use data from a National Calculation Method. In terms of obtaining values and data (8 testers), the disaggregation of the main indicator into different energy needs, the contribution of renewables and the gathering of monitored data were cited as problems. In addition, the guidance and in particular the reporting tool itself posed some problems (7 testers), with user friendliness cited as the most common problem.

Table 12. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	*Number of citations*	*Problems and workarounds identified by testers*
Standards and methods	**11**	– IPMS not same method on some aspects or as used in EPC calculation (4) – Unclear the extent to which NCM provides necessary data (3) – Sub-categories of reporting for energy uses don't align with national method (2) – NCM does not provide the results in the same detail – They are different from those used on the project – The standards referred to are outdated
Obtaining values and data	**8**	– Delivered energy not available from modelling (2) – Not all energy needs could be reported on (2) – Obtaining data retrospectively was difficult – Effort required to split renewable/non-renewable – Floor area had to be recalculated – For existing buildings individual energy needs not monitored – Method for obtaining total and net PE not clear – There was no energy certificate to consult – Not all energy needs could be reported on – Gathering monitored data was challenging and it was not disaggregated – The quality and interpretation of monitored data was an issue – Small power had to be calculated/estimated
Accessibility of materials and resources	**7**	– Reporting tool was not user friendly (5) – Very unclear what should be filled out Inflexible assessment sub-types – Difficulty using the guidance – Instructions and reporting too complex – Not available in native language
Guidance	**3**	– Clarity of definitions (2) – Clarity of guidance – Definition of different types of energy demand – Summation of energy needs not clear
Time and resources	**2**	– Using Level 2 would have needed analysis additional to the project (2)
Knowledge and training	**1**	– Knowledge of the methods – Knowledge of the standards
Project stage	**1**	– Quantitative information not available at early stage
Test building	**1**	– Selected building was not ideal

Q4. _When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?_

Just over half of the respondents had found previous assessments to be useful. Amongst those that identified what they had used (see Table), the majority referred to a regulatory tool or the values obtained from a calculation method.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?
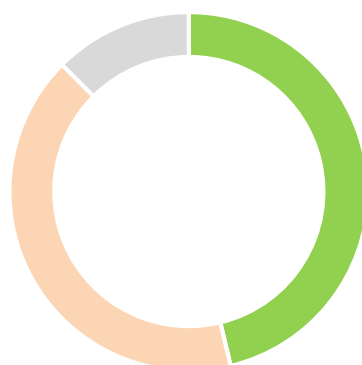
■ Yes ■ No ■ No reponse

### *Please specify useful resources from previous projects*

Table 13. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of citations	Specific resources identified
Regulatory tool	15	− National calculation method (e.g Be 15, BE18, BSiM, IDAICE. NCM: NEN 7120,TEE KENAK, RT 2012) (10) − E+C-(France) (3)
Obtaining values	7	− Be 18 - SBI 213 (Belgium) (2) − Tools (RIUSKA, MagiCAD, IFC integration) (2) − Bâtiments exemplaires de Wallonie (Belgium) − KI energy tool (PURES) − EPC software (TS 11300)
Building certification	6	− HQE (2) − DGNB (2) − LEED (2)
Data	1	− Primary energy factors from GaBi LCA database

Q5. *To what extent did you already have access to the required results from other assessments of the building?*

The majority considered that to a great or very great extent they already had access to the required results. A small but notable proportion responded 'not at all'. Of the 55 respondents that identified their sources (see Table), the majority referred to data obtained from energy reports of various types followed by building certifications.

Q5. To what extent did you already have access to the required results from other assessments of the building?

Legend: ■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed
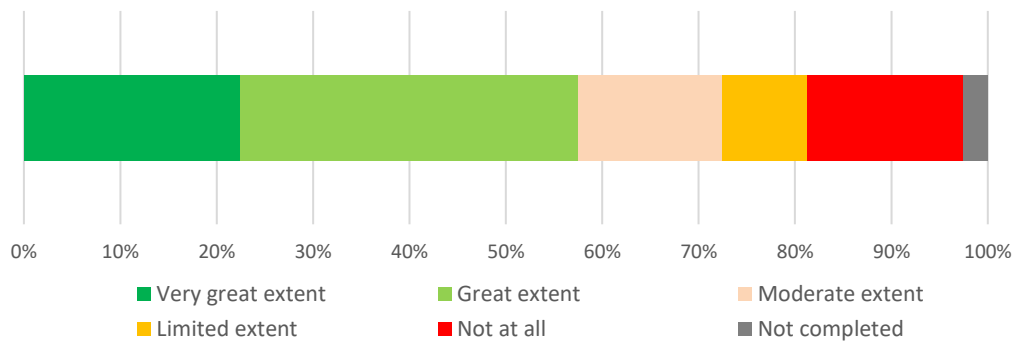
### *Please identify the source of results that were already available*

Table 14, Q5 open response to identify the source of existing results and data

Source of the results/data	Number of citations	Specific resources identified
Energy reports	36	– Performance assessment and/or EPC (30) – Research simulations (3) – BIM model – Operational costs – Life cycle GWP calculations – Thermal simulation
Building certification	12	– DGNB (4) – E+C- (3) – LEED (3) – DGNB LCA tool – GBC Italia scheme – Home Quality Mark (UK)
LCA calculations	2	– Life cycle GWP calculations
Energy monitoring	1	– BMS system
Environmental management system	1	– EMAS

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

In the majority of cases the standards, data and tools appear to have been readily available to a great or very great extent. Data and tools required some effort to obtain in a small but notable proportion of cases.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?
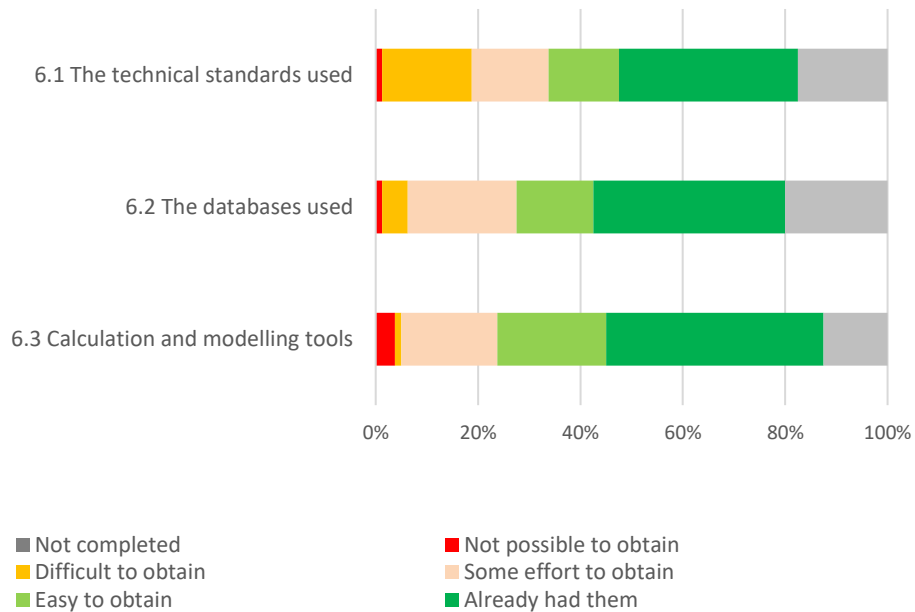
Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Over 70 testers responded to 7.1 and 7.2, with the majority citing the cost of standards and tools as one factor or the main fact presenting a barrier to using the indicator. The proportion of respondents citing purchasing as a main factor was greater for databases and tools, although only 46 responded to 7.3, likely reflecting Q6.3 in which a high proportion of testers can be see to already have such tools.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?
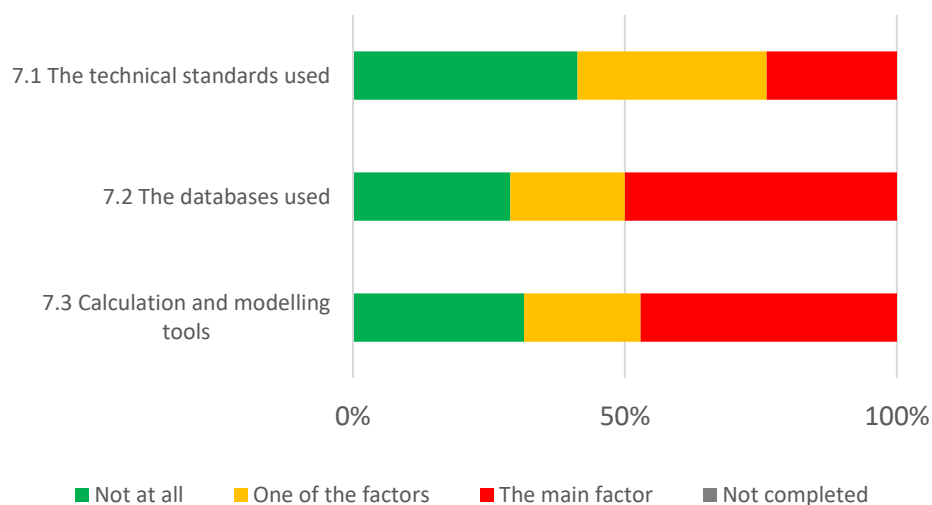
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

Clearly, this indicator was relatively familiar to most testers, with extensive previous experience being cited in the majority of cases. A small but notable number of testers stated that they had no previous experience, suggesting that they had not previously been directly involved in carrying out energy assessments for permitting purposes.
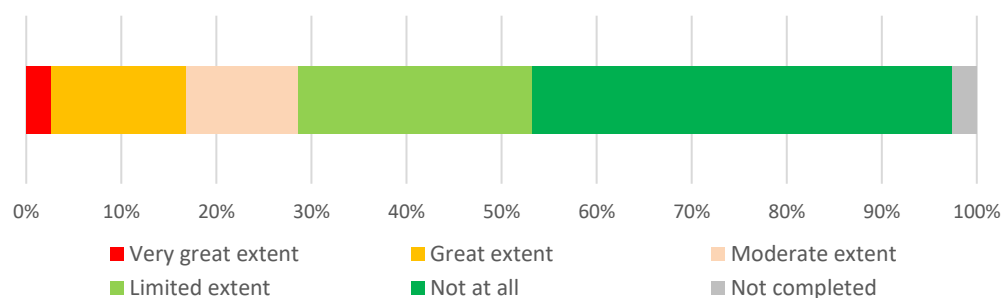
Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend:
- Extensive previous experience
- Some previous experience
- Limited previous experience
- No previous experience
- Not completed
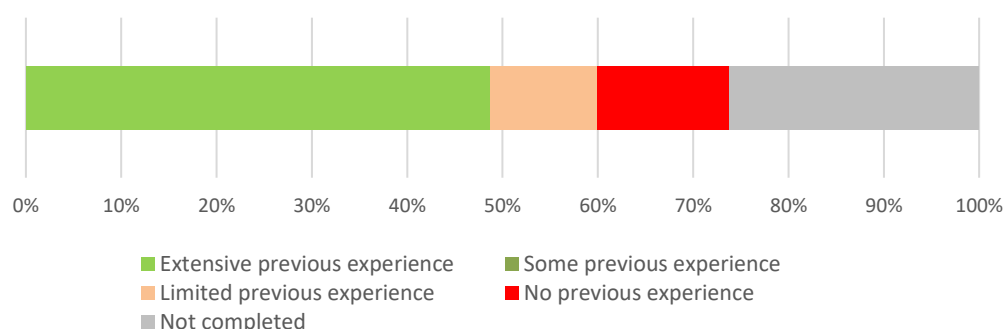
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

The majority of testers considered that additional training and support was not required or only to a limited extent. A small but notable proportion required training and support to a great extent, likely reflecting those who responded in Q8 that they had no previous experience.
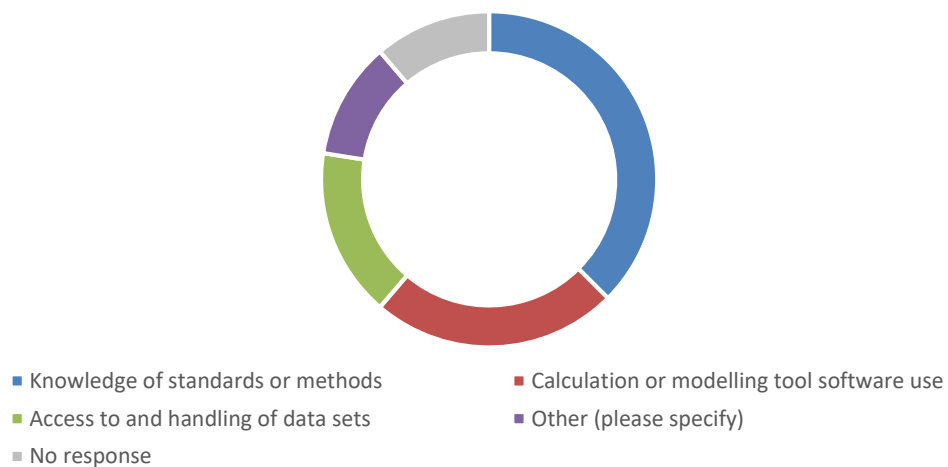
Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed

If additional training and support was required, please identify the main areas where it was necessary:

Of the 71 respondents that cited areas where training and support were necessary, the majority cited 'knowledge of standards or methods'. Further suggestions for the training and support necessary were provided by 30 respondents and they are clustered in Table . Their suggestions comprise a mix of information, support targeted in a number of areas and webinar training.

If additional training and support was required, please identify the main areas where it was necessary

- Knowledge of standards or methods
- Access to and handling of data sets
- No response
- Calculation or modelling tool software use
- Other (please specify)

Please identify the type of training and/or support that was needed

*Table 15 Q10 open response to identify training and support needs*

Broad type of training or support	Number of citations	Specific need identified
Information	7	– Understanding how to adjust use to local practices (3) – Requirements and reporting (2) – Calculation basis in standards – Understanding the manual
Support	7	– For the project team (2) – For consultants – Energy assessments for non-experts – Data needs versus other models/tools – Prescription for data collection – Interpretation for existing buildings
Webinar training	5	– Energy simulation and uses (2) – Using concrete examples – LCA software training
Software related	4	– Excel reporting sheet – Software training – LCA software training (2)
Valuation rating	2	– Better understanding needed
Standards	1	– Access to them is difficult
Internet	1	– Individual research was carried out

Q10. _**If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool**_.

Of the 50 testers that provided time estimates it can be seen that 76% required up to 5 person days and 96% up to 10 days. The average was 4.1 person days.
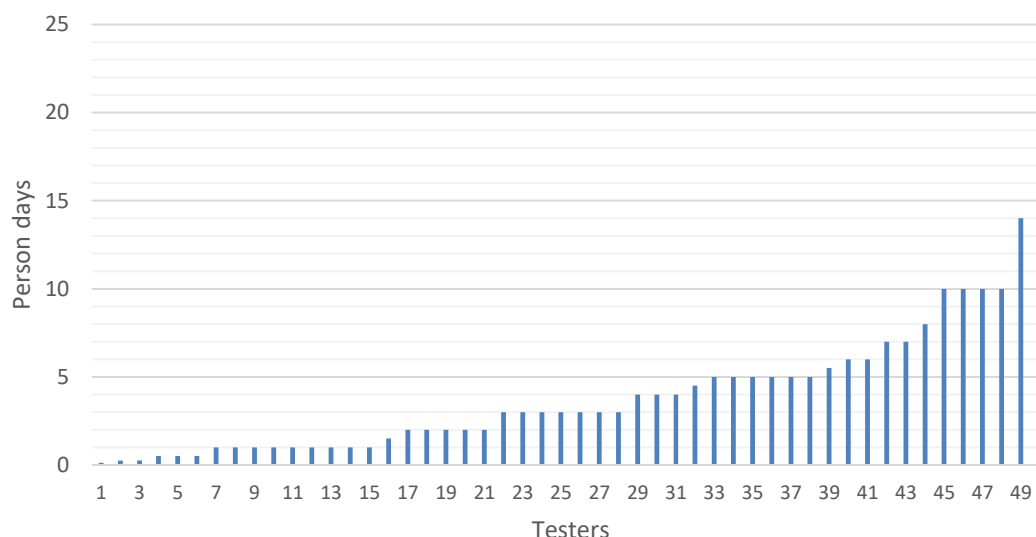
Of the 37 testers that provided cost estimates, 70% assigned up to €3.000 and 90% up to €5.000.
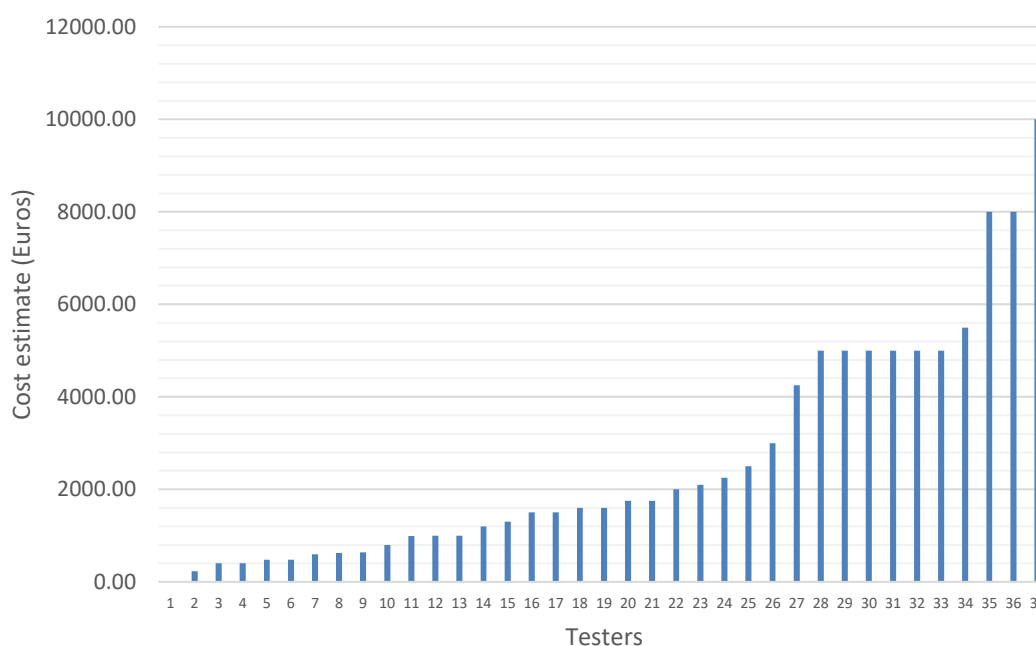
Q11. _**Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use**_.

Amongst the 55 testers that made suggestions for improvements, the majority made reference to standards and methods, the indicators themselves and the guidance.

In regards to standards and methods, the relationship between the indicator and the ability to use national standards should be clearer. Where instructions and references in EN standards are referred to, these should be provided in the guidance.

In regards to the indicators, greater clarity is needed in relation to the difference between the two sub-indicators and their disaggregation into different energy needs. How the contribution of renewables should be applied also requires clearer instructions.

In terms of the guidance, overall it needs to be made simpler, with greater consistency in the use of terminology, more definitions and more explanations. The approach to selecting and reporting on the floor area measurement method requires attention. A minor suggestion was to provide examples of general improvements and solutions to get users started.

Table 16. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of citations	Specific resources identified
Standards and methods	**13**	– Improve the read across to national standards (6) – Include instructions from standards (2) – Provide EN standards especially referenced tables (2) – Be more specific on which calculation method is compliant – Improve the read across to the type of energy simulation – Harmonise with the floor area standard in each country
The indicators	**10**	– Clarify difference between 1.1.1 and 1.1.2 (2) – Clarify how to calculate the sub-components of 1.1.1 (2) – Greater clarity on appliances and small power – Ability to report in detail auxilliary power uses – For small power provide default split of renewable/non-renewable energy – Allow to report on "simulated" and "as constructed" results – Clarify how to enter the contribution of renewables – Improve understanding of the value and reliability ratings
The guidance	**9**	– Guidance needs to be simpler – Simplified guidance on how to get the required figures – Better differentiation of new and existing buildings – Consistency in terminology and definitions – Clarity on key terms - macro-objectives, indicators, life cycle tools – Provide instructions on floor area method for each indicator – Improved definition of EU climate zones – Make suggestions of standard improvements in order to start discussions – Creation of database with prevalent optimised building solutions (as reference for comparison)
Accessibility	**6**	– Availability in other languages (2) – Guidance needs to be simpler (2) – Improve ease of accessing detailed information (2)

Supporting tools	5	– A standalone tool like the water calculator (2) – Checklist for assumptions and software characteristics – Link between tool and guidance needs to be better – Reporting tool needs to work properly
Training and learning	4	– Provide materials for self-learning (2) – For architects to understand standards usually used by engineers – Make several examples of how to report the results correctly
Feedback	4	– Performance of the building (2) – Validity of the assessment (2)
Reliability and comparability	3	– Better definition of parameters needed for Level 2 – Suggested as being based on confidence level for data – The ability to compare performance of buildings in detail
The levels	1	– More precise definition of the difference between the three levels

**Indicator 2.3: Construction and demolition waste and materials**

Q1. To what extent was the indicator or life cycle tool easy and logical to use?

In total 57 testers reported that they tested indicator 2.3. The guidance, unit of measurement and reporting format for indicator 2.3 were considered easy and logical to use to a moderate or greater extent by the majority of testers. A significantly greater degree of positive sentiment was expressed by testers with regards to the units of measurement used (more than half responding "*very great or great extent*")

The response to the calculation method and standard specifications was more mixed, with just over a fifth responding "*very great or great extent*". On balance testers were less positive to the suggested calculation tools and reference data sources (less than half of testers responding *moderate or greater extent*).

The tester response to questions 1.6 and 1.7 in relation to Levels 2 and 3 was much more lower. Of those that responded, the majority were more neutral or less supportive in their feedback for both Level 2 and Level 3.

Q1. To what extent was indicator 2.3 easy and logical to use?
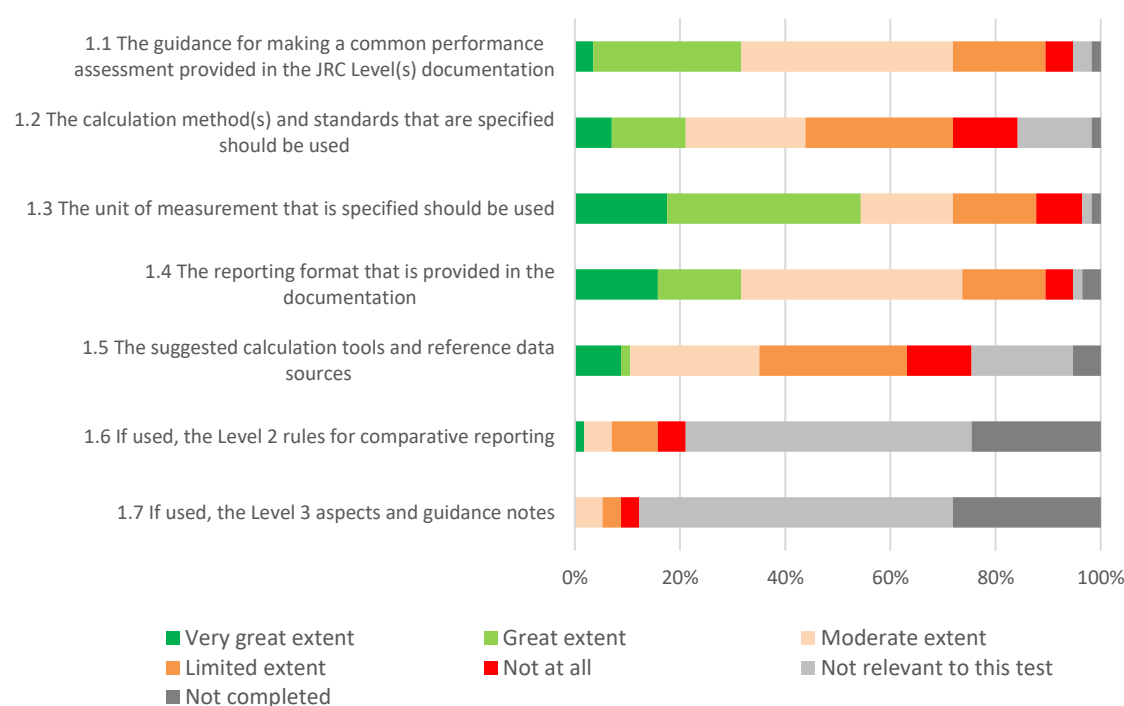
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?
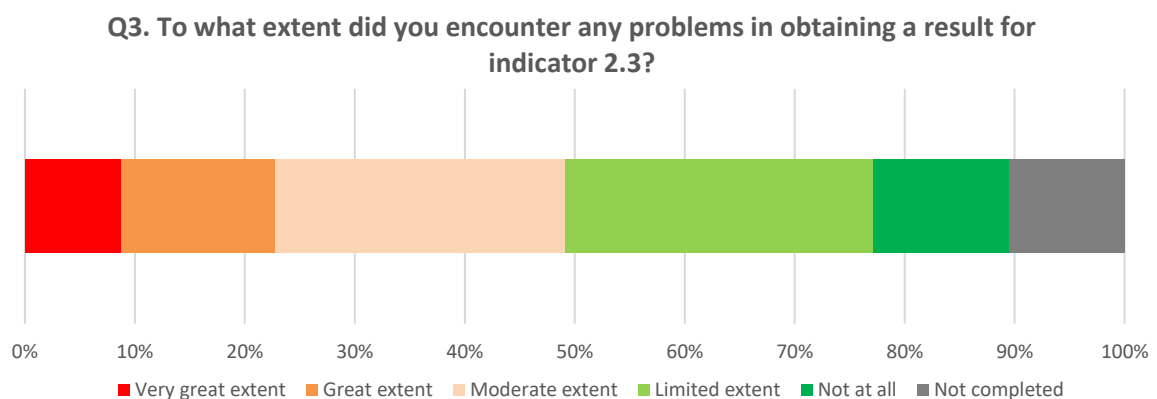
Of the 57 testers that used indicator 2.3, over 70% were either considered it to be of limited help or not at all in comparing these results for different building design options or were unsure about how such a comparison would be helpful. Only one in ten expressed a positive sentiment (responding with "*very great or great extent*").

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not sure ■ Not completed
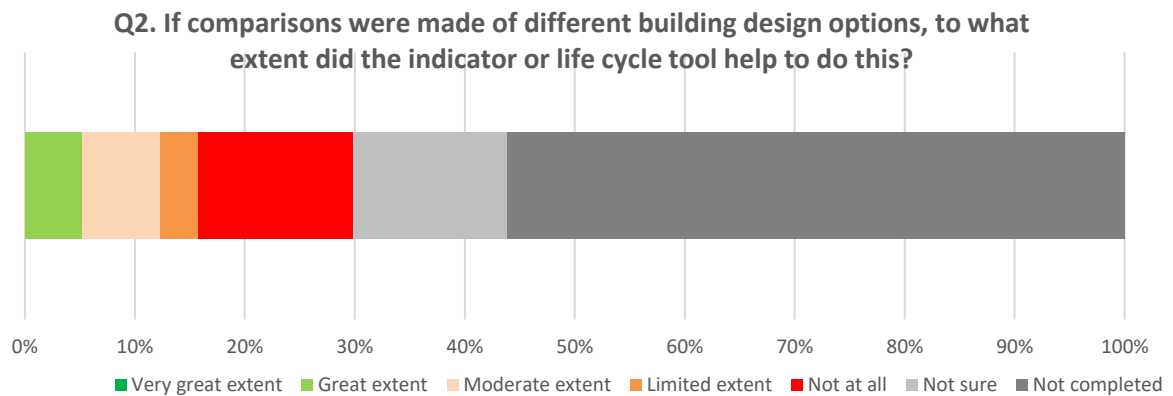
The results for Q2, especially the high non-response rate, imply that estimates of CDW are not a main factor that building designers take into consideration when deciding upon the preferred design option for building projects.

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Overall, 51 of the 57 testers that reported on indicator 2.3 provided a response to Q3. Responses with a positive sentiment encountering problems to a limited extent or not at all (23 of 51) clearly outweighed those that had encountered problems to a great or very great extent (13 of 51). There were a significant number of intermediate responses (15 of 51) which stated a "moderate extent" of problems with obtaining a result for indicator 2.3.

Q3. To what extent did you encounter any problems in obtaining a result for indicator 2.3?

■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed

Open response: *If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.*

In total 32 testers provided further information about problems they had encountered with indicator 2.3. In Table their responses have been clustered under the main themes that could be identified, together with a summary of the main problems they encountered and also the workarounds put forward by testers,.

It can be seen that the reference standards and methods (11 testers) posed particular problems, including both the floor area measurement and the possibility to use data from a National Calculation Method. In terms of obtaining values and data (8 testers) the disaggregation of the main indicator into different energy needs, the contribution of renewables and the gathering of monitored data were cited as common problems. In addition the guidance and in particular the reporting tool itself posed some problems (7 testers), with user friendliness cited as the most common problem.

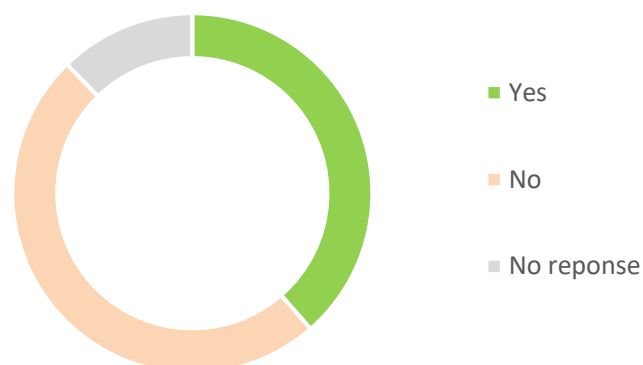*Table 17. Q3 open response to identify the main problems encountered and how they were overcome by testers*

Theme that could be identified	Number of problems cited	Problems and workarounds identified by testers
Difficulty obtaining values and data	**20**	– Difficulty in obtaining data from contractors, especially if not mandatory (8) – A lack of standards or software for estimates, especially for Level 2 (6) – Not normal practice to gather this data during projects (in DK) (3) – A lot of work to compile this data from real projects (2) – Unclear if and how this indicator should link to outputs from LCA studies (when relevant)
Supporting software or tools	**5**	– Expecting the possibility to automatically generate waste estimates based on default factors linked to material inputs or Bill of Materials (5)
Inappropriate scope or units	**3**	– Split between hazardous waste and non-hazardous is difficult to estimate or understand (1) – Confusion about difference between Module D estimates and deconstruction/demolition pre-estimates (1) – Unit of measurement does not fit well with data generated onsite
Unsuitability for certain Project stages	**3**	– Irrelevant at the early design stage (2) – Irrelevant at the occupation stage (1)

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

Amongst the 50 testers that provided a response to this question 22 (44% of active responses or 39% of indicator 2.3 testers) identified useful tools or sources for reporting.

Amongst those that identified what they had used (see Table), their sources for results and data were split quite evenly between building certification schemes, regulatory tools and LCA calculation tools. Actual data was also mentioned as a useful source of information but without specifying how/from whom it had been obtained .

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- Yes
- No
- No reponse

Please specify useful resources from previous projects

Table 18. Q4 open response to identify the extent to which testers already had access to the required results and data
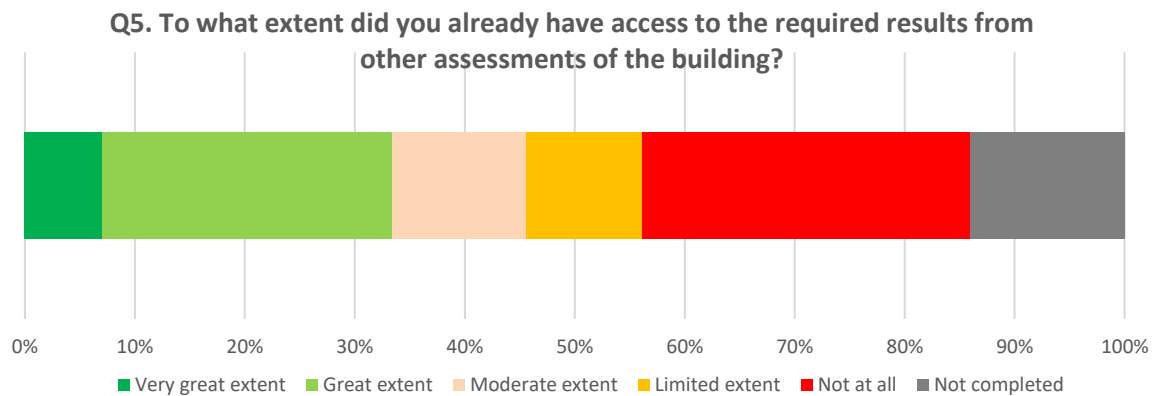
Source of the results/data	Number of resources cited	Specific resources identified
Building certification	5	– BREEAM-NL (1) – DGNB (2) – LEED (2)
Actual data	4	– Via reports from construction site and from previous experience in other projects.
Regulatory tool	3	– Milieudatabase Nederland (NL) (1) – E+C-(France) (2)
Calculation tool	3	– LCA (Bionova OneClickLCA; GaBi)
Other tools	2	– Own program (not named) (1) – Steligence (1)

Q5. *To what extent did you already have access to the required results from other assessments of the building?*

49 testers responded to this question. The result was split between those that they already had access to a moderate or greater extent and those for whom this was the case only to a limited extent or not at all.

The responses who had much less access ("*limited extent*" and "*not at all*") were slightly higher (23 in total) than the 19 who had good access ("*very great extent*" or "*great extent*"). The highest specific response was "*not at all*", likely because many of the testers were not familiar with collecting Construction and Demolition Waste (CDW) data during building projects or that their test was conducted during project stages where such data would not be available (i.e. early design stage for new buildings or occupation stage for existing buildings).

Of those that identified their prior data sources (see Table), the majority referred to data obtained from assessments for building certification schemes (mainly DGNB), from actual project data and from building documentation, such as structural drawings, invoices and permits. A few testers had also obtained data from LCA models.

Q5. To what extent did you already have access to the required results from other assessments of the building?

Legend: ■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed

Please identify the source of results that were already available
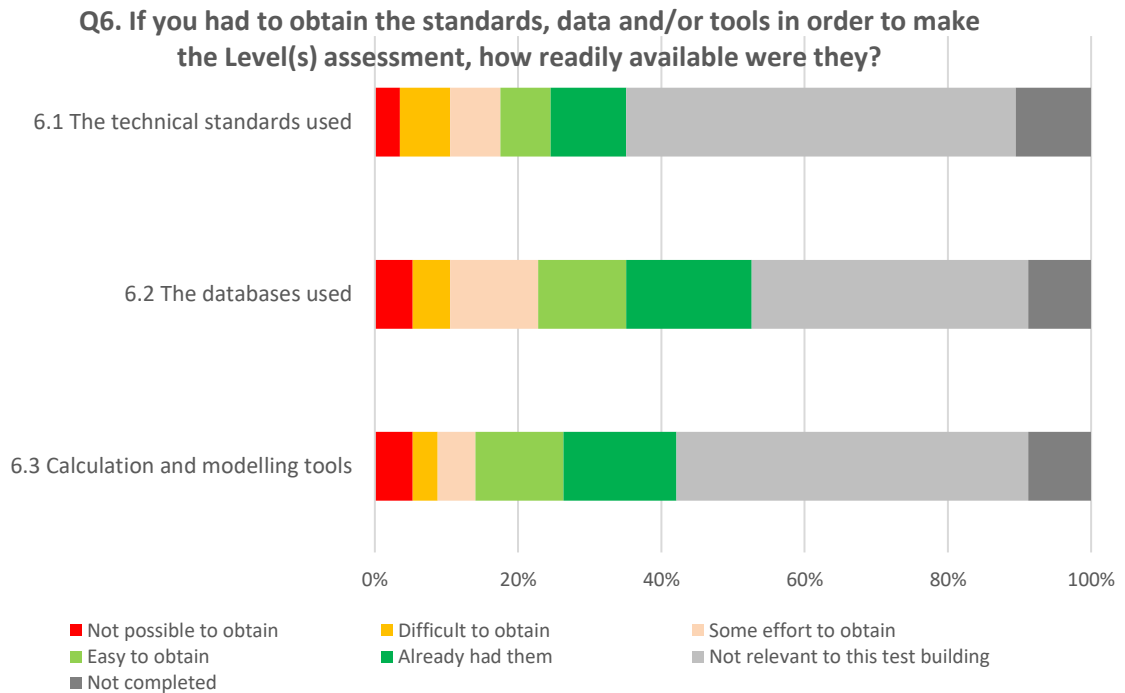
Table 19. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of sources cited	Specific sources identified
Actual data	**10**	– Contractor reports (8) – Old projects (2) – Audits (1) – INIES (1)
Building certification	**10**	– DGNB (6) – E+C- (2) – LEED (2) – GBC HOME (1) – BREEAM-NL (1)
Building documentation	**6**	– Structural drawings (3) – Building permits (1) – TCQi 2019 (1) – Bill of Materials (1)
LCA calculations	**3**	

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

51 testers responded to this question. The most common response was that they were not considered relevant for that indicator in the building project in question (around 4 in 10, 6 in 10 and 6 in 10 citing the non-relevance of technical standards, databases and calculation/modelling tools respectively).

Testers that had had to obtain standards, databases and calculation/modelling tools had a generally positive sentiment about their availability and the ease of obtaining them.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Legend:
- Not possible to obtain
- Difficult to obtain
- Some effort to obtain
- Easy to obtain
- Already had them
- Not relevant to this test building
- Not completed

Q7. _If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?_

The response rate was much lower to Q7 than for previous questions, with only 25-28 of the 57 relevant testers responding. The low response rate is consistent with the high degree of "*not relevant*" answers to Q6, which related to the need to obtain standards, data and/or tools.

Of the testers that did respond, the cost of technical standards, data and/or tools was not generally considered as a barrier to their use. However, a small but notable minority did mention the cost of technical standards and databases as a barrier.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Legend:
- Not at all
- One of the factors
- The main factor
- Not completed
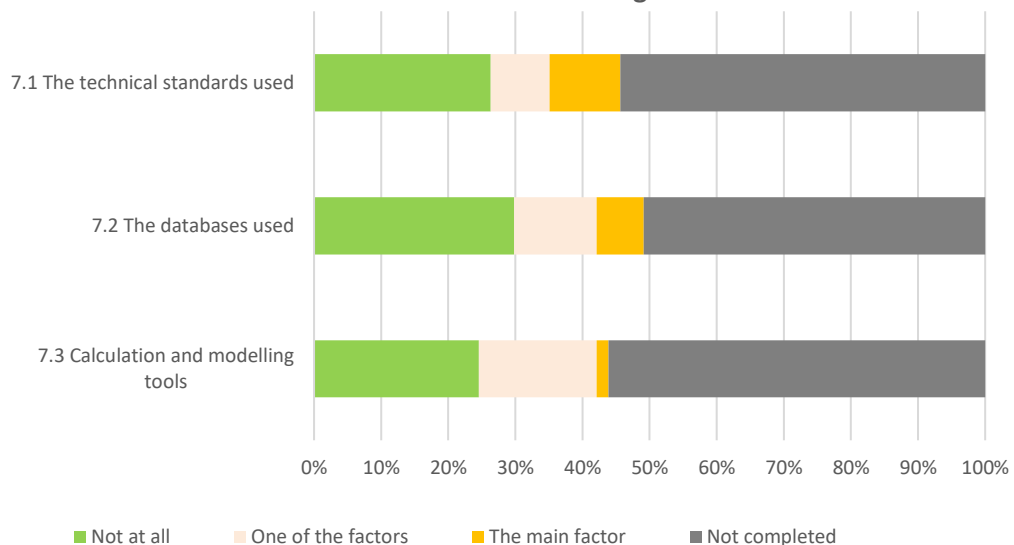
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

40 testers responded to Q8. The majority of respondents (33 of 40) had either extensive or at least some "*limited previous experience*" in reporting CDW for building projects. The remainder (7 of 40) had no previous experience at all.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?
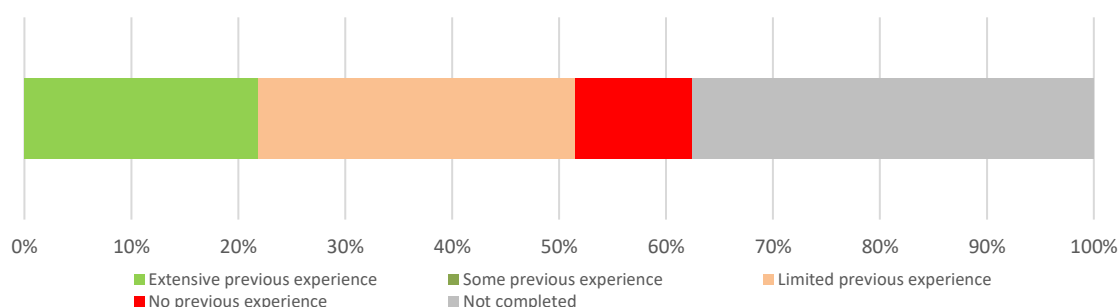
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

50 testers responded to this question. A clear majority of respondents considered that additional training and support was either not required at all or only required to a limited extent (34 of 50). A small but notable proportion considered that training and support was required to a "*great extent*" or "*very great extent*" (6 of 50). This latter total matches well with the 7 testers responding in Q8 that they had no previous experience with the indicator. However, a look at individual survey responses revealed that this connection ("*no experience at all*" in Q8 with "*great/very great extent*" of training and support needed in Q9) only applied for 3 of the 6 responses in Q9.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?
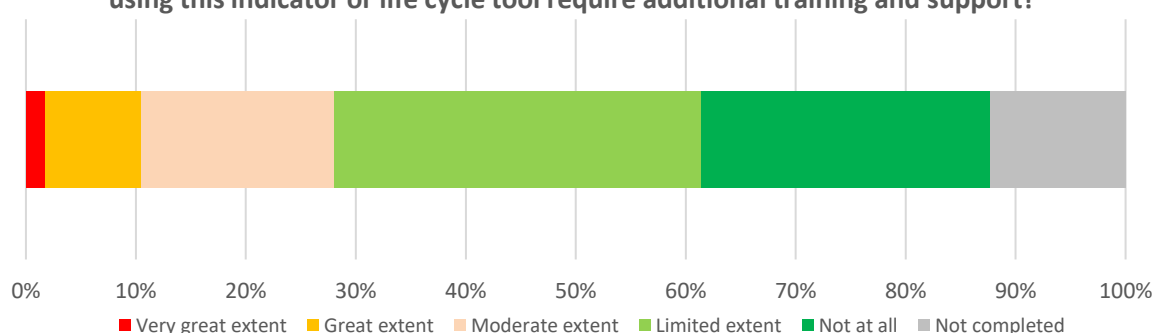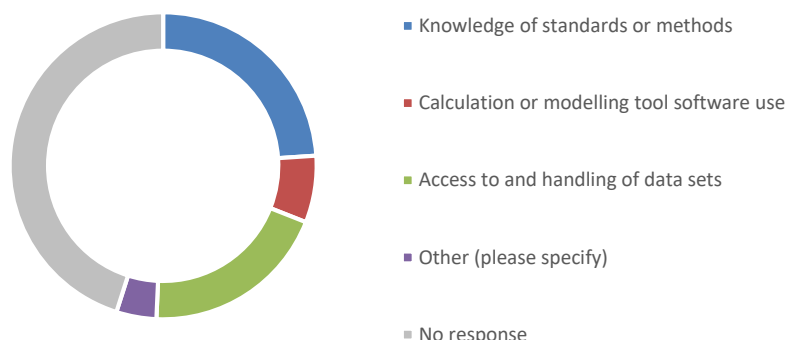

If additional training and support was required, please identify the main areas where it was necessary:

The response rate to this question was lower, only 25 of 57 testers reporting on indicator 2.3. The low response rate is a logical consequence of the answers to the previous question, where 34 testers stated that additional training/support was either not needed at all or only to a limited extent. The main needs identified by such testers were to improve their knowledge of standards and methods (17) and/or improve access to data sets (14).

Further suggestions for the training and support necessary have been analysed from the open question response and are clustered in Table .

If additional training and support was required, please identify the main areas where it was necessary

- ■ Knowledge of standards or methods
- ■ Calculation or modelling tool software use
- ■ Access to and handling of data sets
- ■ Other (please specify)
- ■ No response

### *Please identify the type of training and/or support that was needed*

Table 20. Q10 open response to identify training and support needs

| Broad type of training or support	Number of needs cited	Specific need identified
Webinar training	4	– To understand the logic of the reporting form (1) – Specially targeted to consultants or contractors (2) – Explaining the Level(s) reporting format and how it compares to GBC HOME.
Information	4	– How exactly to report correctly (1) – Access to useful (default) data examples (3)
Support	1	– About how best to collect real site data.

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of those testers that provided time estimates (25) it can be seen that 60% required 1 person day or less and 92% required 4 person days or less to complete reporting under indicator 2.3. The average was 2.1 person days. Two estimates appeared unusually high (8 and 11 person-days), but this may have included additional efforts to gather real site data that would not have otherwise been collected.
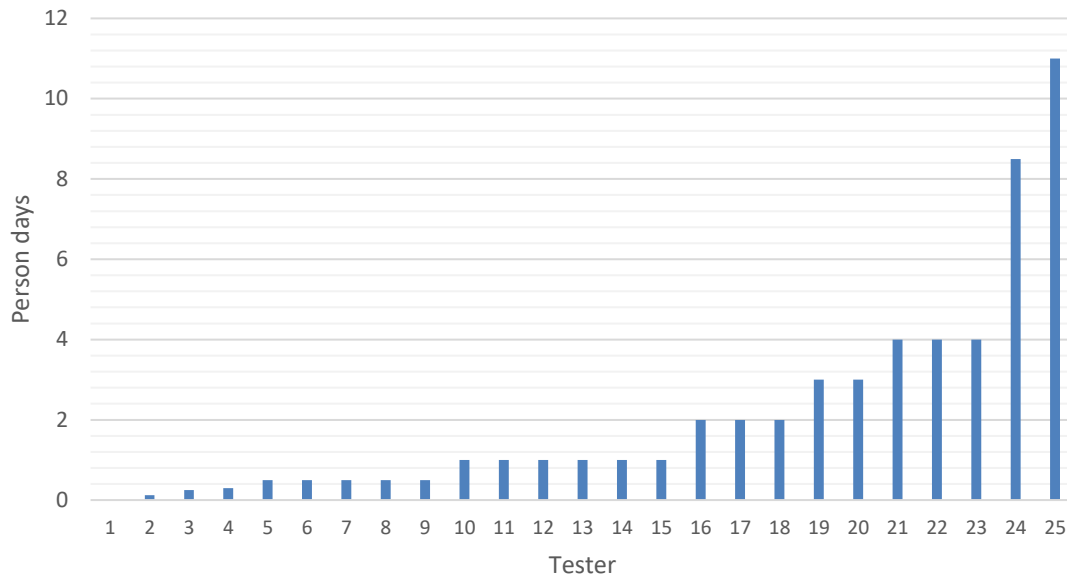
Of the 18 testers that provided cost estimates, 72% assigned around €1.000 or less and 94% around €4.000 or less. One unusually high estimate of €11.000 was also submitted. The average estimated cost was €1.700.
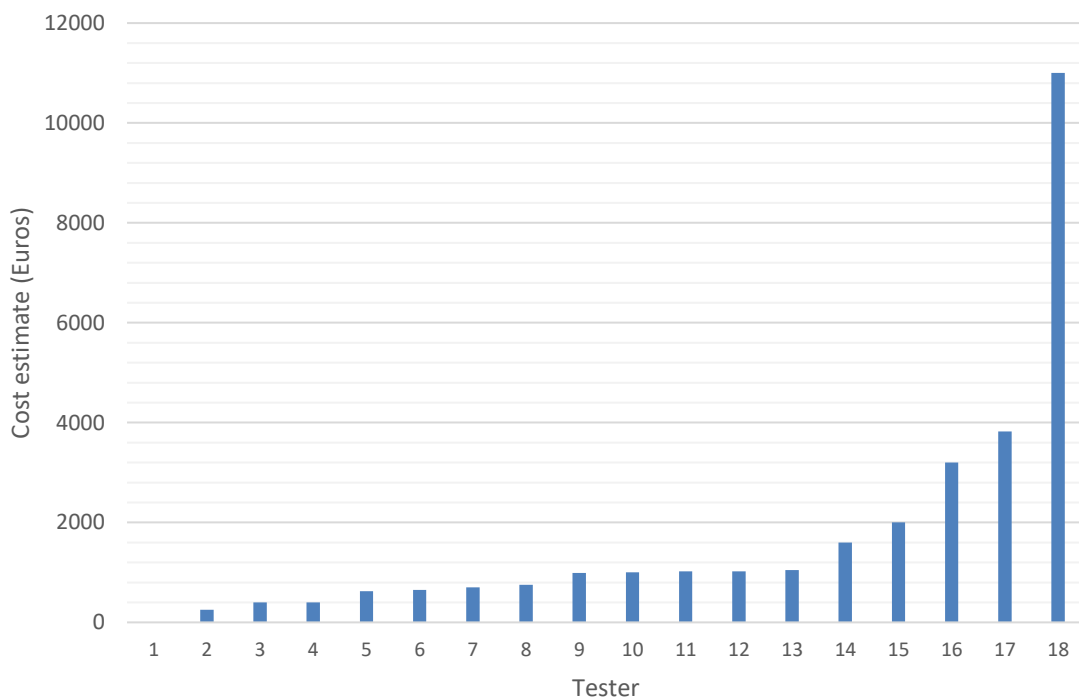
Q11. _**Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use**_.

42 testers offered opinions about possible improvements. Several different messages came across from the responses to Q11.

The clearest message was that it would be considered as a major improvement if default waste values could be provided for different building materials/building types. This could be used

during the design stage, as a backup value for estimates while data is being collected during construction, or as a baseline to compare to real data after completion of the building project.

In cases where an LCA is conducted within the same building project, these default values should be directly linked to the LCA unless they are subsequently overwritten by real data. In cases where real data is available, it should be inserted into the LCA model and then used to automatically generate a value for indicator 2.3. Some of the advocates for a direct link to LCA questioned the need for indicator 2.3 at all.

Testers were also confused about some aspects of the reporting format, namely the distinction between pre-estimates of demolition/deconstruction and Module D; the link to indicator 6.2; the waste audit option and the distinction between knowing when a waste is hazardous or non-hazardous.

Table 21. Q11 open response to suggest improvement that would make the indicator easier to use

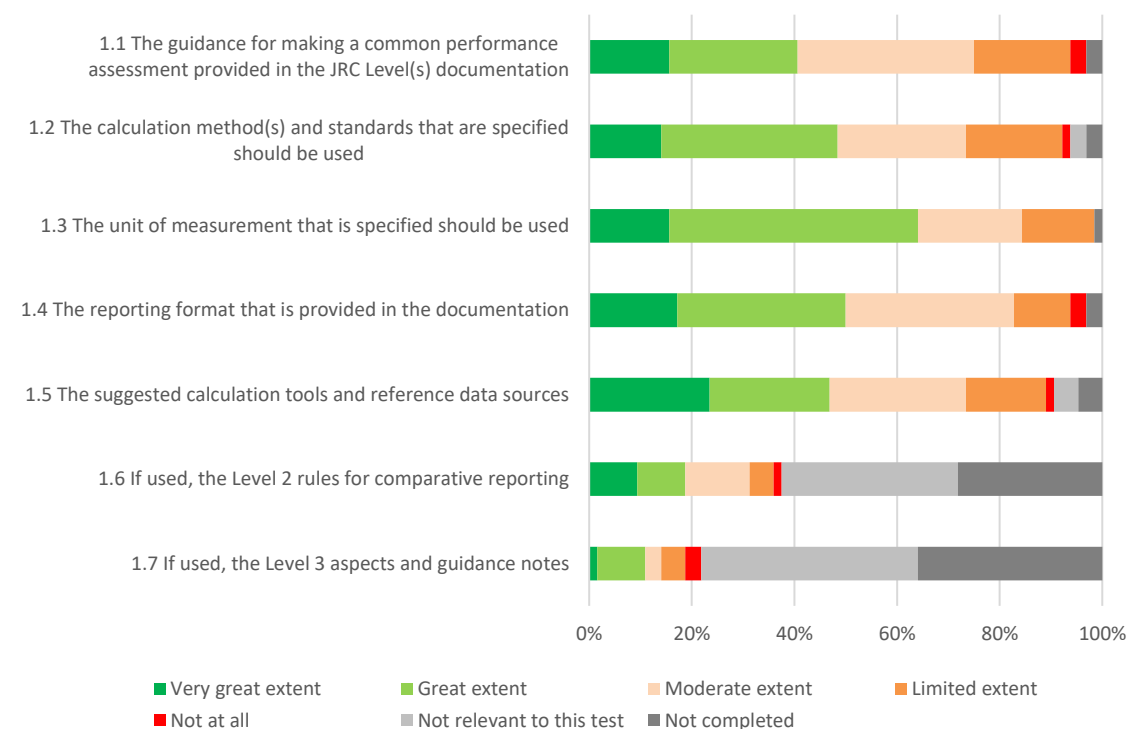| Source of the results/data	Number of resources cited	Specific resources identified
Default information	8	– Waste factors for defined building materials and products (6) – Splitting of waste factors into hazardous and non-hazardous wastes as well (1)
Clarifications	10	– About the difference between pre-estimates of demolition/deconstruction activities and Module D estimates (5) – About how different categories are to be calculated exactly (2) – Specifically about how to define and quantify hazardous waste (2) – About what exactly is included in the scope of CDW and if it should be actual data or calculations only (1)
Alternative approaches	6	– Divide reporting by material (e.g. concrete, metal etc.) (1) – Change the methodology for Levels 2 and 3 as it may affect definition of benchmarks (1) – Treat landfill and incineration differently (1) – Exclude waste audit (2) – Include Module C reporting here (1) – Questioning relevance of pre-estimate on CDW (1)
Link to LCA	4	– Link to LCA whenever this is done for the same Project (3) – Removing reporting requirement for CDW when LCA is done (2)
Building certification	2	– A closer alignment with LEED (2)

Indicator 3.1: Use stage water consumption

Q1. To what extent was the indicator or life cycle tool easy and logical to use?

Of the 64 testers that reported on indicator 3.1, the majority considered that for questions 1.1 to 1.5 the indicator was 'easy and logical to use' to a moderate or greater extent. With the exception of the guidance, the majority of testers also considered this to a great or very great extent. The aspect considered most positively was the unit of measurement. The guidance and the calculation method and standards received the greatest negative response.

The tester response to questions 1.6 and 1.7 in relation to Levels 2 and 3 was much lower. However, of those that responded, the the majority of those that tested these levels considered that they were 'easy and logical to use' to a moderate or greater extent.

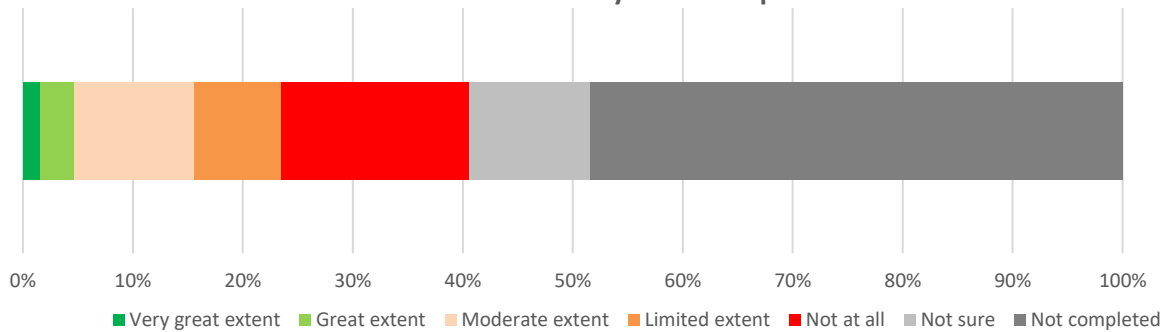**Q1. To what extent was indicator 3.1 easy and logical to use?**

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not relevant to this test
- Not completed

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Of the 64 testers that used indicator 3.1, around 60% either considered that it had been of limited or no help in comparing different building design options or were unsure about how such a comparison would be helpful.

The results for Q2, especially the high non-response rate, implies that estimates of use phase water consumption are not a main factor that building designers take into consideration when deciding upon the preferred design option for building projects. It is also indicative in general of the low number of testers that were actually considering different design options in the test projects.

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not sure ■ Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Overall, 61 testers provided a response to Q3. Responses with a positive sentiment (48 of 61) clearly outweighed those with a negative sentiment (5 of 61). A relatively minor amount of intermediate responses (8 of 61), stating a "moderate extent" of problems in obtaining a result for indicator 3.1 was reported. These results are a very positive reflection on the user friendliness of the water indicator.

Q3. To what extent did you encounter any problems in obtaining a result for indicator 3.1?
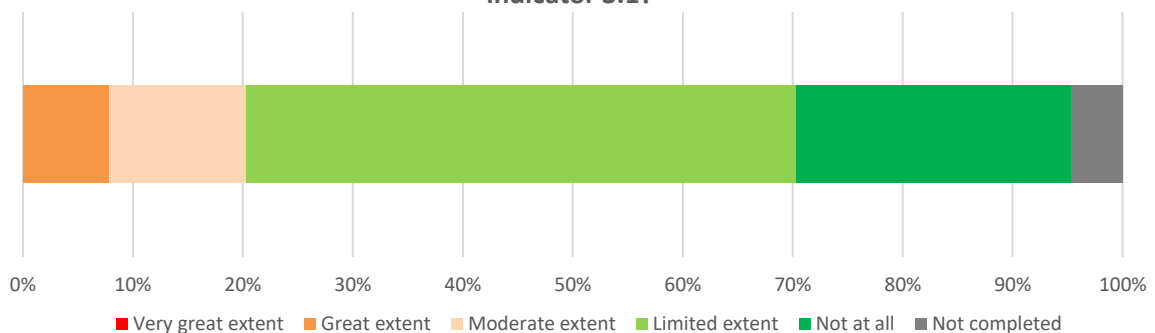
Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed

Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

Ignoring 2 responses that simply stated that the calculator tool had no critical issues, a total of 16 responses were received about problems with reporting under indicator 3.1. In Table tester responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward by testers,.

One problem was confusion when the cells for calculating non-potable water inputs appear or disappear in the Level 1 calculator depending on whether or not the WEI+ index for the relevant river basin is greater or less than 20. It appears that this dependency was not clearly explained in the calculator or the guidance document.

Other users wanted their results to be in the context of some benchmarks or questioned the disaggregation of the data in the reporting.

Table 22. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of problems cited	Problems and workarounds identified by testers
Expectations	9	− Expecting results to be put in the context of a benchmark (2) − Better explanations in guidance manual about definitions and how to use calculator (3) − Want the option to identify river basin data via an interactive map (1) − Want an option for when seawater is the water source (1) − Too many input data required / too complex (2)
Apparent bugs in the calculator	6	− Not understood why non-potable water calculation cells disappear when certain river basins are chosen for Level 1 reporting (4) − Other "bugs" (2)
Other situations or data presentation/splitting	3	− Split between hot and cold water values (2) − Not considered practical to obtain actual meter readings for potable and non-potable water (1)

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

58 testers provided a response to this question. In total 33 testers (57% of active responses or 52% of indicator 3.1 testers) identified useful tools or sources for reporting under indicator 3.1.

The respondents identified a range of useful references, datasets or tools they had used (see Table). The vast majority of useful information and resources can be seen to have come from previous or parallel efforts of testers in obtaining a building certification (the most common being DGNB).

Some testers also made reference to climate data, even mentioning the same EEA database that is used in the calculator to estimate river basin WEI+ values and rainfall and evapotranspiration rates.

Some mention was also made of regulatory tools and even LCA software, but only one tester mentioned actual water bills and only one mentioned the technical datasheets of installed fittings and devices.

It was also very surprising that only 2 of the 29 responses cited the Level(s) calculator as a useful tool for reporting under indicator 3.1.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?


- Yes
- No
- No reponse
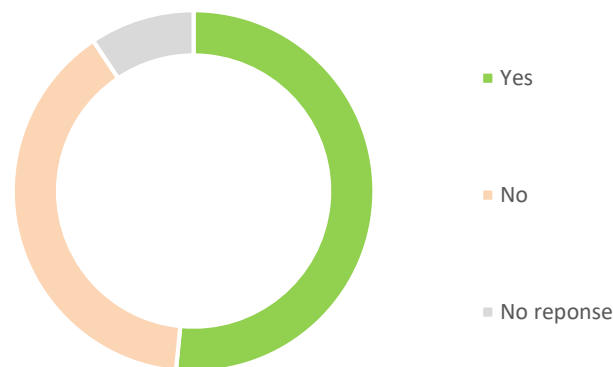
Q5. *To what extent did you already have access to the required results from other assessments of the building?*

61 testers responded to this question. The result was evenly split, with negative sentiment responses ("*limited extent*" and "*not at all*") being almost identical in number (25 in total) to the 26 positive sentiment responses ("*very great extent*" or "*great extent*"). A significant number of intermediate responses (10) saying there was a "*moderate extent*" of prior access to required results was also stated. The number of positive sentiment responses (26) compares well to the number of testers stating that they had specific references, datasets or tools that proved useful (29) in the answers to Q4.

Of those testers that identified their prior data sources (see Table), the dominant sources were the same as those identified in the open responses to Q4 (i.e. previous or parallel efforts to obtain green building certification, especially with the DGNB scheme). Some testers obtained data via information that was necessary under national level regulatory tools or had used information from other projects. One tester claimed that data from a carbon footprint calculation was useful. Presumably, this would link to the hot water supply although it was unsure if the embodied carbon in potable water was then also included.

Q5. To what extent did you already have access to the required results from other assessments of the building?

- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
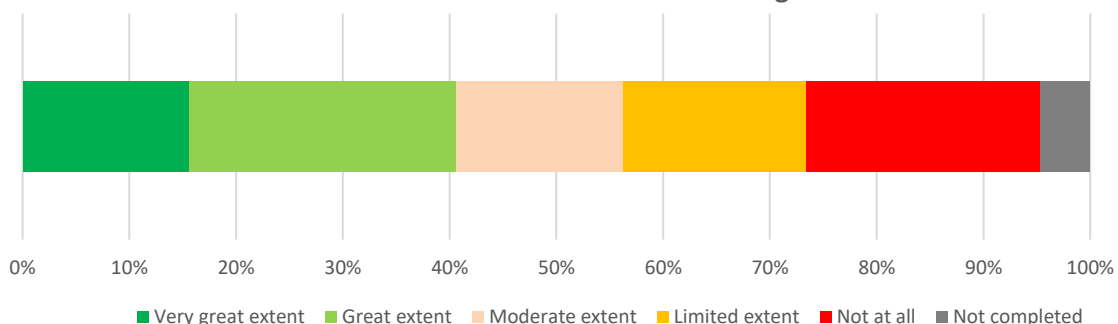
Please identify the source of results that were already available

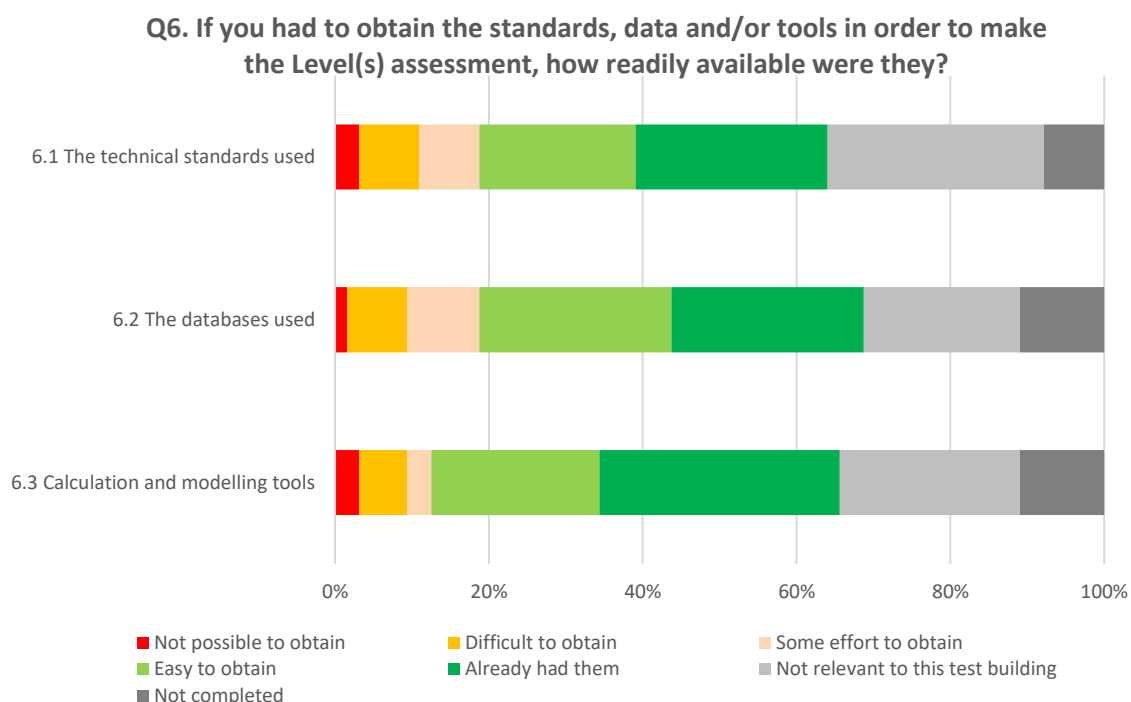*Table 23. Q5 open response to identify the source of existing results and data*

Source of the results/data	Number of sources cited	Specific sources identified
Other projects / actual data	**6**	– Other projects (3) – EMAS (1) – Internal monitoring each month for several years (1) – Monitoring individual fittings (1)
Building certification	**20**	– DGNB (13) – E+C- (2) – LEED (3) – GBC HOME (1) – Various (1)
Technical datasheets	**3**	– Water consumption rates in l/s (1) – Bill of quantities for fittings and devices (2) – Irrigation áreas, number of occupants (1)
Regulatory tools	**2**	– National building codes (2)
LCA calculations	**1**	– VTT and Bionova carbón footprint calculations (1)

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

59 testers responded to this question. A significant number of testers considered technical standards, databases and calculation/modelling tools as "*not relevant*" for reporting under indicator 3.1 (13 to 18 of the responses received).

It was surprising that 15 testers considered calculation/modelling tools as "*not relevant*". The development of a specific water calculator for reporting under indicator 3.1 is a testimony to the importance of such calculation tools for estimating water consumption. It is likely the result of testers who already had data to report from existing building assessments.

Testers that had to obtain relevant standards, databases and calculation/modelling tools overall had a highly positive sentiment about their availability. This is likely a reflection of the provision of not only the Level(s) water calculator, but other calculators associated with green building assessment schemes.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Legend:
- Not possible to obtain
- Difficult to obtain
- Some effort to obtain
- Easy to obtain
- Already had them
- Not relevant to this test building
- Not completed

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

There was a much lower response rate to Q7, with only around half (31-33 of 64) responding. While the low response rate can be partly explained by the answers to Q6 (availability of standards etc. being "*not relevant*" in Q6), there are still 10 or so non-responses that cannot be so easily explained.

For the testers that did respond, the availability of technical standards, data and/or tools were not generally considered as a barrier for reporting at all. However, around a quarter of (8 of 31 active responses) did mention the cost of technical standards as a main barrier to their use, and for databases and tools cost was one of the factors.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?


Legend: Not at all | One of the factors | The main factor | Not completed
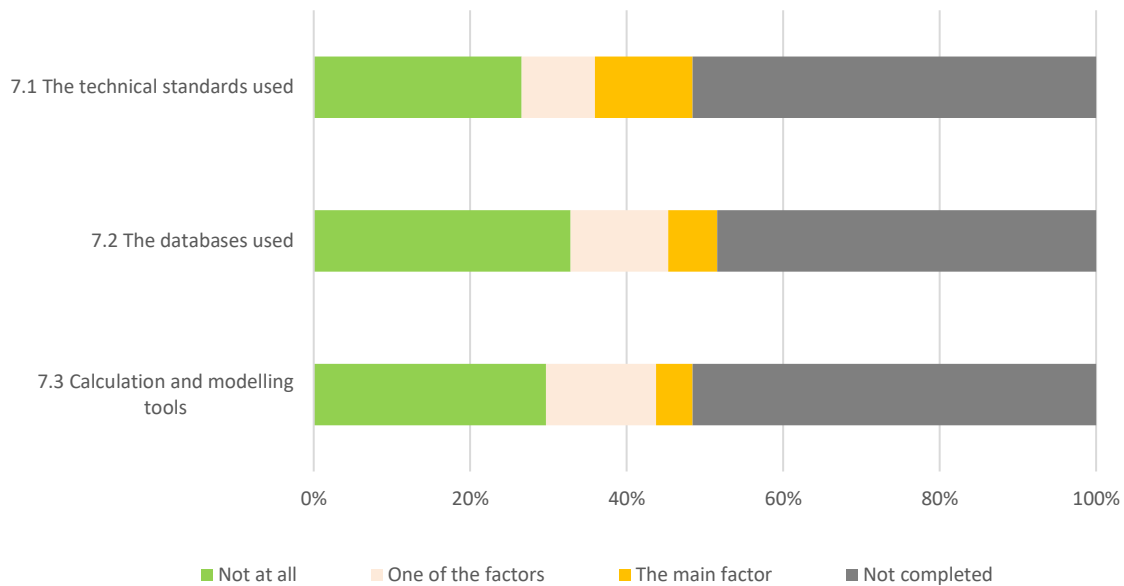
Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

43 testers responded to this question. Less than half of the testers that responded (17 of 43) had "*extensive*" or "*some*" previous experience with reporting use stage water consumption for buildings. The majority had either "*no previous experience*" (11 of 43) or only "*limited previous experience*" (15 of 43).

It is perhaps worth highlighting that 7 of the 11 testers with no previous experience in reporting use stage water consumption were from DK (4) or FI (3). In other comments received, it was stated that in DK, only hot water consumption is normally estimated. Perhaps water consumption monitoring in these countries is not such a priority given their climatic conditions.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?


Legend: Extensive previous experience | Some previous experience | Limited previous experience | No previous experience | Not completed
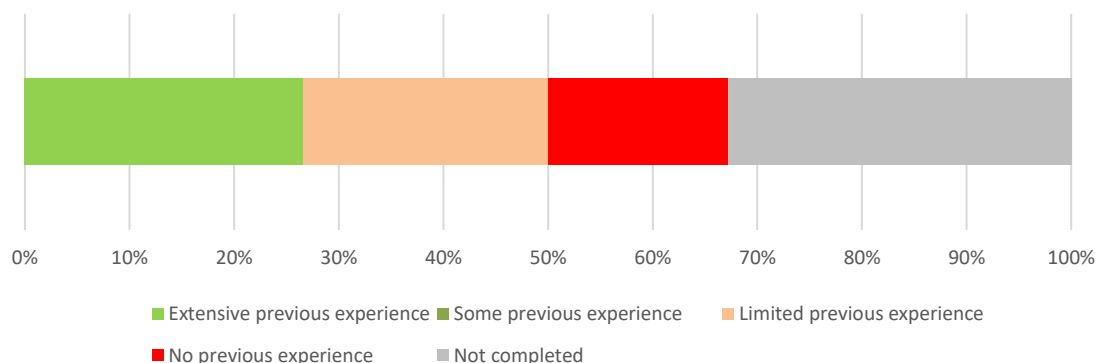
Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

59 testers responded to this question. A clear majority of respondents considered that additional training and support was either not required at all or only required to a "*limited extent*" (47 of 59). Only around 1 in 15 respondents considered that training and support was required to a "*great extent*" and none thought it was needed to a "*very great extent*".

The fact that 11 testers had no previous experience in reporting use stage water consumption (see Q8 responses), but that none felt that there was a very great requirement for additional training and support, implies that the indicator is based on a concept that is simple to grasp, visualise and to report on.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend: ■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed
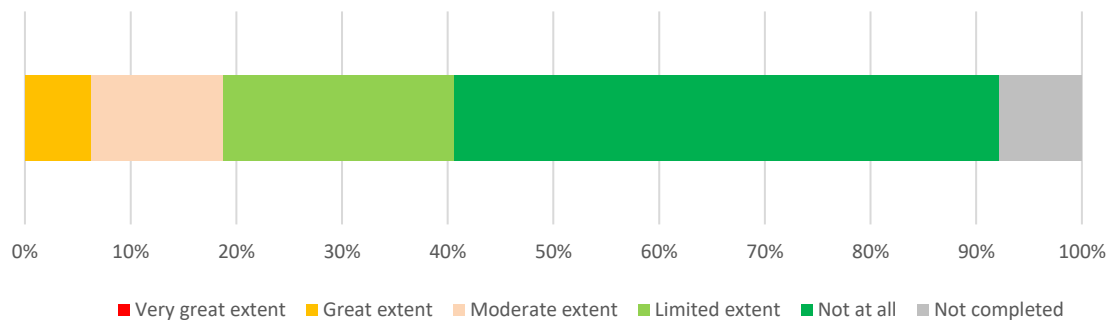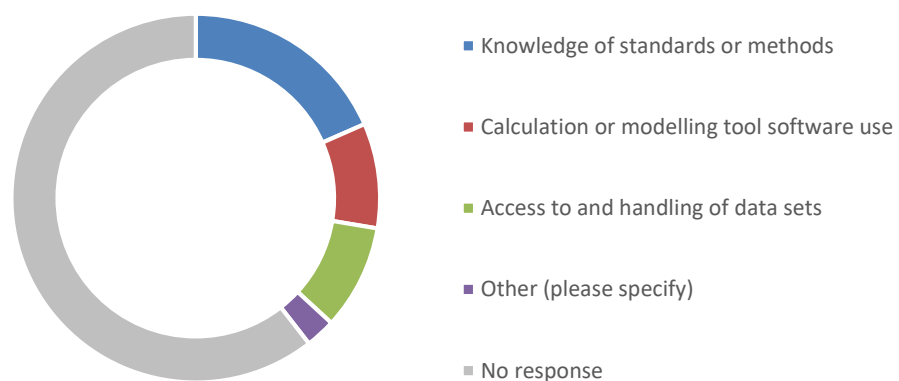
If additional training and support was required, please identify the main areas where it was necessary:

The response rate to this question was very low, with only 18 testers offering their opinion.

The low response rate is a logical consequence of the answers to the previous question, where only 12 testers stated that additional training/support was needed to a "*moderate extent*" or a "*great extent*".

From the 9 testers who then went on to identify training and support, the main need identified was to improve knowledge of standards and methods (14). Training and support in regards to data sets (7) and calculation/modelling tools (7) were also considered necessary.

If additional training and support was required, please identify the main areas where it was necessary

Legend: ■ Knowledge of standards or methods ■ Calculation or modelling tool software use ■ Access to and handling of data sets ■ Other (please specify) ■ No response

Please identify the type of training and/or support that was needed

*Table 24. Q10 open response to identify training and support needs*

Broad type of training or support	Number of needs cited	Specific needs identified
General needs	4	– We would've needed lots of additional training, but that was not available. – Format of reporting. – We would've needed training, but there was none available. Only the One clock LCA provided a training day. – It was not necessary.
Methodology	2	– Reporting method – Consulting training the team on Level(s) reporting criteria and tool
Translation	1	– Understanding and translating the Danish input til levels.
Alternative	1	– Alternative way to collect and use of water
Data	1	– Dataset gathering, some unclear instruction

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of the 36 testers that provided time estimates it can be seen that 75% required 1 person day or less and 94% required 5 person days or less to complete reporting under indicator 3.1. The average was 2.2 person days. Two estimates appeared unusually high (12.5 and 25 person-days), and it is difficult to understand what would take such a long time for reporting under indicator 3.1 unless the real performance of fittings in the building are to be verified and compared with estimates or that extra efforts are made to calculate occupancy and irrigation aspects related to Level 3.
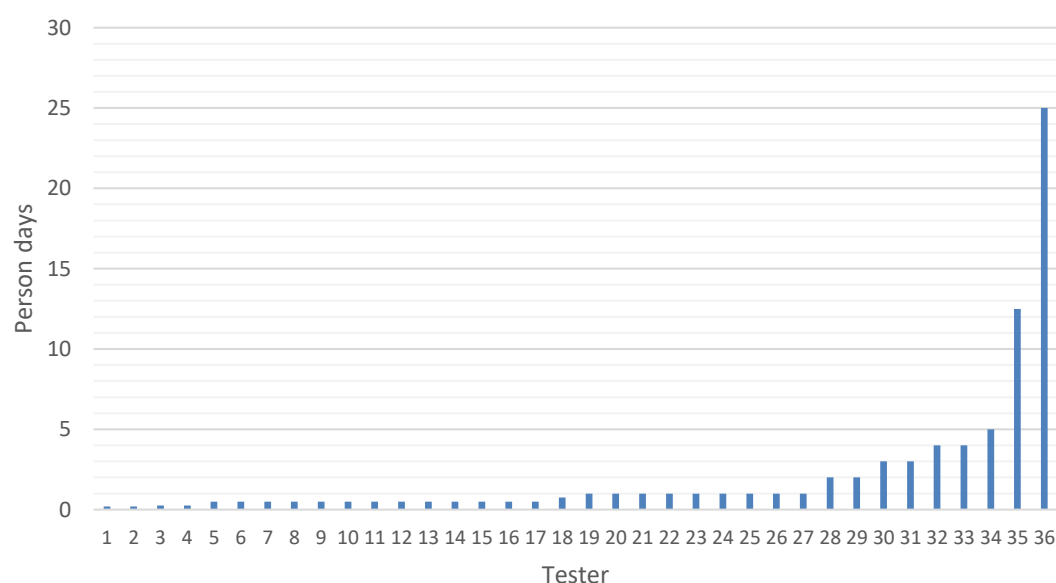
Of the 22 testers that provided cost estimates, 59% assigned €800 or less and 81% around €1.050 or less. Four significantly higher estimates, including one unusually high estimate of €4.250 were also submitted. The average estimated cost was €960.
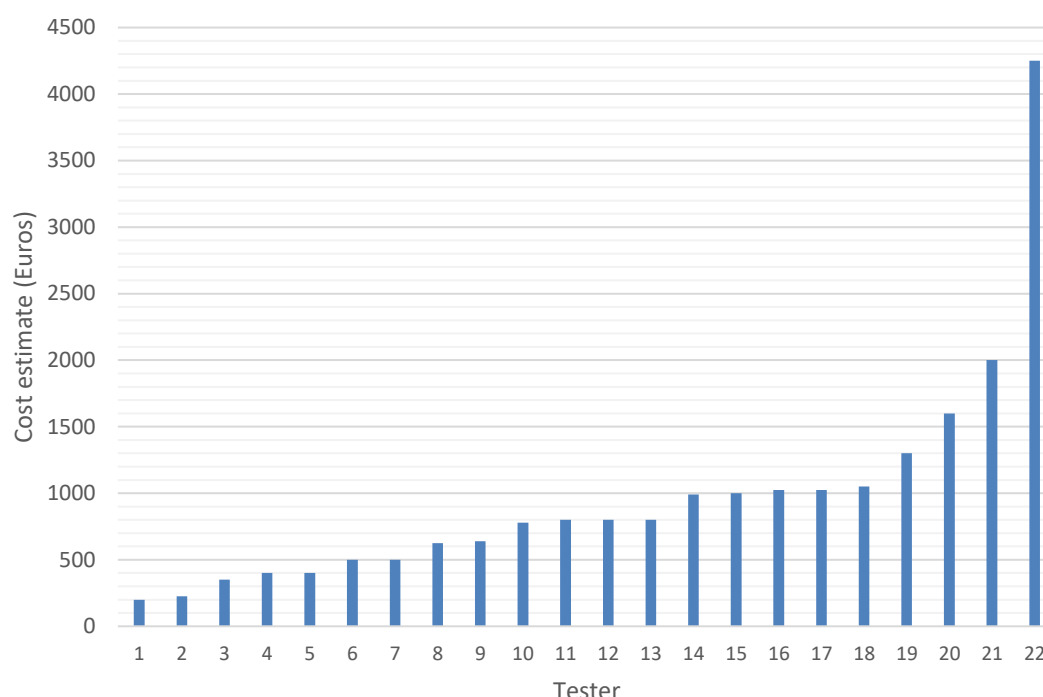
Q11. _**Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.**_

35 testers made suggestions for possible improvements. Several different messages came across from the responses.

Some feedback requested simplification while other feedback asked for new ways of disaggregating and expressing the data. Several testers commented on how the Level(s) approach compared to the DGNB method. A better link between the reporting methodology and the guidance document was also requested.

Table 25. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of improvements cited	Specific improvements identified
Simplification	**6**	− Level 3 in general (2) − Have a "no irrigation" option for Level 3 (2) − Simplify all levels in general (2)
Scope and outputs	**9**	− Allow for sea water as a source (2) − More basins (presumably sub-basins) (1) − More species for irrigation options (1) − Add the option for cleaning water consumption to Level 2 (1) − Also account for "lost" rainwater (1) − Report on wastewater quantity as well (1) − Separate accounting of rainwater and greywater (1) − Separate accounting of hot and cold water (1)

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User interface	4	– Interactive map for WEI+ (1) – Bug for pie chart graph (1) – Confusion about why greywater section sometimes disappears (2)
Other feedback	13	– Better link to guidance and reporting excel (3) – Need for more training (1) – Allow for comparison to real data (1) – Easy to use / works well (3) – Good overlap with DGNB (2) – Unnecessary/useless for designers (3)

Indicator 4.1: Indoor air quality
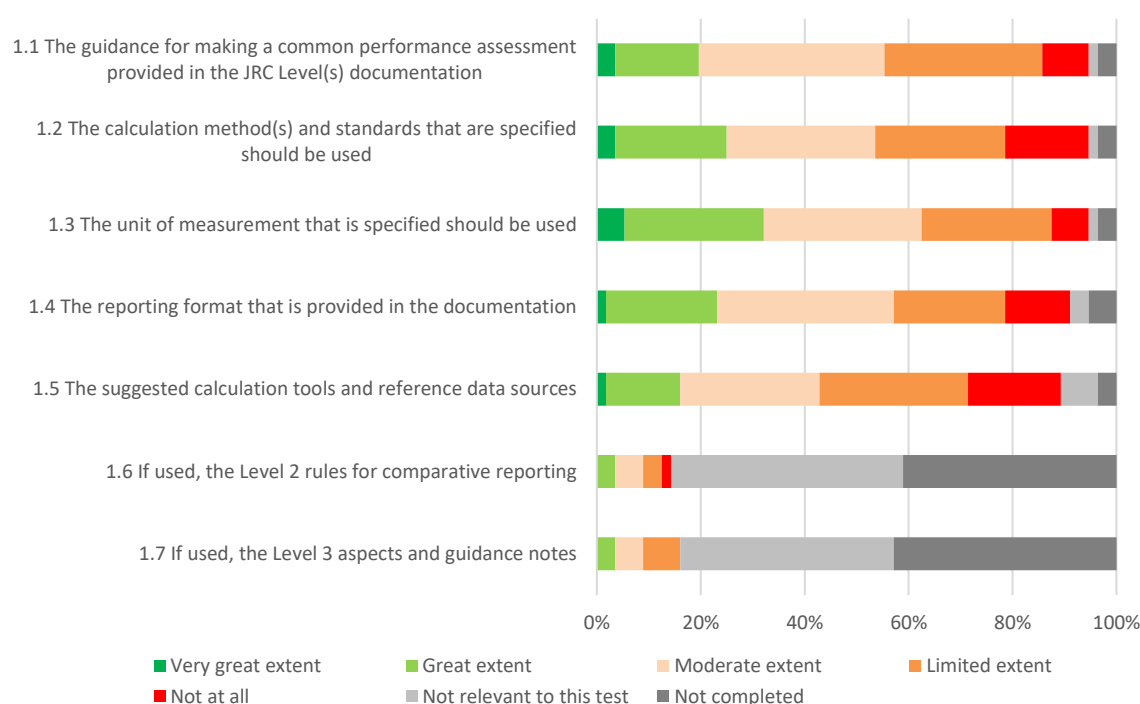
Q1. To what extent was the indicator or life cycle tool easy and logical to use?

Of the 56 testers that reported on indicator 4.1, the majority considered that for questions 1.1 to 1.4 (the guidance, the calculation method and the reporting format), that the indicator was 'easy and logical to use' to a moderate or greater extent.

However, across all the questions this indicator had a relatively high negative sentiment (i.e. considered easy and logical to use to a "*limited extent*" or "*not at all*").   There was a notably high proportion of testers that considered that it was not at all 'easy or logical to use'.

The tester response to questions 1.6 and 1.7 in relation to Levels 2 and 3 were very low (32 or 33 out of 56 responded) and of the responses received, by far the most common response was that Level 2 and 3 were not relevant to their test (implying that they only tested Level 1).

**Q1. To what extent was indicator 4.1 easy and logical to use?**

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Of the 56 testers that used indicator 4.1, around 70% appear not to have made a comparison of different building design options or were unsure about how such a comparison would be helpful.

Of the remaining 17 testers that did offer a clear opinion on this matter, more than half (12 of 17) expressed a negative sentiment (responding with "*not at all*" or "*limited extent*") while only 3 of 17 expressed a positive sentiment (responding with "*very great extent*" or *"great extent*").

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Legend: ■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not sure ■ Not completed
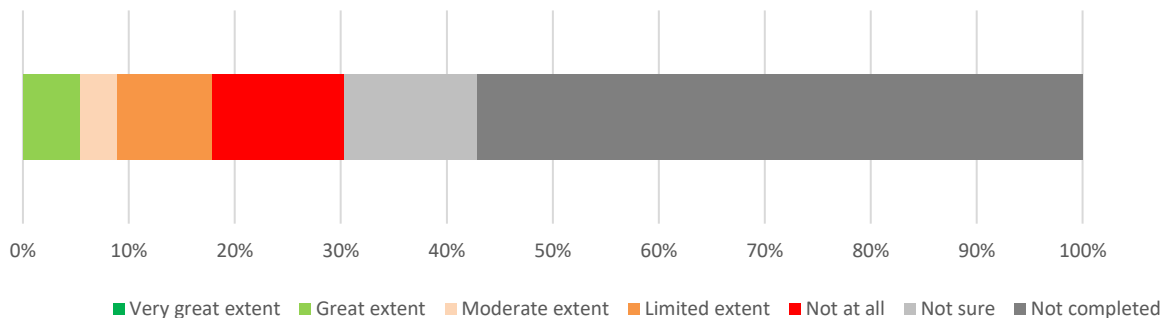
The results for Q2, especially the high non-response rate, implies that estimates of indoor air quality are not a main factor that building designers take into consideration when deciding upon the preferred design option for building projects. It is also indicative of the low number of testers that were actually considering different design options in the test projects.

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Overall, 53 of the 56 testers that reported under indicator 4.1 provided a response to Q3. Responses with a negative response (30 of 53) clearly outweighed those with a positive response (8 of 53). A significant amount of intermediate responses (15 of 61), stating that they had encountered problems to a "*moderate extent*" were also reported. These results imply that indicator 4.1 needs to be considerably re-evaluated.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Legend: ■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent ■ Not at all ■ Not completed
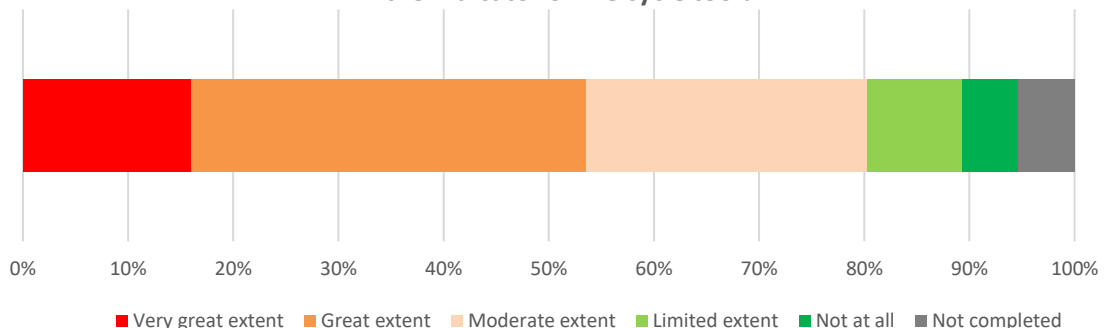
Open response: *If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.*

A total of 40 responses were received that elaborate further on problems with reporting under indicator 4.1. In Table tester responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward by testers,.

The clearest message in the feedback was that a lack of access to the relevant standards was the main problem (EN 16978 and EN 13779 were specifically mentioned). Without these standards, it was unclear how exactly to report for indicator 4.1, even at level 1.

Problems were also highlighted about the difficulty in finding emission data for building materials and, even when data was found, it was not presented in comparable units.

Many testers complained about the poor overlap with existing building regulations and the difficulty and cost of obtaining some in-situ air pollutant measurements.

Some testers did not understand the LCI concept and others felt that Level 1 needed to be simplified. Other users wanted their results to come out in a quantitative manner and be in the context of some benchmarks or questioned the splitting of data reporting.

Table 26. Q3 open response to identify the main problems encountered and how they were overcome by testers

| Theme that could be identified	Number of problems cited	Problems and workarounds identified by testers
No access to relevant standards and data	19	– EN 16978 (6) – EN 13779 (2) – EN 15251 (1) – Data difficult to find or establish (5) – Data units not consistent (1) – Testing is expensive, especially benzene and formaldehyde (4)
Link to building assessment schemes and building regulations	6	– Required values for CO2, benzene and radon not done for Level(s) because these are not required for EPB calculations (1) – No link for this indicator in E+C- scheme (2) – Poor alignment of Italian law (UNI 10339) with EN 16798 (well 16978) (1) – Why not align better with DGNB? (2) – Only mould and ventilation are mandatory in DK (1)
Scope for Level 1	4	– Continuous testing seems to be required for Level 1 - costly (1) – Should focus on what is mandatory in Level 1 and make a clear distinction between mandatory and option monitoring (1) – Level 1 is too difficult to fill in at the moment (1) – VOC emission of individual building materials is perhaps too detailed for Level 1 (1)
Output complaint	3	– No quantitative result, so no concrete feedback to testers, building designers or clients (2) – Not possible to link actual values to building materials, especially during occupation (1)
Other feedback	4	– Typo in standard reference (EN 16798 and 16978) (1) – How should results translate between EN 15251 and Level(s)? (1) – Depending on the project stage, it is not possible to report fully on this indicator (2)

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

49 testers provided a response to this question. In total, only 18 testers identified useful tools or sources for reporting on indicator 4.1.

Amongst the 18 responses that identified what useful references, datasets or tools they had used (see Table), the most common source of useful information and resources came from previous or parallel efforts of testers in obtaining building certification (particularly DGNB).

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- ■ Yes
- ■ No
- ■ No reponse
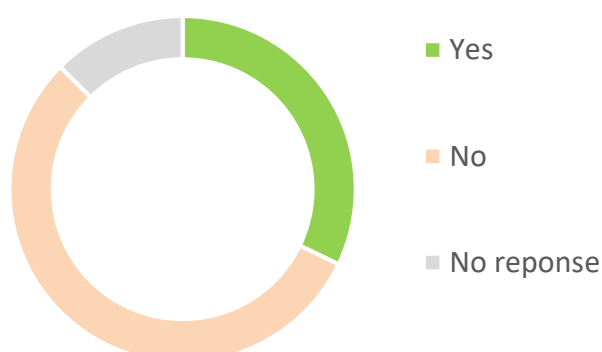
Please specify useful resources from previous projects

Table 27. Q4 open response to identify the extent to which testers already had access to the required results and data

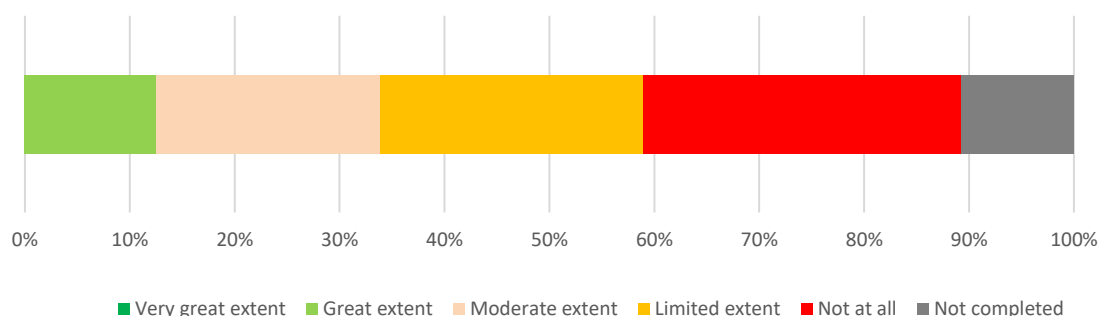| Source of the results/data	Number of resources cited	Specific resources identified
Building certification	6	– DGNB (5) – BREEAM, HQE and LEED (1)
Regulations	3	– National level (3)
EN standards	2	– EN 16798 Table I.4 (1) – EN 15251
WHO	1	– CIBSE guide (1)
Others	4	– Batiments exemplaires de Wallonie (1) – Building simulation tools, IESVE (2) – WELL building standard, but does not fit well with Level(s) (1) – Blue Angel, but does not fit well with Level(s) (1)

Q5. To what extent did you already have access to the required results from other assessments of the building?

50 testers responded to this question. The negative responses ("*limited extent*" and "*not at all*") were more significant (31 in total) than the 7 more positive responses ("*great extent*"). No responses stating "*very great extent*" were received. A significant number of intermediate responses (12) saying there was a "*moderate extent*" of prior access to required results were also received.

The number of positive responses (7) was much lower than the number of testers stating that they had specific references, datasets or tools that proved useful (18) in the answers to Q4. This suggests that even though useful references were available, they were not sufficient to make reporting under indicator 4.1 simple or were not fully relevant to the way in which reporting is required for Level(s).

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The number of testers that identified their prior data sources in the open response to Q5 (23) (see Table), is reasonably comparable to the number of testers that said in Q4 that they had found useful references, datasets or other tools (18). The dominant sources of existing information were generally the same as those identified as useful sources in the free text responses to Q4 (i.e. previous or parallel efforts to obtain green building certification, especially with the DGNB scheme).

Q5. To what extent did you already have access to the required results from other assessments of the building?

Please identify the source of results that were already available

Table 28. Q5 open response to identify the source of existing results and data

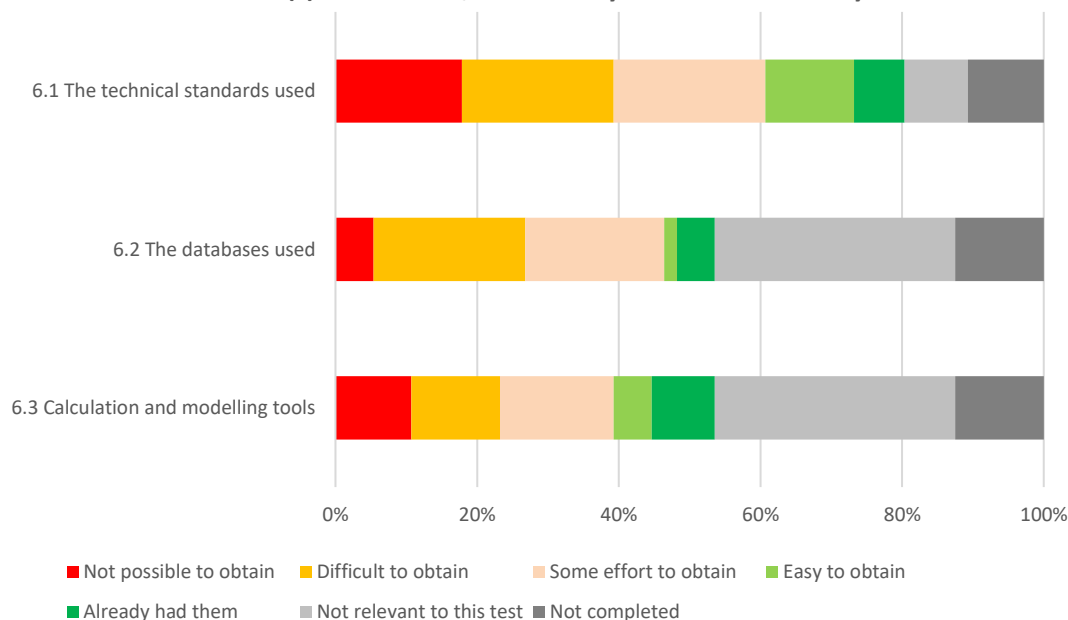| Source of the results/data	Number of sources cited	Specific sources identified
Building certification	8	– DGNB (7) – GBC HOME (1)
Actual data	6	– Formaldehyde (1) – Ventilation rate (1) – Relative humidity, radon and CO2 (1) – As part of an MSc thesis (1) – Measured values (1) – Link to safety data sheets (but not ideal) (1)
Building documentation	3	– Building Management System (1) – Calculations of ventilation specialiist (2)
Other comments	4	– Benchmarks (lack, of) (1) – Literature "Die Temperatur der Architekur" (1) – EN standards, 16798 and 13779 (1) – WELL building standard, Blue Angel (1)

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

49 testers responded on the availability of technical standards, databases and calculation or modelling tools.

Of the responses received, there was a marked different between the perceived relevance of "*technical standards*" (45 of 50 considered them relevant) compared to "*databases*" (30 of 49) and "*calculation/modelling tools*" (30 of 49). The significantly higher relevance of technical standards is quite easy to understand given the importance of standards such as EN 16798 to indicator 4.1.

Testers that did have to obtain relevant standards, databases and calculation/modelling tools existed gave a relatively high negative response in relation to their availability, especially for technical standards and databases,.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?


Legend:
- Not possible to obtain
- Difficult to obtain
- Some effort to obtain
- Easy to obtain
- Already had them
- Not relevant to this test
- Not completed

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

The response rate for "*technical standards*" (36 of 56) was significantly higher than for "*databases*" (25 of 56) and "*calculation/modelling tools*" (27 of 56). This illustrates that the technical standards were considered to be the most relevant aspect to reporting under indicator 4.1 and that this had triggered the need for a purchase to have been made.

For each of the three types of additional information (standards, databases and tools) the degree of positive sentiment (cost not being a barrier at all) outweighed the negative sentiment (cost being the main barrier). So even though a lot of testers complained about the lack of access to relevant EN standards in the responses to the open question in Q3, the cost of those standards was not considered to be a main barrier to reporting under indicator 4.1.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?


Legend: ■ Not at all ■ One of the factors ■ The main factor ■ Not completed
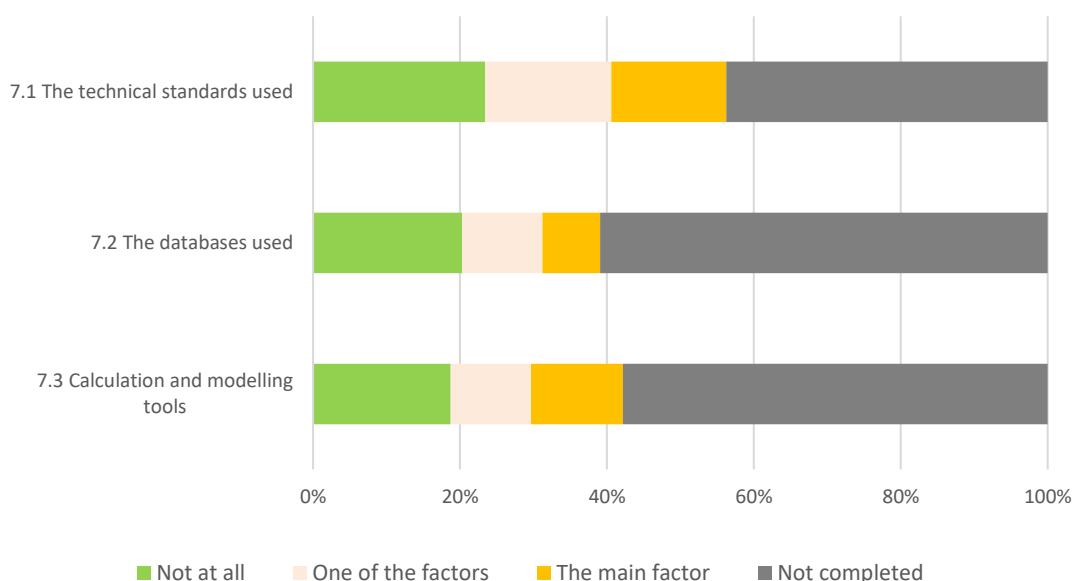
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

34 testers responded to Q8. Less than a quarter of the testers that responded (8 of 34) had "*extensive*" or at least "*some*" previous experience with reporting on indoor air quality for buildings. The remainder had either "*no previous experience*" (12 of 34) or only "*limited previous experience*" (14 of 34).

It is perhaps worth highlighting that 11 of the 12 testers with no previous experience in reporting indoor air quality were from DK (4), FI (4) or FR (3).

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?


Legend: ■ Extensive previous experience ■ Some previous experience ■ Limited previous experience ■ No previous experience ■ Not completed
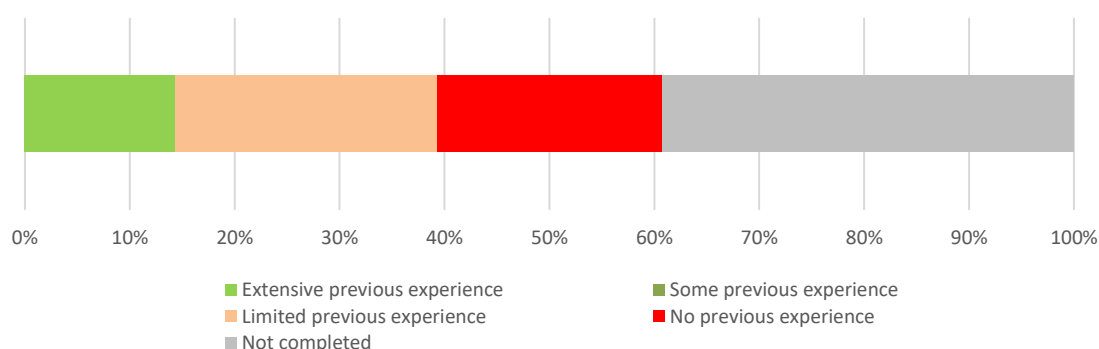
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

49 testers offered a response to this question. Overall, the degree of positive response (25 testers considering that additional training/support was "*not at all*" needed or needed only to a "*limited extent*") was almost twice as high as the negative sentiment (13 testers considering that additional training/support was needed to a "*great extent*" or a "*very great extent*").

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The 13 testers that identified a clear need for additional training/support in Q9 align well with the 12 testers in Q8 that claimed to have no previous experience with reporting on indoor air quality. This alignment implies that without previous experience, the guidance provided in Level(s) is not sufficient to inform testers about how to report with Level(s) on indoor air quality.

However, a look at individual survey responses revealed that this connection is only partial (i.e. testers with "*no previous experience*" in Q8 where only responsible for 2 of the 4 responses identifying a "*very great extent*" and of 3 of the 9 responses identifying a "*great extent*" of need for additional training and support in Q9). Additionally, 3 of the 13 testers with no previous experience with indoor air quality reporting felt that no additional training or support was needed at all.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

- Very great extent
- Great extent
- Moderate extent
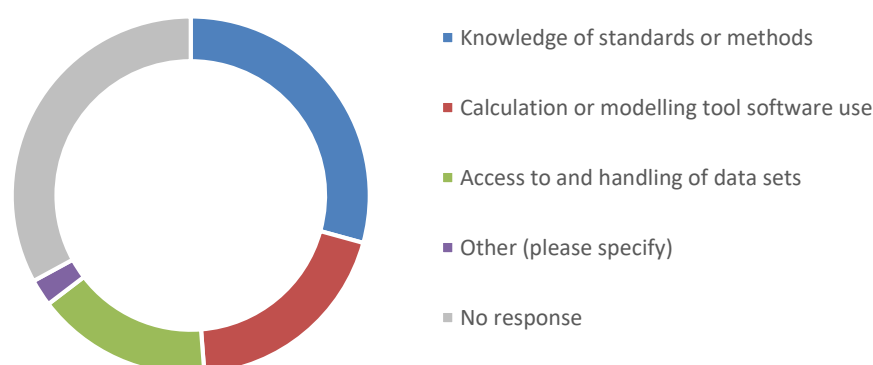- Limited extent
- Not at all
- Not completed
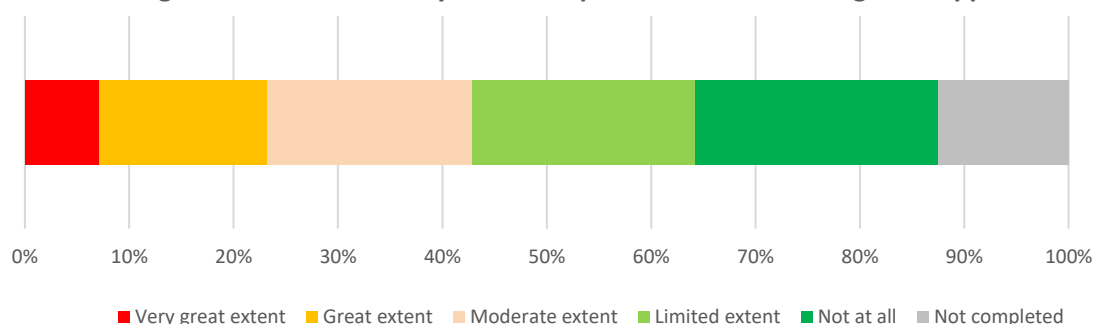
If additional training and support was required, please identify the main areas where it was necessary:

Just over half of testers (29 of 56) offered a response to this question and several testers cited a need for additional training/support in multiple areas.

The main need identified was to improve knowledge of standards and methods (24). Training and support in regards to data sets (13) and calculation/modelling tools (16) were also considered necessary.

If additional training and support was required, please identify the main areas where it was necessary

- Knowledge of standards or methods
- Calculation or modelling tool software use
- Access to and handling of data sets
- Other (please specify)
- No response

Only 12 responses were received to the open question to identify a need for specific types of additional training/support. These are clustered in Table .

Please identify the type of training and/or support that was needed

*Table 29. Q10 open response to identify training and support needs*

Broad type of training or support	Number of needs cited	Specific needs identified
Data	**3**	– In project standard format, information about LCIs (1) – Access to data in general (1) – Interpretation of existing data (1)
Training	**5**	– Lectures (1) – How to deal with multiple types of paints used, with LCIs and with formaldehyde (e.g. worst case scenario?) (1) – On Level(s) reporting (1) – On understanding of applicable standards (1) – On the relationship between European labels and EN standards related to indoor air quality(1)
Others	**4**	– Expertise in simulation tools needed (2) – General knowledge about emissions (1) – Benchmarks (1) – Translating Safety Data Sheet information into potential emissions (1)

Q10. _If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool._

Of the 26 testers that provided time estimates in person-days it can be seen that 77% required 2 person day or less and 92% required 5 person days or less to complete reporting under indicator 4.1. The average was 2.9 person days. One estimate appeared unusually high (30 person-days).
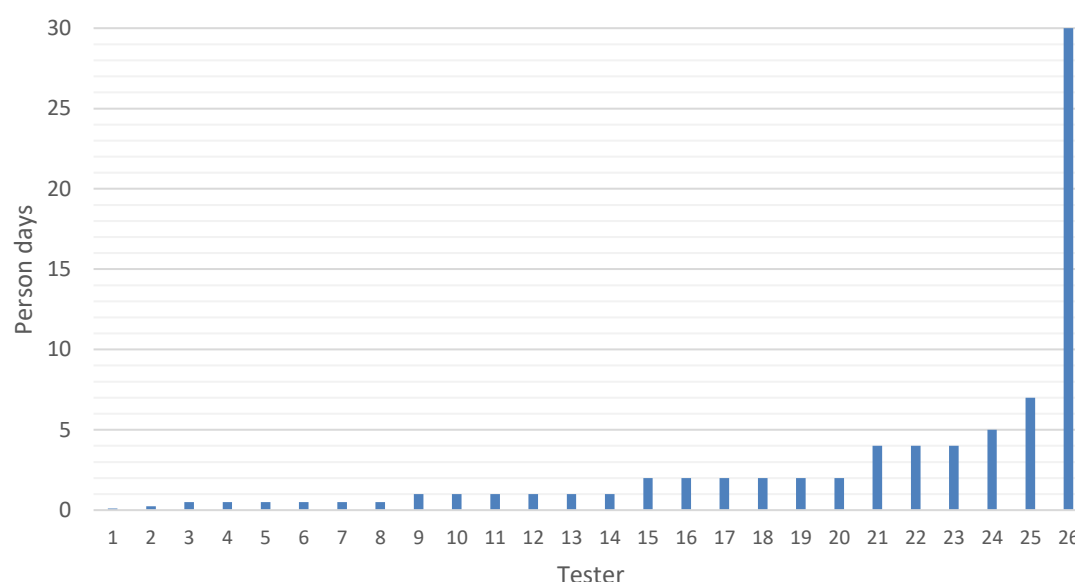
Of the 17 testers that provided cost estimates, 59% assigned €800 or less and 82% around €1.500 or less. Three significantly higher estimates (€4.100, €4.100 and €7.000) were also submitted. The average estimated cost was €1.560.
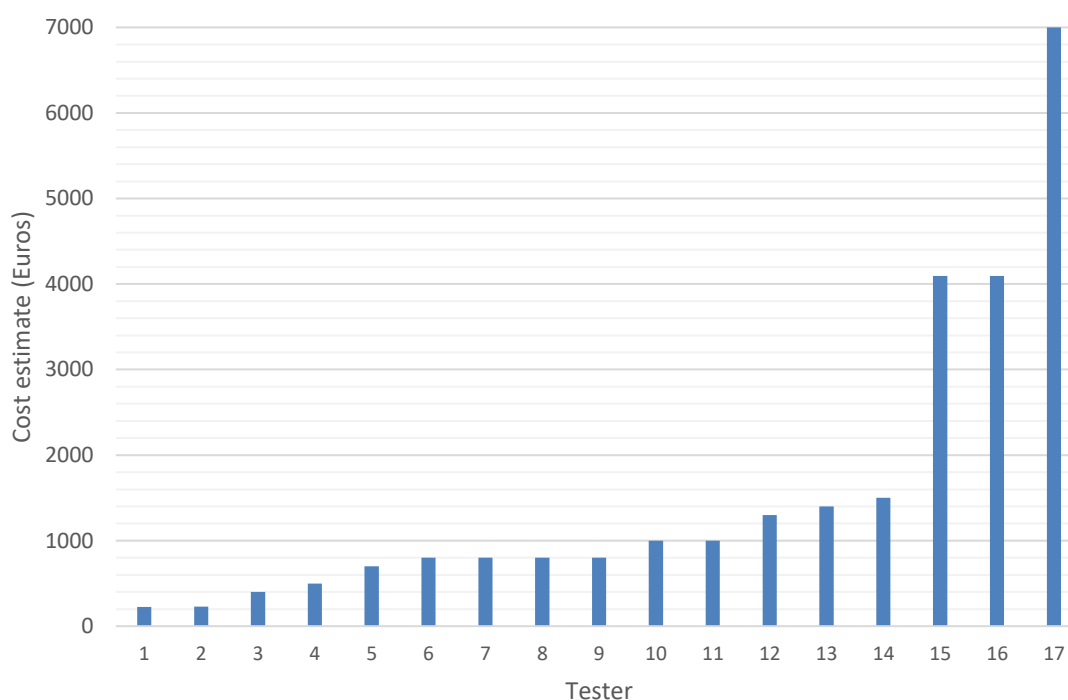
Q11. __Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use__.

34 testers responded with suggestions for possible improvements. Several different messages came across from the responses. The feedback has been analysed and clustered into relevant themes (see Table 30).

The vast majority of suggestions for improvement centred on the need for reference tables from relevant standards to be provided for users of Level(s). Annex I of EN 16798 were specifically mentioned.

Improvements were also suggested as being possible to make by simplifying the Level 1 requirements at least and making a clear distinction between mandatory and optional indoor air pollutants, using existing national regulatory approaches and building certification schemes (DGNB) as a guide or for inspiration.

It should also be clearer how reporting under this indicator differs at different project stages. The provision of default values to guide designers would also be appreciated.

Table 30. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of improvements cited	Specific improvements identified
Provision of reference tables from standards	**14**	− EN 16978 specific (4) − General (8) − Simplify all levels in general (2)
Simplification	**5**	− Specifically of Level 1 (4) − Specifically of Level 3 (1) − Indicator 4.1 to be nuanced at national level, less technical and with simple benchmarks (1)
Building certification / regulation	**5**	− DGNB alignment (3) − DK building regulations (2) − National building regulations (1)

| Other feedback	10	– Difficulty finding data, need default data and benchmarks (4) – Need for better guidance (3) – Errata in Level 3 (2) – Alternative approaches (e.g. continuous monitoring or clear distinction between mandatory and optional measurements) (2) – Positive feedback (design stage 2 is meaningful, objective of stage 2 makes sense) (2) – Negative feedback (should this even be an indicator at the design stage?) (3)

Indicator 4.2: Time out of thermal comfort range

Q1. To what extent was the indicator or life cycle tool easy and logical to use?

Overall 58 testers reported that they tested indicator 4.2. In general the majority of those testers consider the indicator to be 'easy and logical to use' to a moderate or greater extent. However, with the exception of the unit of measurement, only around a quarter of testers considered that to a great or very great extent the guidance, method and reporting format were 'easy and logical to use'. The unit of measurement was the only aspect that was supported to a great or very great extent.

The response to questions 1.6 and 1.7 in relation to Levels 2 and 3 was very reduced. Of those that responded, the response was evenly balanced for level 2 and for level 3 was more positive with most testers considering it easy and logical to use to a moderate or greater extent.
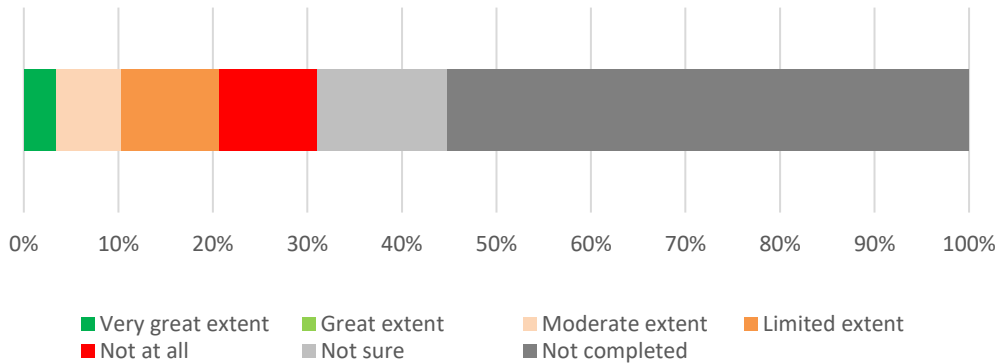
**Q1. To what extent was indicator 4.2
easy and logical to use?**
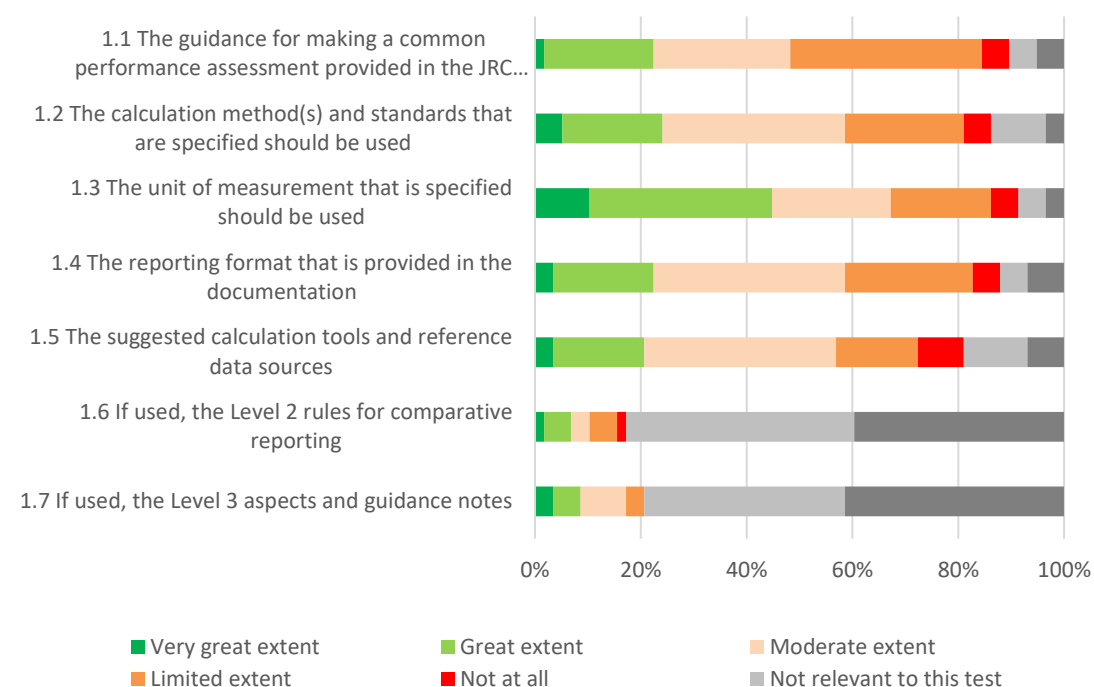
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Of the 26 testers that responded as having made design comparisons, the majority were either not sure or considered that it had only helped to a limited extent, it at all. This likely relates to difficulties obtaining the results from design simulation tools, as identified from the later open responses and the results analysis.

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not sure
- Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 54 testers that responded, the majority only encountered problems to a moderate to limited extent. However, approximately a third of respondents had encountered problems to a great or very great extent, highlighting the presence of fundamental difficulties for a proportion of the tests made. The follow-on open response provided for further analysis of the types of problems encountered.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
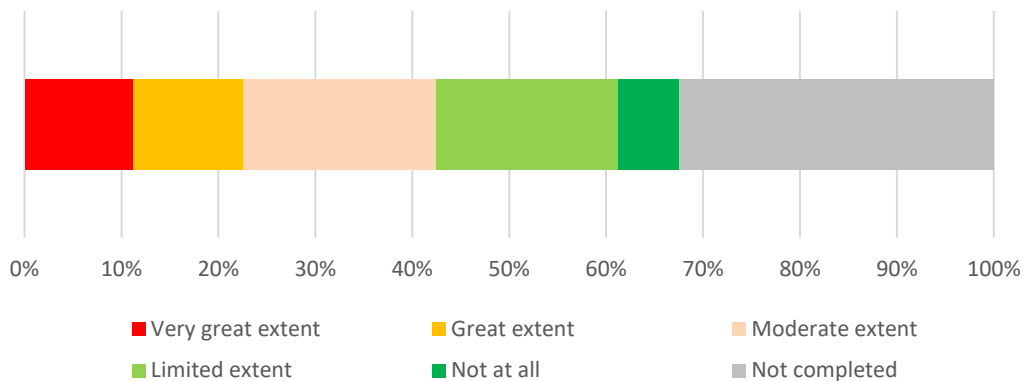
Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

In total 28 testers identified the problems that they had encountered. In Table their responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward by testers..

It can be seen that the approach laid down in the guidance and the promotion of dynamic simulation posed particular problems in obtaining results (16 testers). The compatibility of a dynamic approach with National Calculation Methods was cited as being an issue. The more demanding requirements of dynamic modelling and lack of knowledge and/or possession of relevant software or calculator tools were also cited. The need to simulate a building without heating/cooling was considered problematic, with specific no solutions put forward.

Table 31. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of testers	Problems and workarounds identified by testers
Obtaining results	**11**	– The tool doesn't provide results as such (2) – It is not known how to obtain results – More explanation needed for non-cooled and heated part of the assessment – Parameters had to be obtained from literature and national standards *Technical limitations identified* – There were no results available for the time out of range without mechanical heating or cooling (2) – Calculation without heating is not possible with the national calculation method – It was difficult because the national method requires space conditioning – Calculation without HVAC is not relevant since the building is not designed to be naturally ventilated
Dynamic modelling	**5**	– Team does not possess a simulation tool – Thermal comfort dynamic analysis' is more demanding than a 'thermal static analysis' – Thermal comfort dynamic analysis not usually made for a project – Dynamic simulations are not usual for residential projects – National method not sufficient to fix parameters for modelling
Standards and methods	**4**	– It was not possible to find EN 16798 (3) – Not possible to use EPB method: dynamic energy simulation needed
Time and resources	**2**	– No budget was available for dynamic modelling – Time required to make extra simulations without mechanical systems
Guidance	**1**	– Difficult to understand and translate into national legislation
Input data	**1**	– Open access weather file database suggested in Level(s) did not allow to download usable weather data

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

51 of the testers responded to this question. Only 40% of the respondents had found previous assessments to be useful. This may be because part of the result was difficult to obtain – namely the time out of range without heating or cooling systems. Some testers also interpreted that carrying out a dynamic simulation was a requirement.

Amongst the 20 testers that identified existing sources from which they had obtained their results (see Table), the majority referred to a regulatory tool or the values obtained from a calculation method or simulator tool.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- Yes
- No
- No response
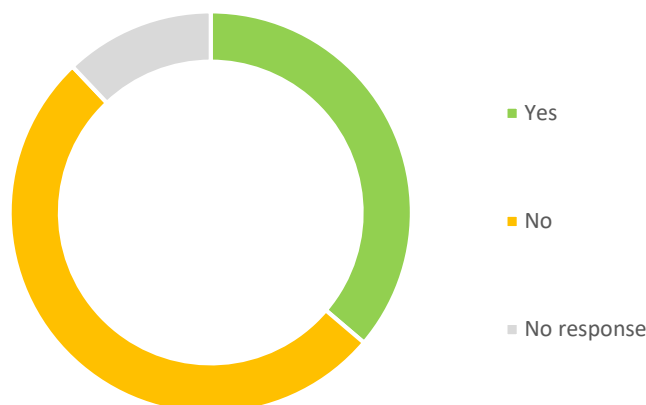
Please specify useful resources from previous projects

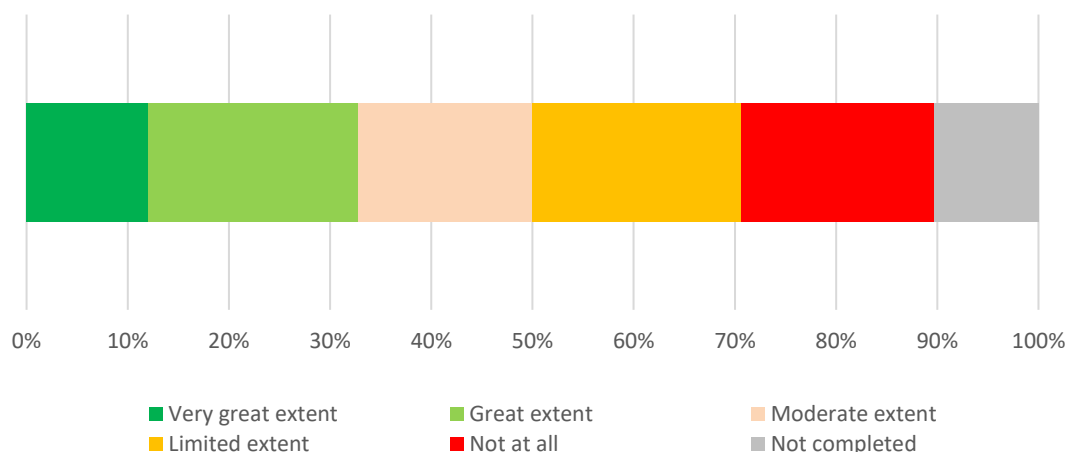*Table 32. Q4 open response to identify the extent to which testers already had access to the required results and data*

Source of the results/data	Number of resources cited	Specific resources identified
Simulation tools	9	– Bsim (Denmark) (5) – IDAICE (2) – COMFIE – IES-VE
Standards and methods	6	– ASHRAE Fundamentals – Be15 energy calculation tool – CIBSE Guide A: Environmental design – NEN EN ISO 7730 (Dutch version) – SBi213 / EN13790 – UNI EN 10339 (Italian version)
Assessment schemes	6	– DGNB (2) – HQE (2) – LEED (2)
Previous simulations	2	– Indoor climate simulations (2)

Q5. To what extent did you already have access to the required results from other assessments of the building?

Reflecting the response to Q4 of the 52 respondents to this question, the majority considered to to a moderate or greater extent that they already had access to the required results. There were, however, a notable proportion that considered this only to a limited extent, if at all – likely reflecting the need to extract the data from existing calculations of simulations. Of those that

identified their sources of results (see Table), the majority referred to data obtained from simulations of various types or that had been already prepared for assessment schemes.

Q5. To what extent did you already have access to the required results from other assessments of the building?
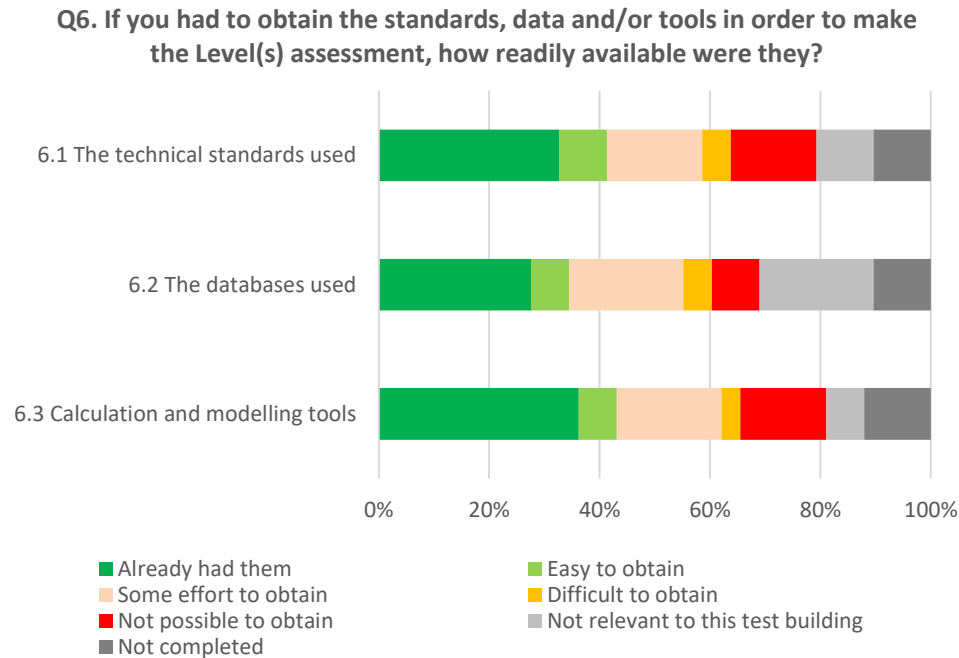
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed

Please identify the source of results that were already available

Table 33. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of resources cited	Specific resources identified
Simulation tools	**11**	– Bsim (Denmark) (5) – Dynamic thermal simulation (2) – Indoor climate simulation – Thermic (dynamic) – KI energy tool – IDAICE
Assessment schemes	**9**	– DGNB (5) – French E+C- but evaluated differently (2) – LEED (2) – Overheating assessment in Home Quality Mark SD232:1.0
National requirements	**4**	– Results from model to comply with a building code – Results from model to comply with a building code (Bsim, Denmark) (2) – Results from model to comply with a building code (RT2012, France)
Standards and methods	**4**	– Based on EN 15251 – EN ISO 7730 PMW/PPD – NEN-EN ISO 7730 – SBi213 / EN13790
Building monitoring	**1**	– Building Monitoring System (BMS)

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*
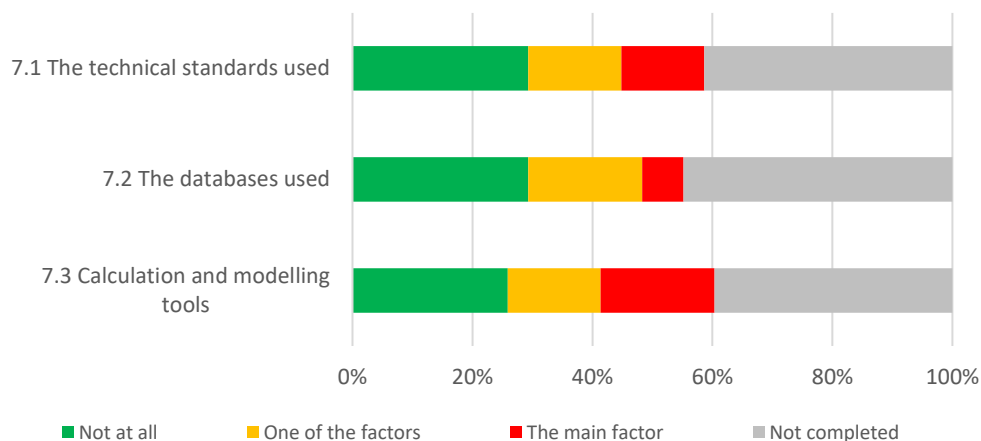
Of the 52 testers that responded to this question, nearly half the standards, data and tools appear to have been readily available. However, a notable proportion of those testers considered that the standards and tools were not possible to obtain.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Of the 32 testers that responded to this question and had had to purchase something, a notable proportion considered that the standards and tools were one of the factors or, in a smaller but notable number of tests, the main factor that created a barrier to their use. Approximately half of testers already possessed what they needed – likely reflecting those team members that had previous experience making this type of assessment.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

53 testers responded to this question. This indicator was relatively familiar to most testers, with extensive previous experience being cited in around a third of the cases. A small but notable number of testers stated that they had no or limited previous experience, suggesting that they had not previously been directly involved in carrying out such assessments for permitting purposes.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

- Extensive previous experience
- Some previous experience
- Limited previous experience
- No previous experience
- Not completed
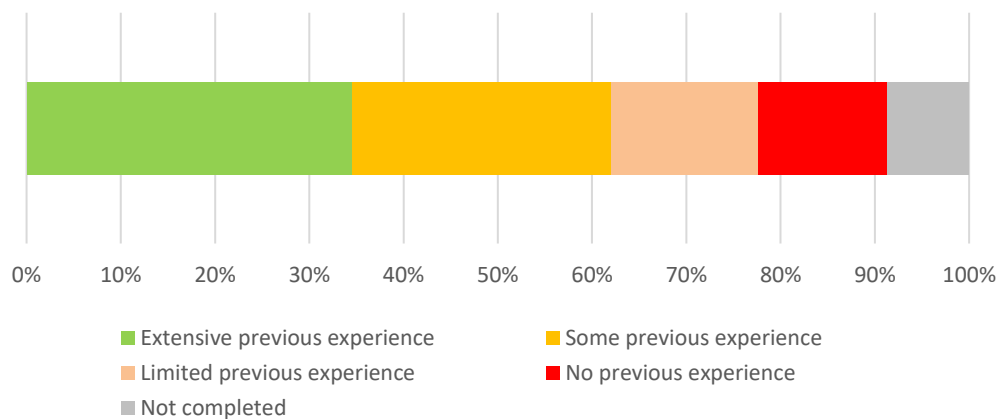
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

51 testers responded to this question. The majority of those who responded considered that additional training and support was not required or, if so, only to a limited extent. A small but notable proportion required training and support to a very great extent, reflecting those who responded in Q8 that they had no previous experience.
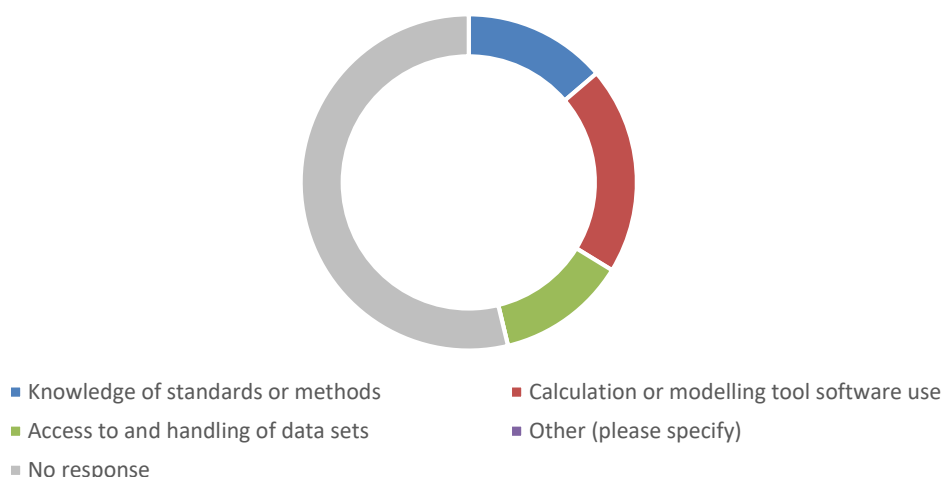
Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
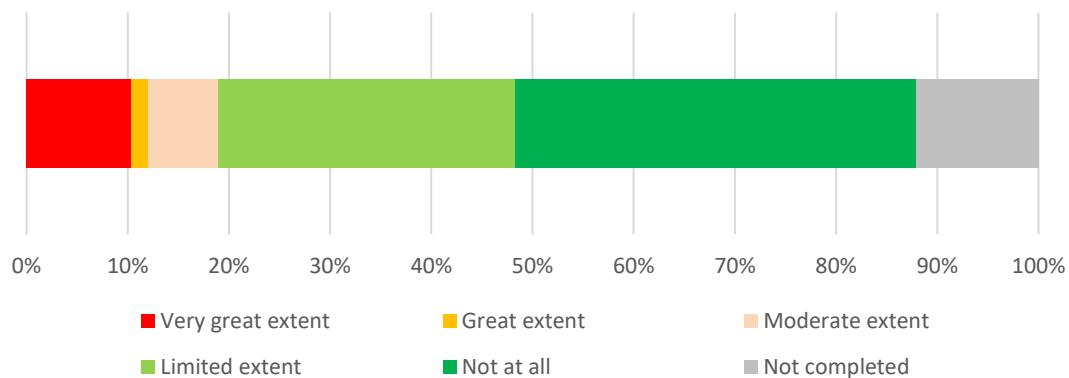
If additional training and support was required, please identify the main areas where it was necessary:

Of the 37 testers that cited areas where training and support were necessary, 16 cited *'calculation or modelling tool software use'* reflecting the implied dependence of the result on simulations. Further suggestions for the training and support necessary have been analysed from the open responses that followed.

If additional training and support was required, please identify the main areas where it was necessary

- Knowledge of standards or methods
- Calculation or modelling tool software use
- Access to and handling of data sets
- Other (please specify)
- No response

Please identify the type of training and/or support that was needed

Only 8 testers identified any needs. They referred to the need to study and acquire knowledge of the relevant standards. Reference was also made to the possibility to consult with other professionals who had the specific knowledge and expertise.
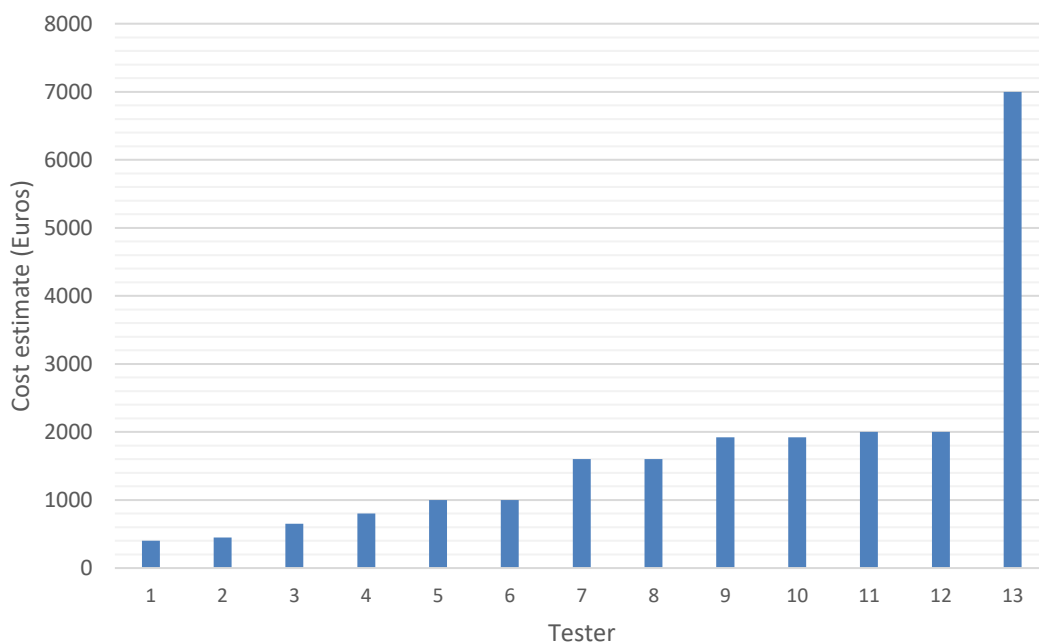
Q10. <u>If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool</u>.

Of the 15 testers that provided time estimates it can be seen that 60% required up to 2 person days and 80% up to 4 days. The average was 2.9 person days.
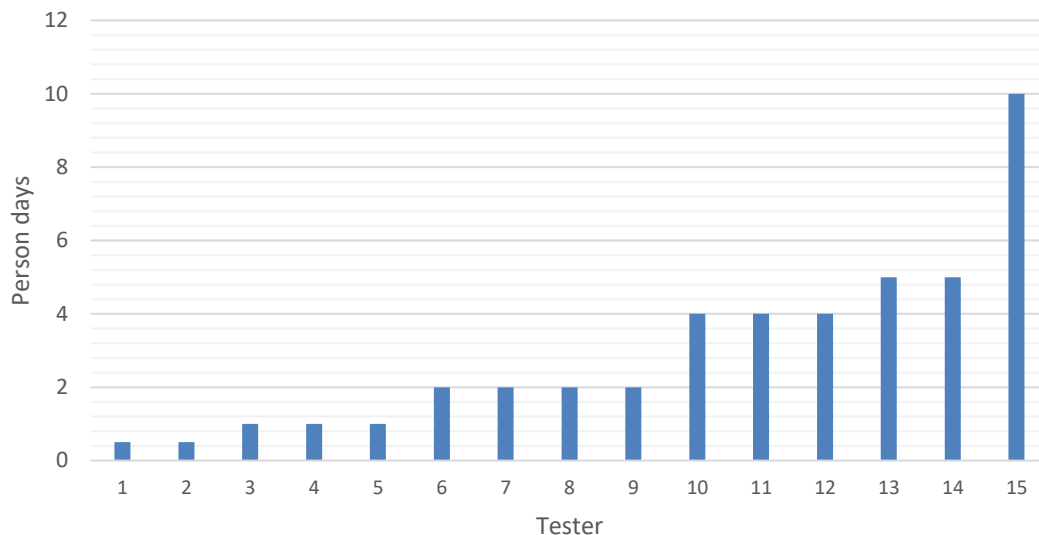
Of the 13 testers that provided cost estimates, 62% assigned up to €1.600 and 92% up to €2.000. The average was €1.719.

Q11. *Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.*

Amongst the 27 testers that made suggestions for improvements, the most feedback received was clustered around the Level(s) guidance (6), national calculation methods (6) and calculation tools. Seven testers made reference to specific technical aspects of the indicator, and this feedback is also summarised in the second part of the Table 34.

In regards to the Level(s) guidance, the text should be simplified and it should include extracts from standards. There should be more detailed instructions on how to implement standards.

In regards to national methods, the indicator should somehow be made more compliant with these methods. This could include: allowing for the use of results from calculations according to these methods; omitting heating as it cannot always be simulated; and providing alternative qualitative assessment options.

In terms of the calculation tools to be used, some testers considered that one should be recommended. The tool could diverge from national assumptions on use of buildings, as these may not always be representative.

Table 34. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of improvements cited	Specific improvements identified
The Level(s) guidance	6	– Simplify the text and include extracts from harmonised standards (3) – Provide more detail instructions on how to implement ISO standards (there is limited access) (2) – Better link between the guidance and the reporting tool
National methods and requirements	6	– Make it more compliant with national compliance methods (3) – Allow for the use of results from national calculation software's – In the national context, this indicator is relevant without cooling but not without heating. – Provide alternative possibilities for qualitative analysis based on national requirements
Calculation tool	4	– A calculation tool should be recommended (2) – More detailed suggestions should be made about tools that can be used to assess this criterion. – For accurate simulations NCM assumptions for occupancy, ventilation etc can be quite different to reality
Residential buildings	1	– Greater clarity on options for calculations would be useful (and in case, simplified estimations, transparently made).
Calculation method	1	– Remove the requirement to calculate Time out of range (%) - *without* mechanical heating and cooling
Performance benchmarking	1	– There should be some form of benchmarking
Accuracy and representativeness	1	– A more granular approach: allow for full breakdown of building zones or ask for percentage of zones which are within the range for 95% of the time (in line with the approach of the EN standard).

Further technical comments received

Technical aspect	Number of issues cited	Specific technical issue raised
Calculation method	**7**	*Scope of the assessment* – The difference between southern and northern Europa regarding the temperetures in summer and winter should be taken into account. E.g. it is not realistic to simulate indoor thermal climate without heating in the winter in Denmark – Some 'double counting' or overlap in indicators: in our view it is not relevant to report 'out of range without mechanical heating/cooling' when the latter energy is already embedded in indicators reporting the consumption of the building *Methodological basis for the indicator* – Scientific basis for comfort theories in EN 15251 is in office building performance – Reflect adaptive approach: temperature for each day is derived from the outside temperature, rather than a set comfort range. – Clarify that in case that calculations can not be performed the indicator can be assessed with questionnaires to the users of the building *Taking into account thermal mass* – The indicator does not allow to optimise or make the link with the thermal mass of the building – Always request dynamic simulation that takes account of thermal mass

3.5.   Using the test indicators and life cycle tools: _recommended additions to the minimum scope_

This second batch of indicators and tools represent recommendations that were made to testers as an extension of the 'minimum requirements' for carrying out a test. They comprise:

- 2.1 Life cycle tool: Building Bill of Materials (BoM)
- 1.2 Life cycle Global Warming Potential

Indicator 1.2: Life cycle Global Warming Potential

Q1. _To what extent was the indicator or life cycle tool easy and logical to use?_

Overall, 31 testers reported that they had tested indicator 1.2. The majority of respondents considered that the documentation, method, unit of measurement and reporting format was to a moderate or greater extent 'easy and logical to use'. More than half of respondents considered this to a great or very great extent for the unit of measurement.

There were, however, a notable proportion of testers that in each case considered this true only to a limited extent. The feedback was less positive for the guidance, the reporting format and the suggested calculation tools and reference data sources.

The response rate to questions 1.6 and 1.7 on Levels 2 and 3 was much lower reflecting the fact that less testers worked at these levels. Of those that responded on Level 2, the majority selected a moderate or greater extent for both levels. The result for Level 3 was more evenly split.

**Q1. To what extent was indicator 1.2 easy and logical to use?**
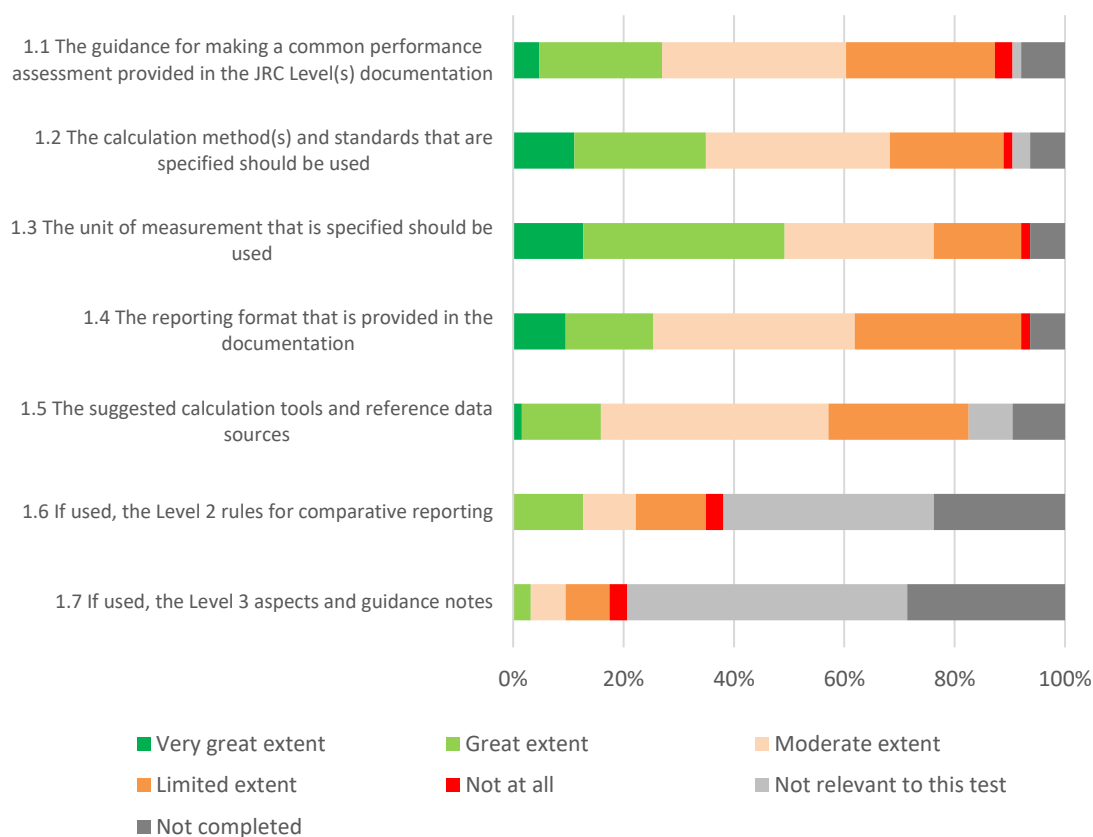
92

Q2. *If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?*

Of the 25 testers that responded, the majority considered that it helped to a moderate or greater extent. In equal proportions a smaller number of testers considered that it helped to a very great extent or that it did not help at all.
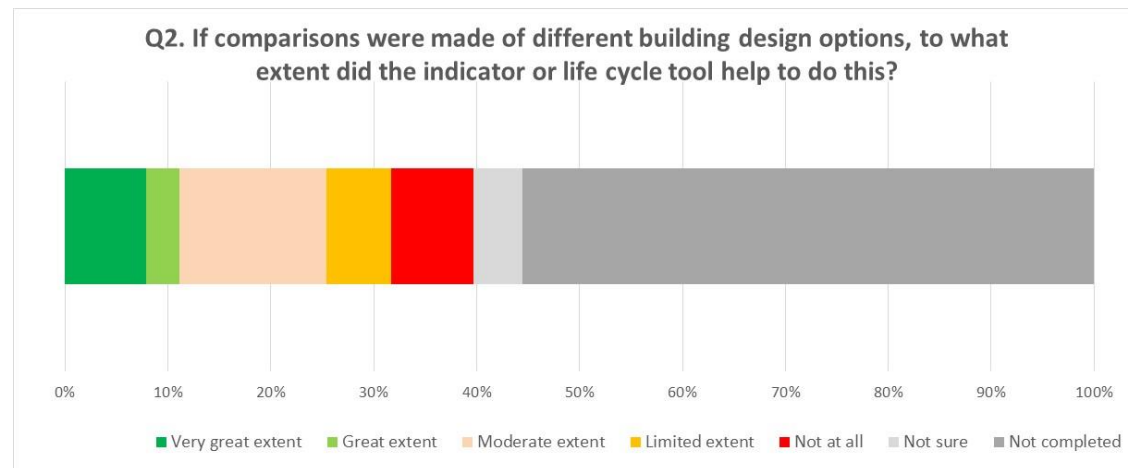
Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 53 testers that responded just over half encountered problems to a moderate or greater extent. A notable proportion did not encounter any problems.
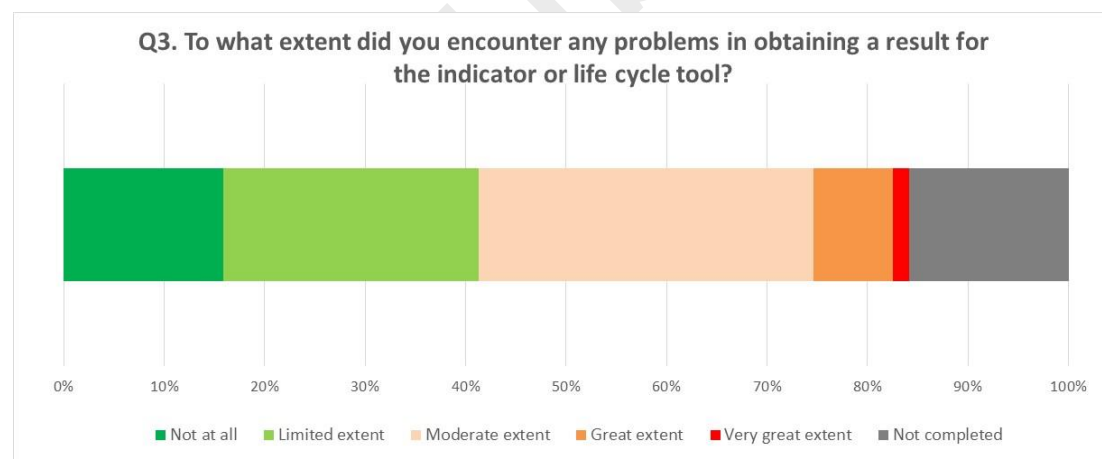
Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

In total 30 testers described problems they had encountered. Their responses have been clustered under the main themes that could be identified, together with a summary of the main problems as well as the workarounds put forward by testers, in Table .

It can be seen that both the guidance and the tools/methods posed particular problems, as well as the actual calculation of results. Some testers also experienced difficulties with the reporting of results.

Table 35. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of citations (*)	Problems and workarounds identified by testers
Calculation of results	**11**	– Assumptions and interpretation of results are needed for the design stage (2) – Quality of data in BIM and EPDs, which required assumptions (2) – Effort to convert building specifications into LCA models (2) – Data provided in 2D-drawings, which required BIM and manual crosscheck (2) – Problems to quantify the BOM as no BOQ was provided – Problems/issues to quantify energy figures (2)
Tools and methods	**10**	– The breakdown into biogenic CO2, fossil CO2 and CO2 from land transformation is difficult (at least until tools and databases are aligned with the revised EN15084-A2) (8) – The tool/database used is not compliant with EN15804 in term of life cycle stages breakdown and/or possibility to model modules C and D (6) – Different reference service life (50 years) compared to Levels (60 years) (1) – Incomplete database (1)
Guidance	**9**	- Unclear definitions and guidelines - Not clear which building surface is to be considered - Very complicated guidance even for a specialist - Simple to quantify only if LCA conducted with dedicated software (2) - Lack of experience - Some metrics do not add value and data for their calculation is not easily-available (e.g. macro-categories of materials) - There is a lot of focus in building under construction rather than during operation phase - Embodied emissions appear to have greater weight than operational emissions.
Reporting of results	**6**	– The tool is not clear and requested information can easily be misplaced (2) – The tool does not operate correctly – There is no possibility to introduce negative values – Redundancy in the reporting of GWP (1.2 and 2.4) – Result should be presented per IPMS B3 area that was difficult to define as instructions about how garage area should be taken into account was not clear (2). – Indication per year in Level(s) is not logic since the impact of the materials is generated at the moment that they are installed and not divided over the service life of the building

(*) some testers identified more than one issue

Q4. _When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?_

Just over two third of the 53 respondents had found previous assessments to be useful. Amongst those that identified what they had used (see Table), the majority referred to software (19) and databases (11). 33 respondents then cited useful resources in the open response which is analysed in the next section.

Please specify useful resources from previous projects

Table 36. Q4 open response to identify the extent to which testers already had access to the required results and data

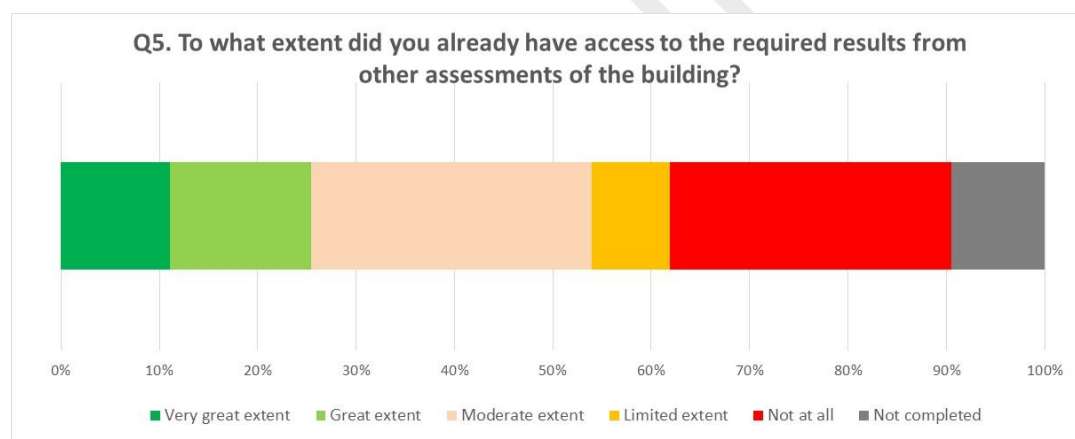| Source of the results/data	Number of testers (*)	Specific resources identified
Software	**19**	– OneClick LCA (8) – GaBi (3) – LCA Byg (3) – Bionova – ELODIE – Excel – SimaPro – Totem
Databases	**11**	– EPDs (4) – INIES (3) – Ökobaudat (2) – Ecoinvent – _Not specified_
Building certification	**8**	– DGNB (3) – E+C- (3) – HQE (2)

Information from previous studies and the literature	5	– Inventory data and preliminary LCA/PEF results from PEF4Buildings Project (DOI: 10.2779/23505) (2) – Comparative LCA within IEA EBC Annex 72 (DOI: 10.1088/1755-1315/323/1/012037) (1) – *Not specified* (3)
Others	4	- Energy audits - IFC integration (2) - Internal software

(*) some testers identified more than one issue

Q5. *To what extent did you already have access to the required results from other assessments of the building?*

The majority of respondents considered that they had access to the required results to a moderate or greater extent. However, a notable proportion did not have access to data from other assessments and had to start from the beginning.

Of the 31 that identified their sources (see Table), the majority referred to data obtained from building certifications followed by LCA calculations and information necessary for quantifying other indicators.

Please identify the source of results that were already available

Table 37. Q5 open response to identify the source of existing results and data

| Source of the results/data	Number of testers	Specific resources identified
Building certification	10	– E+C- (5) – Bionova (3) – DGNB (3) – LEED – Home Quality Mark (UK)

LCA calculations	**10**	– Excel – LCA Byg – SimaPro – TCQi 2019 – VTT – PEF – Not specified
Information for other indicators	**8**	– BOM (5) – Energy simulations (3)
Technical specifications	**3**	– 2D drawings
Costs	**1**	– Invoices
Standard	**1**	– EN 15978

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

Of the 56 respondents to these questions, in the majority of cases, they already had or found it easy to obtain the standards, data and tools required.
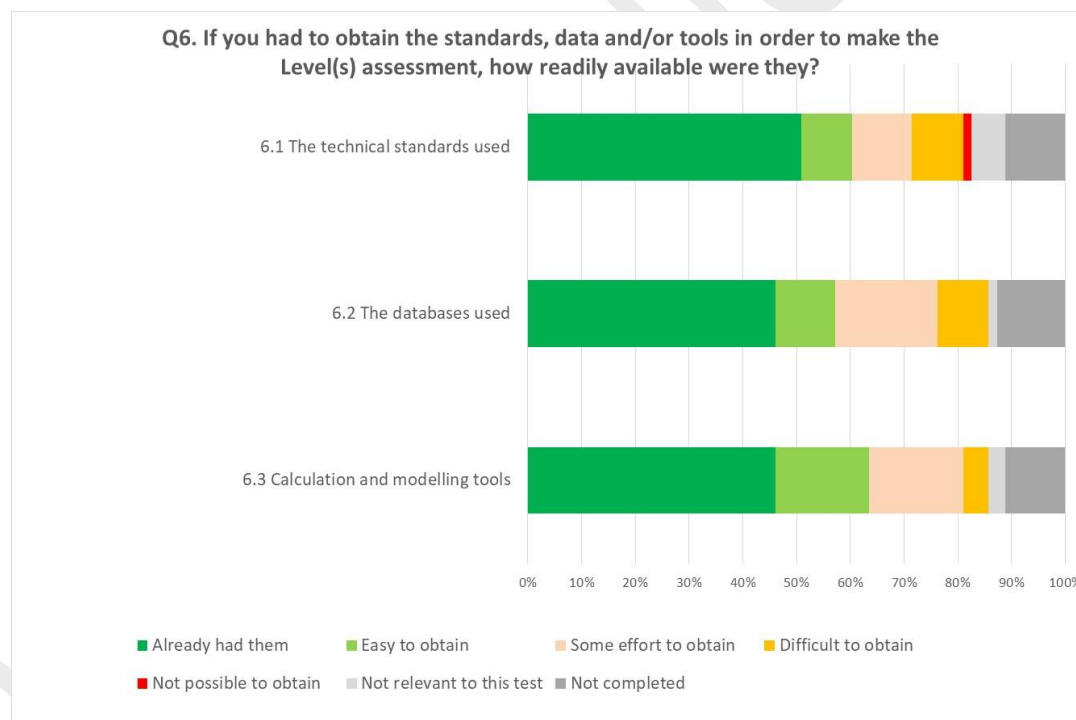
Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Of the 40 respondents to these questions, in the majority of cases, the standards and tools were not a cost barrier or were only one of the factors acting as a barrier to use of the indicator. Cost was a greater factor in the case of the calculation and modelling tools.
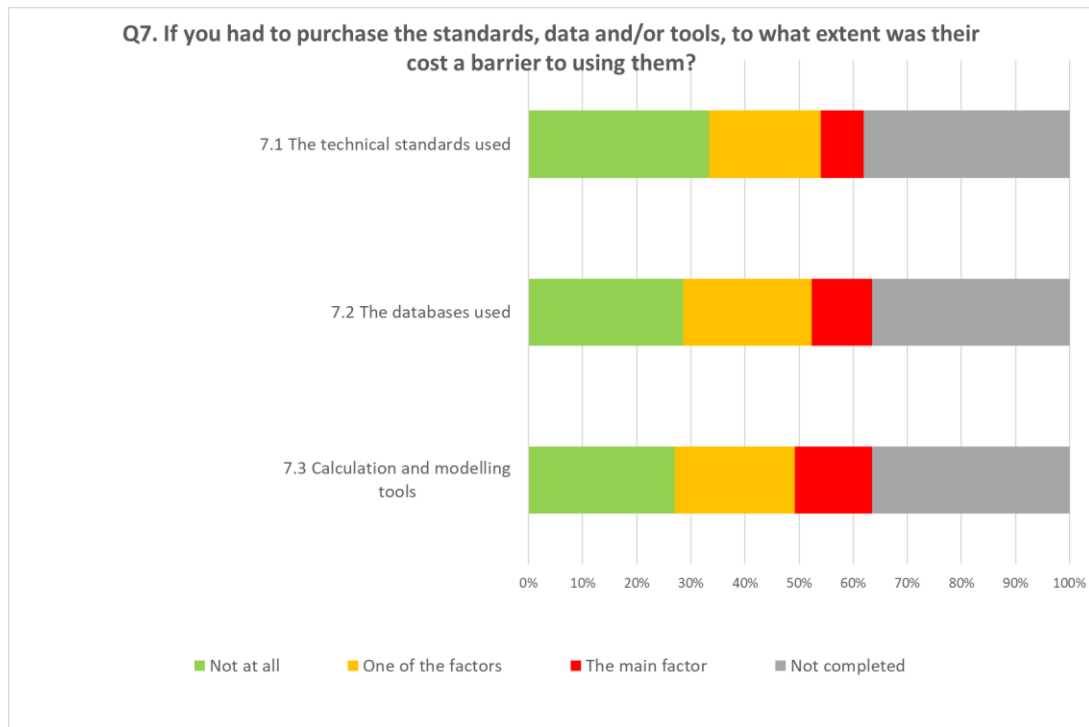
Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Legend: Not at all | One of the factors | The main factor | Not completed

Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

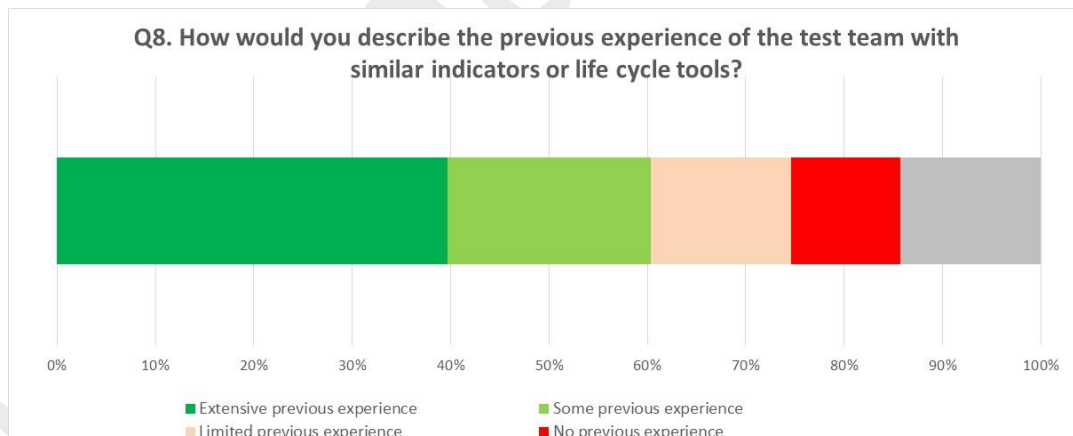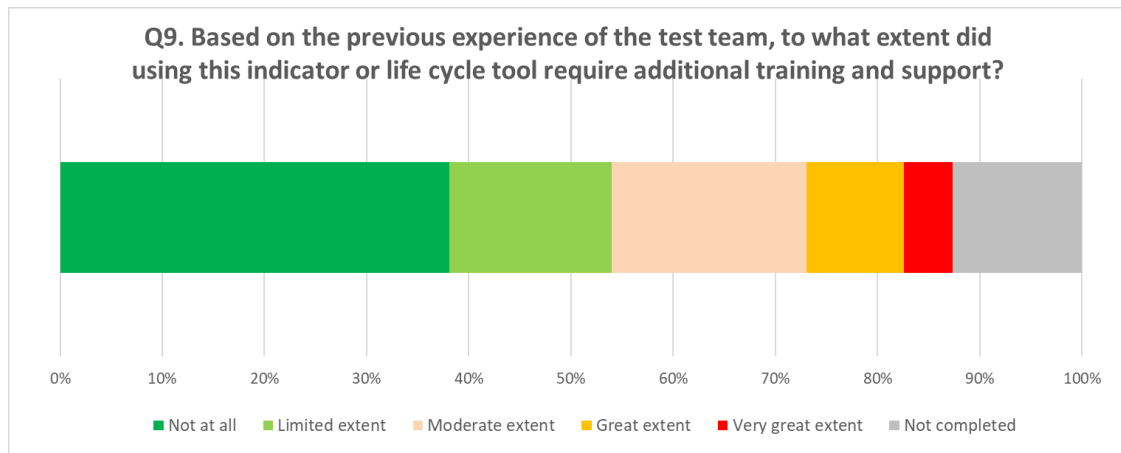Of the 55 respondents to this question, a substantial proportion already had extensive experience with this indicator. In general most testers had some familiarity with this indicator, even if only to a limited extent. A smaller but notable number of testers stated that they had no previous experience.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend: Extensive previous experience | Some previous experience | Limited previous experience | No previous experience

Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

Of the 55 respondents to this question, the majority considered that it only required limited additional training and support if at all. A smaller but significant proportion responded that they required training and support to a moderate or greater extent, likely reflecting those who responded in Q8 that they had no previous experience.

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Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend: Not at all · Limited extent · Moderate extent · Great extent · Very great extent · Not completed

If additional training and support was required, please identify the main areas where it was necessary:

Of the 29 testers that cited areas where training and support were necessary, there were roughly equal citations of 'Calculation or modelling tool software use', 'knowledge of standards or methods' and 'access to and handling of data sets' – suggesting a broad need for training and support.

Further specific suggestions for the training and support necessary have been analysed and are clustered in Table . These suggestions comprises a mix of information provision, targeted support in a number of specific areas and webinar-based training.

If additional training and support was required, please identify the main areas where it was necessary

- Knowledge of standards or methods
- Calculation or modelling tool software use
- Access to and handling of data sets
- Other (please specify)
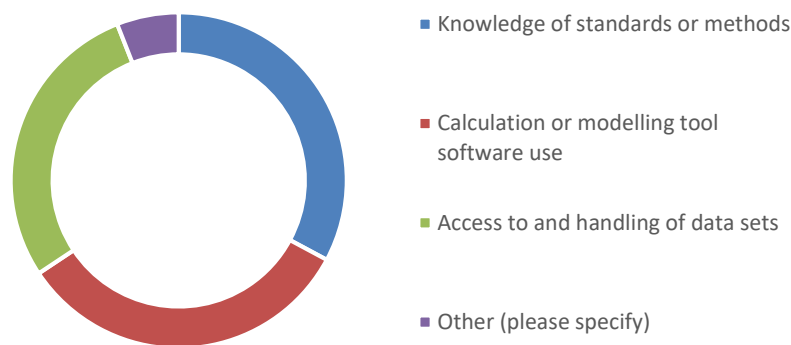
Please identify the type of training and/or support that was needed

Table 38. Q9 open response to identify training and support needs

Broad type of training or support	Number of testers	Specific need identified
Use of LCA	**11**	– LCA methodology and standards (6) – LCA tools and databases (5)
Information on Level(s)	**2**	– Guidance on scope

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GWP	**1**	– Calculation methods for biogenic v fossil emissions of CO_2
Reporting tool	**3**	– Not specified

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of the 40 testers that provided time estimates it can be seen that 50% required up to 5.5 person days and 75% up to 10 days. The maximum was 60 person days and the average was 8.6 person days.
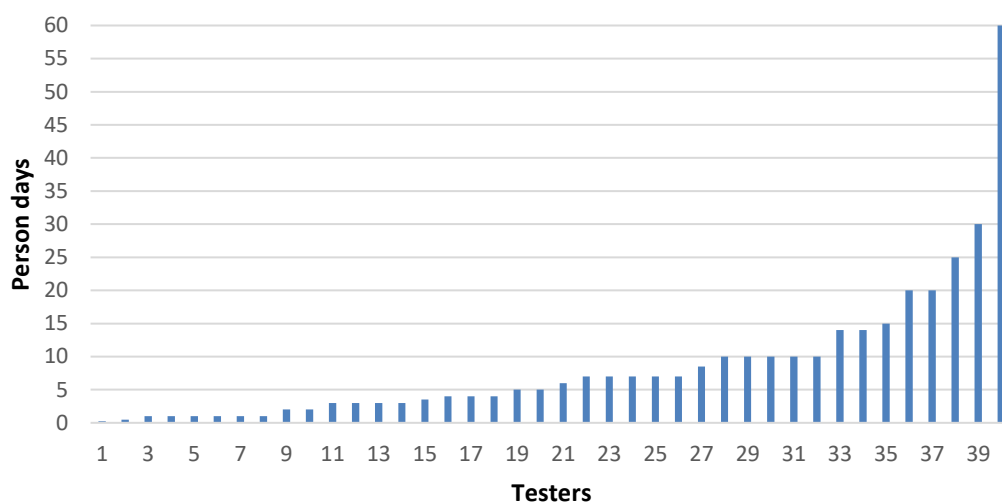
Of the 28 testers that provided cost estimates, 50% assigned up to € 2500 and 75% up to € 5700. The maximum was € 20000 and the average was € 4010.
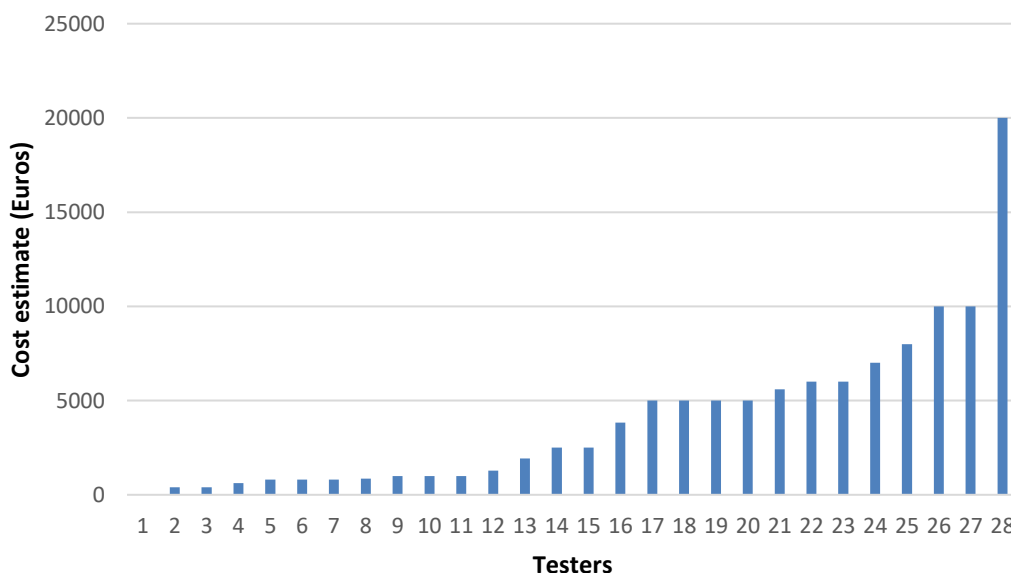
Q11. *Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.*

Amongst the 42 testers that made suggestions for improvements, the majority referred to the concept itself for this indicator and the guidance information provided. It was highlighted that:

- Simplifications or clarifications of the guidance are needed, in particular on how to use the different Level(s) and how to define the scope of the analysis,
- Guidance for benchmarking should be included,
- Flexibility is necessary with respect to the reference service life,
- Indicator 1.2 (GWP) is already covered by 2.4 (LCA).

Moreover, there is an apparent need for more support in the calculation of results and how the reporting should be made. Many requested detailed information about tools and databases, and possibly the availability of free information/tools. In the reporting, more granularity in terms of sub-stages should be allowed, and it should be possible to differentiate between embodied and operational emissions. The need to fix some bugs and facilitate the insertion of methodological assumptions was also highlighted.

With respect to the methods, a tester called for alignment with PEF. However, in line with comments received by the majority of testers, key standards for buildings are the reference methods, for which a revision process has been completed/started.

Table 39. Q10 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of testers	Specific resources identified
Concept and guidance	**21**	- Indicator 1.2 should be handled as part of a full LCA (2.4) to avoid redundancy (x2) - Different Level(s) make the assessment complex and not transparent - To make simpler/clearer how to handle the indicator for different Level(s) (x11) for instance by providing examples and webinars and by removing redundant text. In particular, rules for the definition of the scope of the analysis have to be defined better (x4). - Projects developed in accordance with some certification schemes only allow entering some Level(s) - For level 3 it is essential that the construction process stage is reported and documented from the beginning of the project - Highlight the importance of carrying out LCA in the pre-design phase, as decisions made at this stage have more influence on the environmental performance of a building project. - Different reference service life (e.g. 50 yrs) should be allowed - The analysis duration of 60 years is short compared to the life of the structure (designed with safety factors to exceed 200 years). This can lead to errors in the evaluation of the contributions of construction products - Set benchmarks for comparability and motivation for improvement (x2) - To make guidance available in all official languages of the EU

Reference methods	6	– The methodological reference for Indicator 1.2 has to be bounded to EN 15978 and EN 15804 standards, based on which EPDs are developed (x4) – Make reference to PEF – Align the guidance to existing tools
Data and tools	14	– Availability of a calculation tool (x2) – Fair description and access to LCA tools and databases (x7), as well as provision and/or use of default data, proxies or safety factors for missing elements (x4) – Avoid requiring data that is not yet available broadly (e.g. land use and land transformation)
Reporting	15	– Improve the reporting tool (x2) – To align units of measurement between guidance (kgCO2eq/m2/year) and reporting tool (kgCO2eq). Providing results per m2 and year is necessary to assess design options aimed at prolong the lifetime of buildings – Report aggregated results only and without splitting between biogenic and non-biogenic carbon (x2) – To enable interpretation and comparability of results it is necessary to describe clearly which sub-stages are included in a study (e.g. B5-B6 instead of B1-B7) (x4), with a clear split between embodied (B2-B4) and operational carbon (B6, B7) (x2) – To allow the introduction of negative values (x4) – To facilitate the insertion of methodological assumptions

Q12. _To what extent did Level 2 prove to be useful in making comparisons between buildings?_

Of the 12 testers that responded, 5 indicated that Level 2 was useful in making comparisons between buildings to moderate or greater extent. Other testers considered that it was useful only to a limited extent (5) or not at all (2).

If the value was moderate or higher, please identify how its use influenced the results

Only 6 responses were received for this open question. Indicator 1.2 was considered an important aspect to consider in the comparison of building design options. On the other hand, several responses indicated a concern that the flexibility in the method and data that can be used means that there is limited comparability and a high potential level of variance.

Q13. _To what extent did Level 3 prove to be useful in making comparisons between buildings?_

Only 5 responses were received and of those 3 found it to be useful to a moderate or greater extent and the remaining to a limited extent.

### If the value was moderate or higher, please identify how its use influenced the results

Only 3 responses were received for this open question. They highlighted the need for the precision of Level 3 in decision support, that it had highlighted that 90% of the impacts were due to use stage energy and that the reliability rating was useful but that the method needed simplifying.

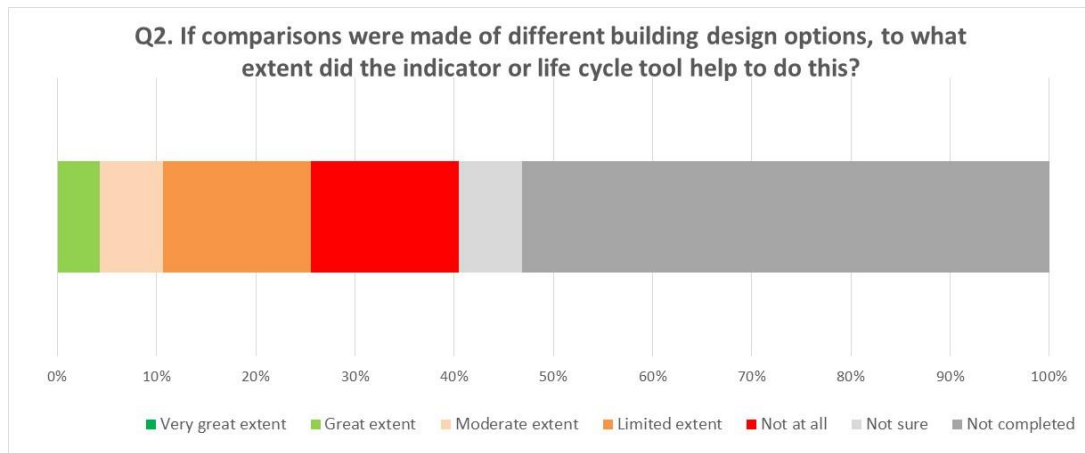## 2.1 Life cycle tool – Building bill of materials

Q1. *To what extent was the indicator or life cycle tool easy and logical to use?*

Overall 47 testers reported that they had tested life cycle tool 2.1. In general, the majority of respondents considered that the guidance, method and unit of measurement were 'easy and logical to use' to a moderate or greater extent. However, for the unit of measurement and in particular the reporting format and the suggested calculation tools there were a more substantial proportion of respondents who found this only to a limited extent or not at all.
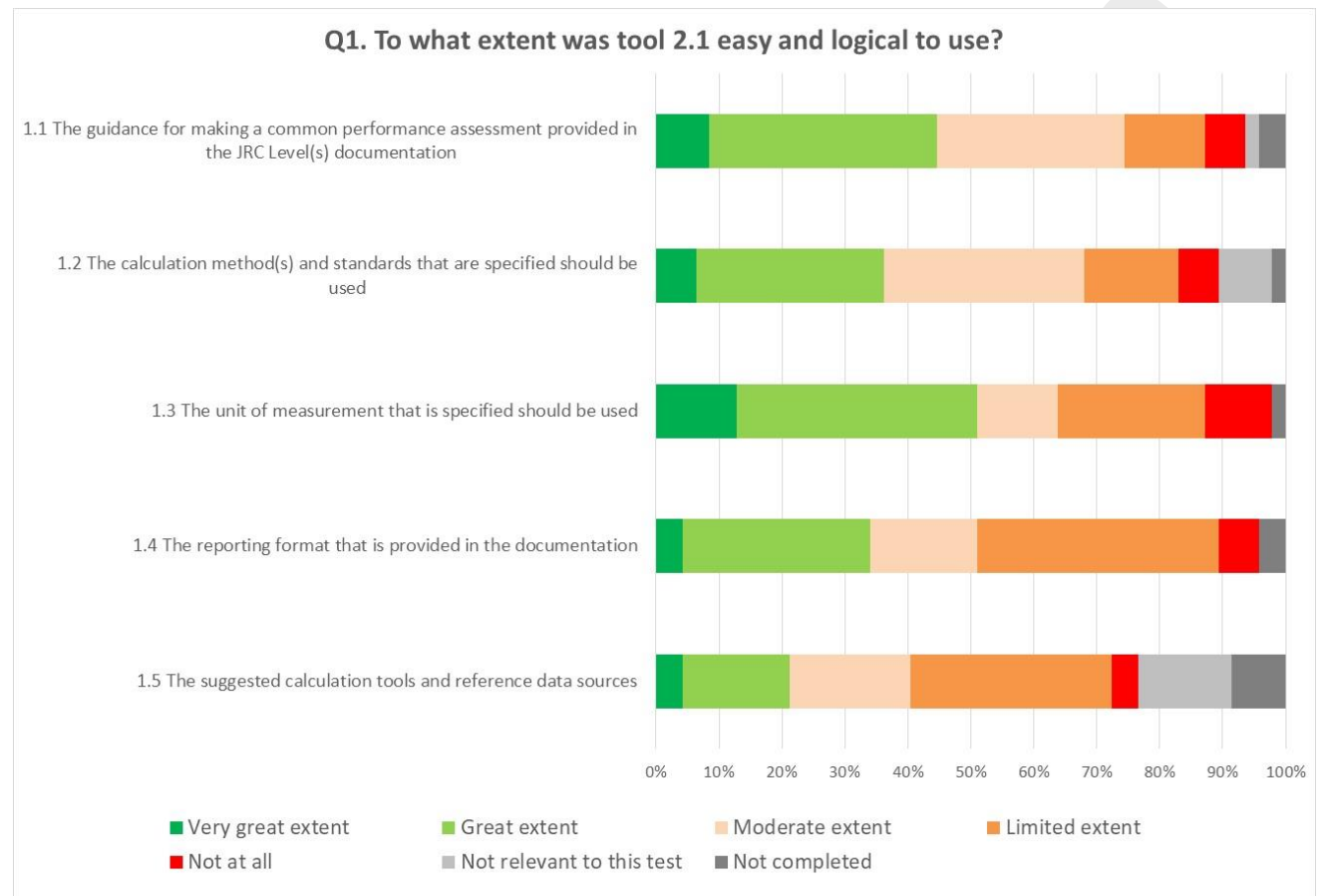
Q2. *If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?*

Of the 22 testers that responded to this question, the majority considered that it did not help or only helped to a limited extent (14 in total).
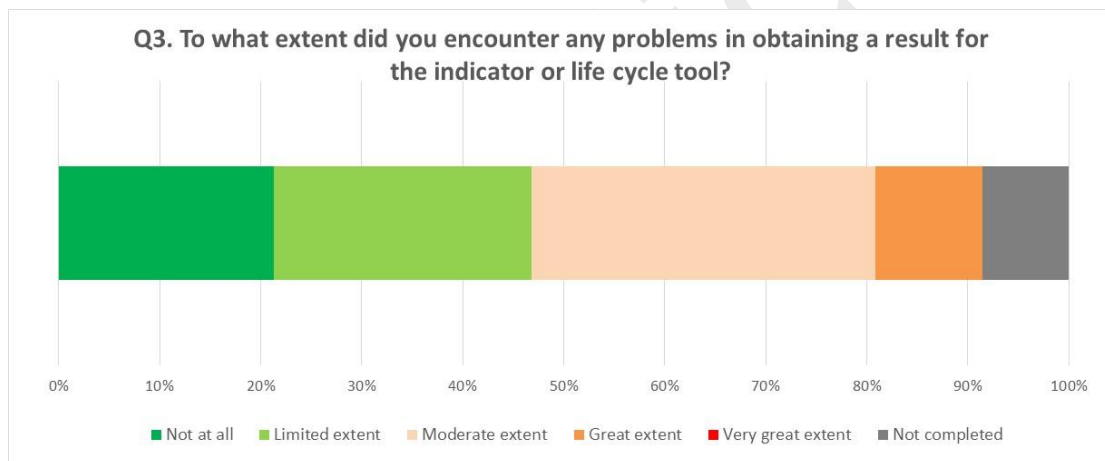
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Legend: Very great extent | Great extent | Moderate extent | Limited extent | Not at all | Not sure | Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 43 testers that responded to this question, just over half encountered problems to a moderate or greater extent (22). The other half only encountered problems to a limited extent or not at all (21).

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Legend: Not at all | Limited extent | Moderate extent | Great extent | Very great extent | Not completed

Open response: *If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.*

In total, 20 testers identified the problems they had encountered. Their responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward by testers, in Table .

It can be seen that the main concern of testers was about the collection of data (19 testers), including both availability of information (11) and data processing burden (8). In terms of methods and tools, some testers (7) reported a lack of clarity or guidance on some aspects. In addition, there were also some who questioned the added value of this life cycle tool (5 testers).

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Table 40. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of problems cited (*)	Problems and workarounds identified by testers
Data collection	19	11 testers raised a problem in terms of data gaps and/or quality of data 8 testers were concerned about the workload necessary for this tool
Methods and tools	7	4 testers reported a lack of clarity 3 testers considered the guidance incomplete with respect to how to handle ancillary materials (e.g.. packaging) and replacement of materials in the building use phase
Added value	5	5 testers questioned the added value of this tool

(*) some testers identified more than one problem

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

About a third of the respondents had found previous assessments to be useful. Amongst those that identified what they had used (see Table), the majority referred to LCA tools or to the values obtained from a related calculation.


Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

■ Yes ■ No ■ No reponse
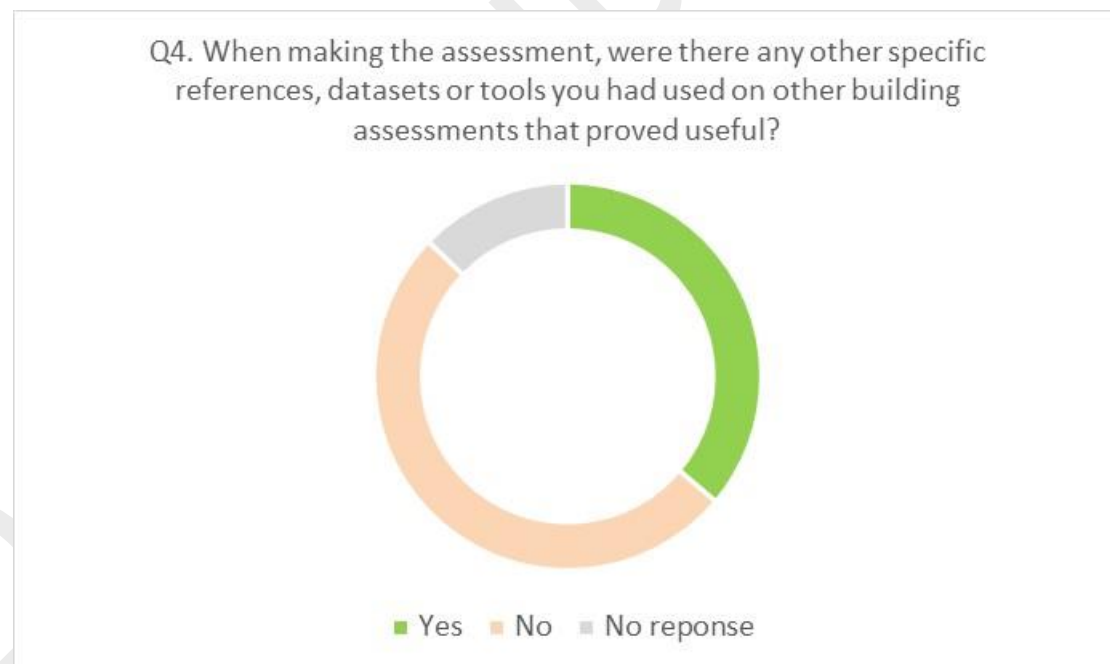
Please specify useful resources from previous projects

Table 41. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of resources cited	Specific resources identified
LCA tool/calculation	**13**	– OneClick (11) – Available information (2)
Building certification	**2**	– DGNB (2)
Internal tools	**2**	– *Not Specified*
Building specifications	**1**	– *Not Specified*

Q5. *To what extent did you already have access to the required results from other assessments of the building?*

The majority (22) considered that they already had access to the required results to a moderate of greater. A notable proportion responded 'not at all' (9). Of those that identified their sources (see Table), the majority referred to data obtained from LCA calculations (9). Building certifications (5), cost estimation methods (4) and building specifications and drawings (3) also appeared as frequent sources of information.
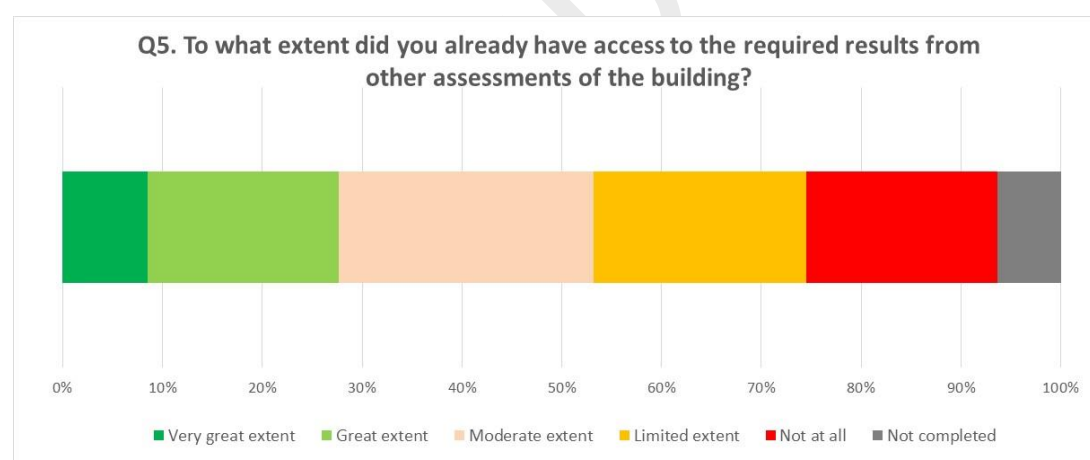
### *Please identify the source of results that were already available*

Table 42. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of resources cited	Specific resources identified
LCA calculations	**9**	- *LCA models/software (3), including PEF models (2) and TCQi 2019* - *carbon footprint models (2)* - *EPDs* - *IEA EBC Annex 72*

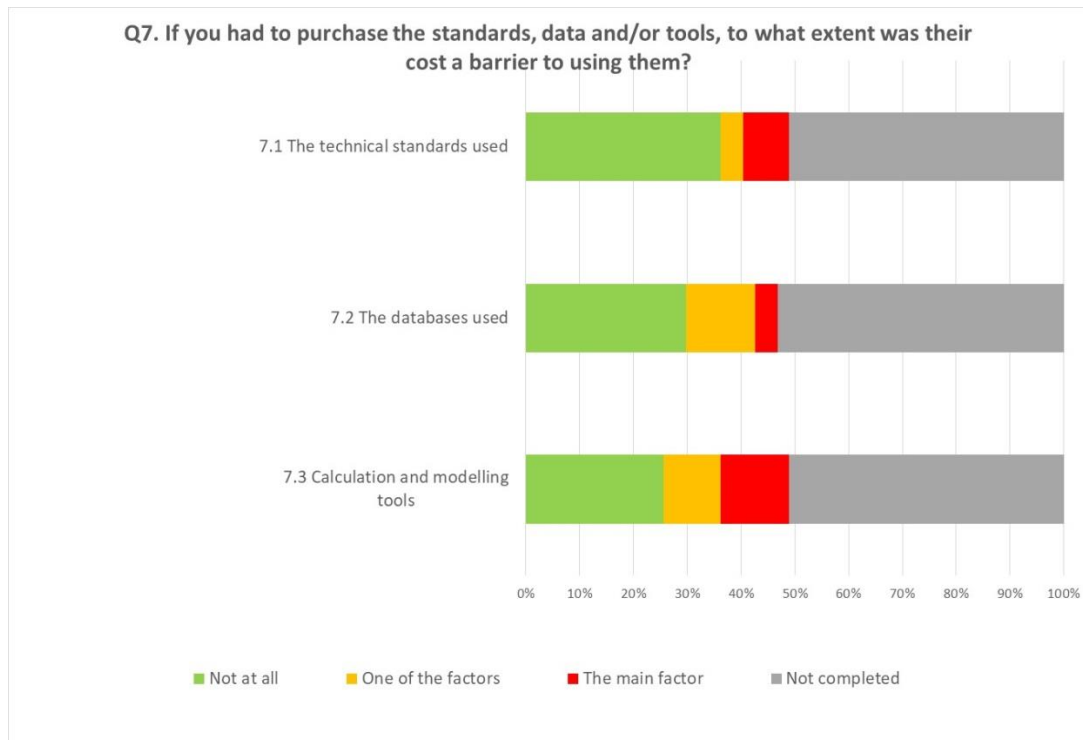| Building certification	5	– DGNB (3) – E+C- (1) - Home Quality Mark (UK)
Cost estimation methods	4	- *Not specified*
Building specifications and drawings	3	- *Not specified*
Internal tools	1	- *Not specified*
On-site data	1	- *Data collected during the construction stage*

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

From the 42 testers that responded, the calculation and modelling tools appear to have been the most readily available or easy to obtain. No tester indicated that standards, data or tools had been *not possible to obtain*.
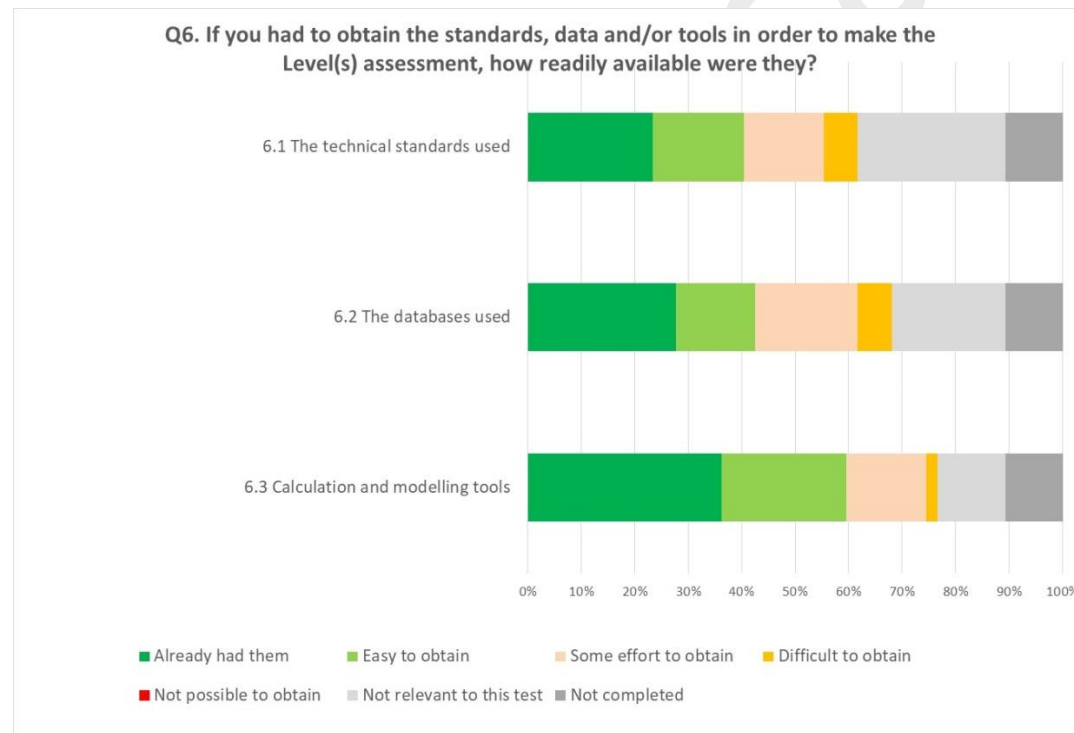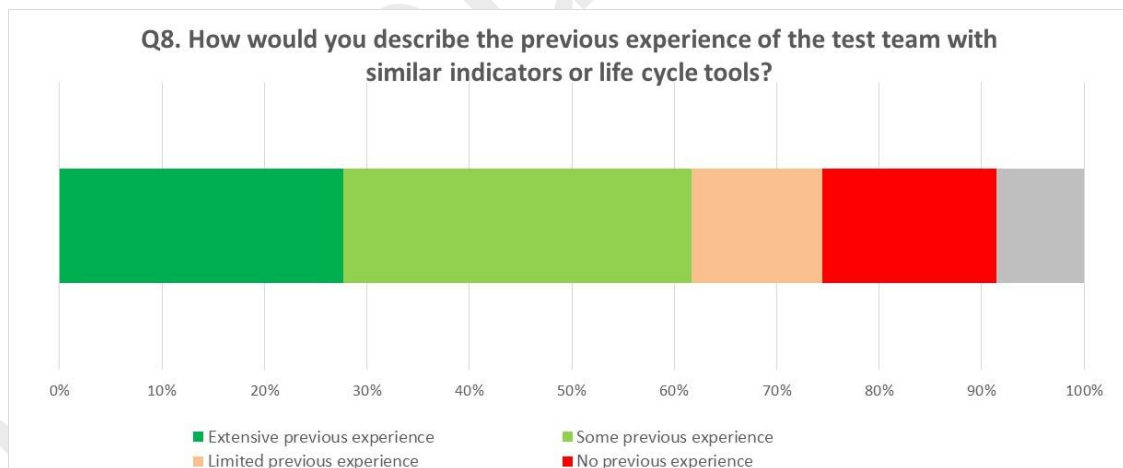

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

From the 23 testers that responded, the majority did not consider the cost of the technical standards and databases that they had to purchase was a barrier. However, it can be observed that cost was more of a factor in cases where databases and calculation tools had to be purchased, with a notable number of respondents citing cost as the main barrier for the latter.
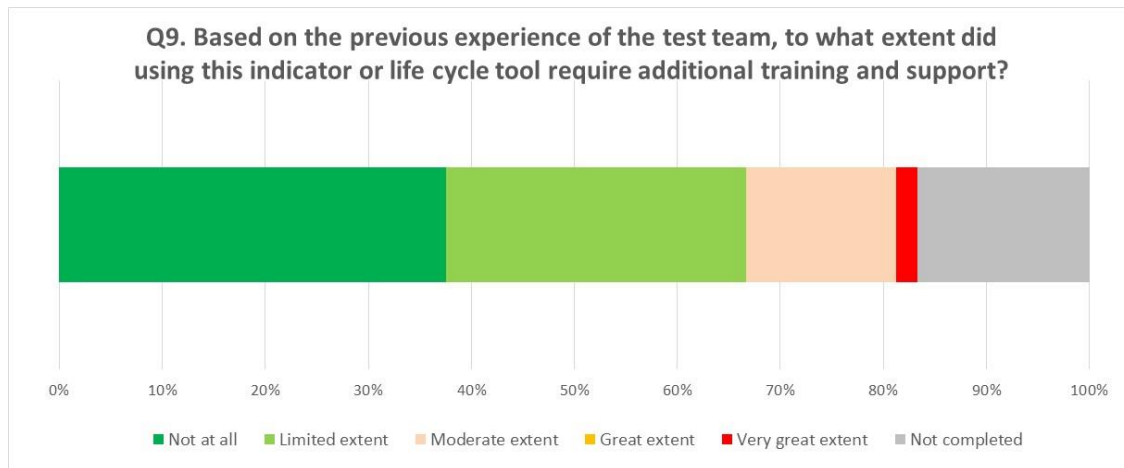
Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Legend: Not at all · One of the factors · The main factor · Not completed

Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

This indicator was relatively familiar to most testers (13 declared to have extensive previous experience and 16 to have some previous experience). However, a smaller but notable number of testers stated that they had no (8) or limited (6) experience.
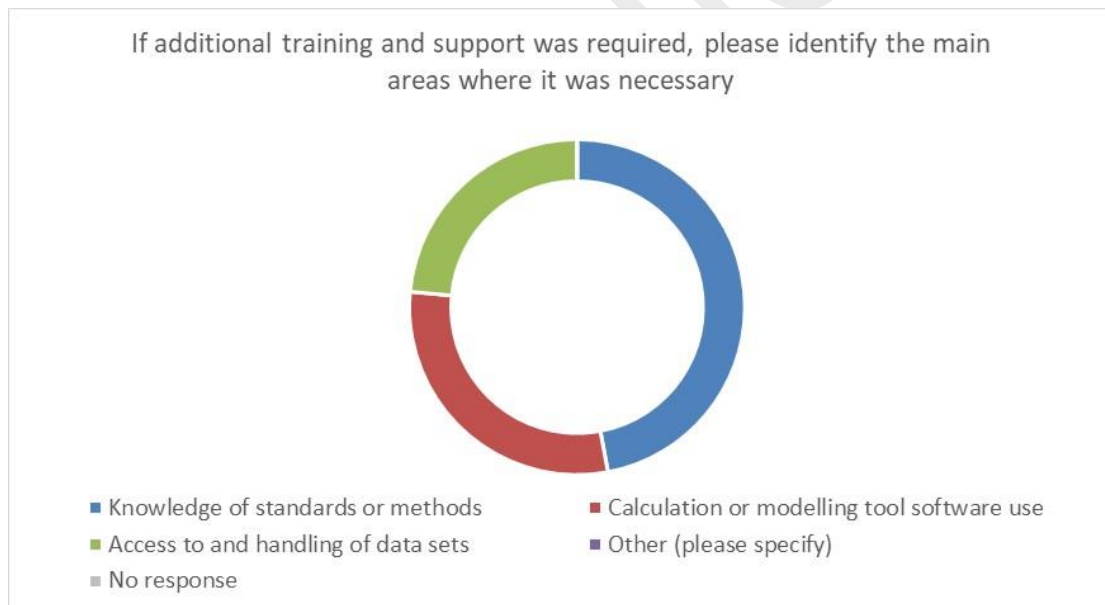

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend: Extensive previous experience · Some previous experience · Limited previous experience · No previous experience

Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

The majority of the 40 respondents to this question (32) considered that additional training and support was not required or if so, only to a limited extent. A small proportion required training and support to a moderate extent (7), likely reflecting those who responded in Q8 that they had no previous experience.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend: Not at all · Limited extent · Moderate extent · Great extent · Very great extent · Not completed

If additional training and support was required, please identify the main areas where it was necessary:

Of the 17 that responded to this follow-up question, the majority cited 'knowledge of standards or methods' (8). Further suggestions for the training and support necessary have been analysed and clustered in Table . This comprises a mix of further suggestions relating to input data, methods and the reporting of results.

If additional training and support was required, please identify the main areas where it was necessary

Legend: Knowledge of standards or methods · Calculation or modelling tool software use · Access to and handling of data sets · Other (please specify) · No response

Please identify the type of training and/or support that was needed

Table 43. Q9 open response to identify training and support needs

| Broad type of training or support	Number of needs cited	Specific need identified
Information	2	– Obtaining the data – Studying standards and literature
Methods	2	– Using the tool to produce results – Calculating the Bill of Quantities

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Reporting	2	– Understanding the format – Training needed

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of the 27 testers that provided estimates, it can be seen that 50% required up to 2 person days and 75% up to 5 days. The maximum was 20 person days and the average was 3.7 person days.
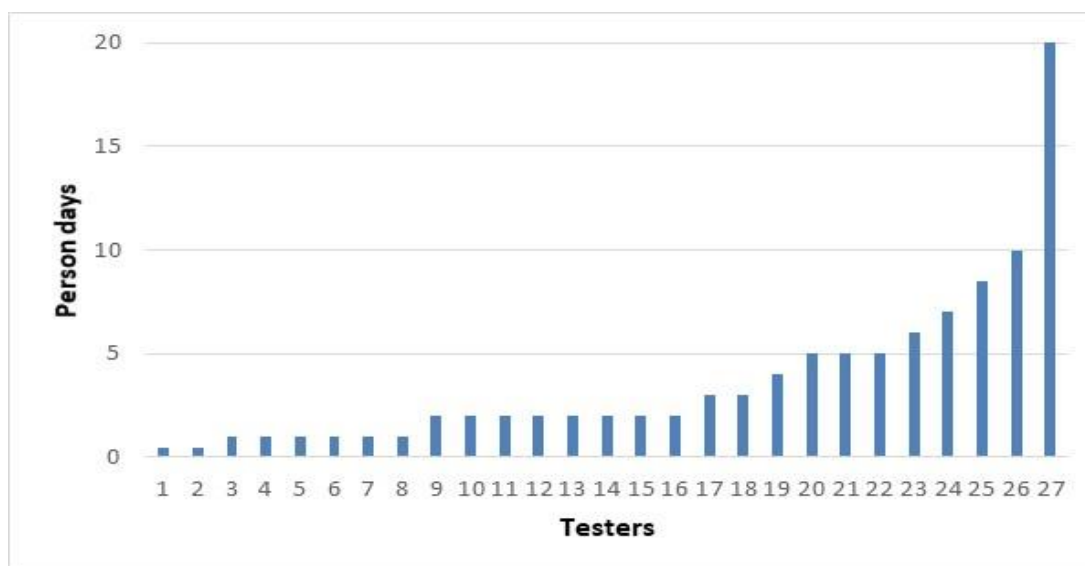
Of the 15 testers that provided cost estimates, 50% assigned up to € 1400 and 75% up to € 2000. The maximum was € 5000 and the average was € 1566.
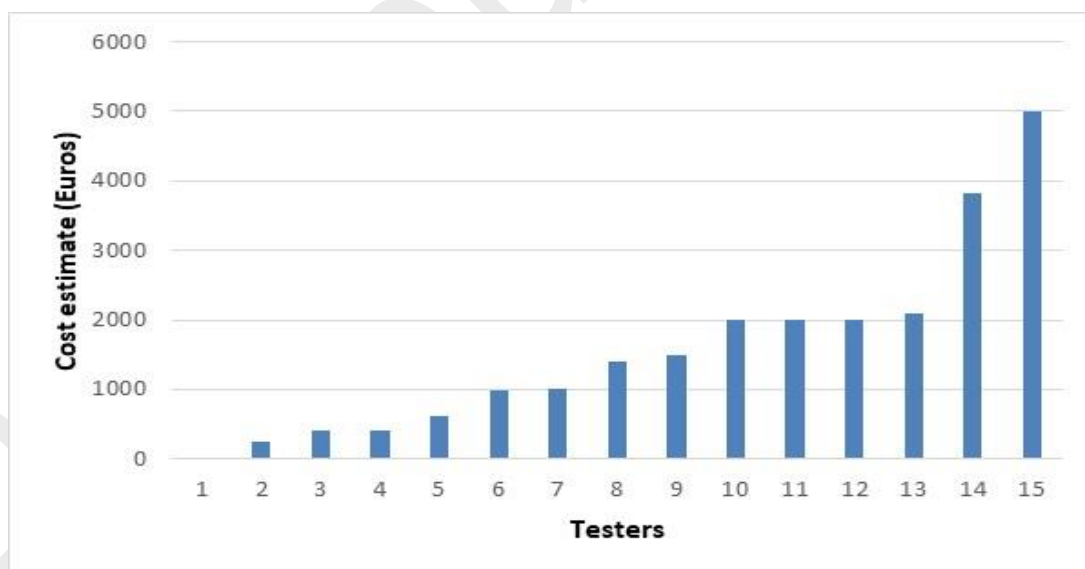
Q11. *Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.*

Amongst the 27 testers that made suggestions for improvements, the majority made reference to classification issues relating to building materials and elements, calculation tools and the reporting format. Some testers also commented on the overall concept of tool 2.1.

Some clarifications and/or simplifications should be applied to Tool 2.1. This could include a division of the reporting into different Level(s), as for the other tools/indicators.

Some testers reported that using the material classification and structure provided for the bill of materials resulted in extra work (5) and that it may be misleading/incorrect in terms of how design teams are in practice able to gather the data from bills of quantities (2).

Options to improve the classification were suggested:

- To connect the material groups to those required for LCA (4) or national/regional systems (2) instead of Eurostat categories;
- To create a list that can be used as material bank information (3).

A technical description of materials should be provided and reported on (material definition, material characteristic, material origin, characteristics of connection to neighbouring layers, etc.) since it is necessary for the analysis of service life, disassembly, reusability, recyclability for each material in a building component.

It was also indicated that additional information should be provided:

- The list of building elements/parts should be expanded to also reflect that there are parts made of different functional layers and of composite materials.
- A reference tab/number could moreover be added to each building element.

In contrast, some testers considered the classification of building parts and elements to be very detailed and called for a simplification.

It was reported that a clearer linkage with LCA software or an integrated BIM processes would make it easier to compile this indicator. However, some software solutions are not able to define single layers within one component, making it difficult to make this disaggregation using BIM (Building Information Modelling).

Finally, the general user friendliness of the reporting tool should be improved (5).

Table 44. Q10 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of improvements or issues cited (*)	Specific improvements identified
Classification of materials	16	– Level(s) classification for bill of materials causes extra work (5) – Level(s) classification for bill of materials may be misleading (2) – Link the material groups to those required for LCA (4) or national/regional systems (2) instead of Eurostat categories – Create a list that can be used as a material bank information (3)

Classification of building elements/parts	12	– Expand the list of default elements/parts (4) – 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, 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 (2) – Request 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) (3) – Provide a reference tab/number for each building element – Simplify the classification making it more general (2)
Tools	7	– Using LCA software (4) or an integrated BIM process would make it easier to compile this indicator (2) – Some software solutions are not able to define single layers within one component making difficult to carry out BIM (Building Information Modelling).
Reporting format	5	– Structure and user friendliness to be improved (5) – Since the guidance is common to all levels, it is 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 the materials, as the actual three first columns remain vague in this. Calculation of percentage contribution of each material could create more insights for users
Concept	4	– Clarify the purpose of this indicator – Clarify the division into levels – Abandon this indicators or make it easier – BoM is needed for a building LCA and could be considered a sort of "Level 1" LCA

(*) some testers identified more than one improvement of issue

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3.6. Using the test indicators and life cycle tools: _optional additional reporting_

This third batch of indicators and tools represent 'optional additional reporting' that goes beyond the scope of the 'minimum requirements' for carrying out a test. They comprise:

- 2.2 Life cycle tool: scenario 1 – Building and elemental service life planning
- 2.2 Life cycle tool: scenario 2 – Design for adaptability and refurbishment
- 2.2 Life cycle tool: scenario 3 – Design for deconstruction, reuse and recycling
- 2.4 Life cycle tool: Cradle to cradle Life Cycle Assessment (LCA)
- 5.1 Life cycle tool: scenario 1 – Protection of occupier health and thermal comfort
- 6.1 Life Cycle Cost (LCC)
- 6.2 Value creation and risk factors

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

Q1. _To what extent was the indicator or life cycle tool easy and logical to use?_
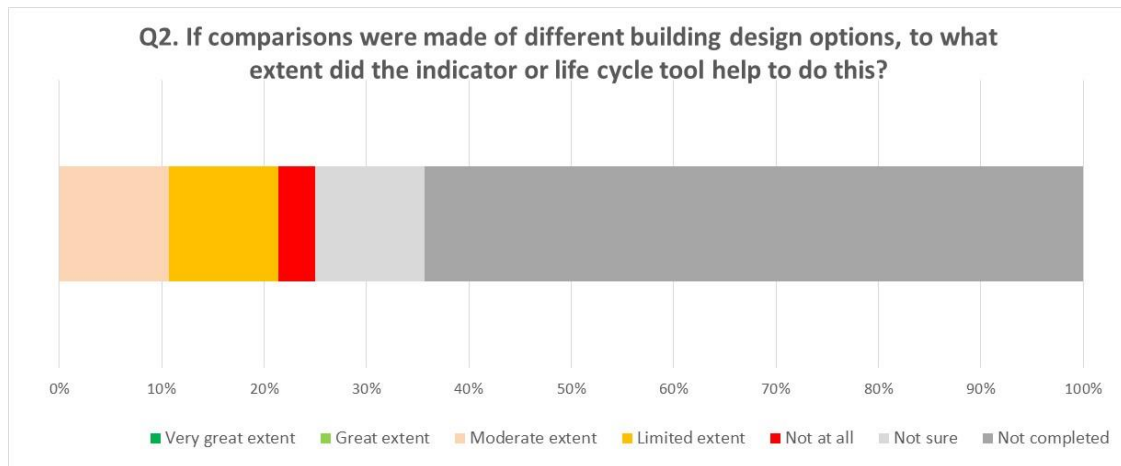
Overall 28 testers reported that they had tested scenario tool 1. More than a half of respondents considered that the guidance and the unit of measurement were 'easy and logical to use' to a great or very great extent. In respect to calculation methods and standards, reporting format and suggested calculation tools and reference data sources the majority considered this to be the case to a moderate or greater extent. In the case of the calculation method and standards, and the calculation tools and reference data sources, a notable proportion only considered this to a limited extent

The response to questions 1.6.and 1.7 on Levels 2 and 3 was much more limited. Of those that responded, the majority responded to a 'moderate extent' or 'not at all'. The responses were slightly more positive for Level 2.
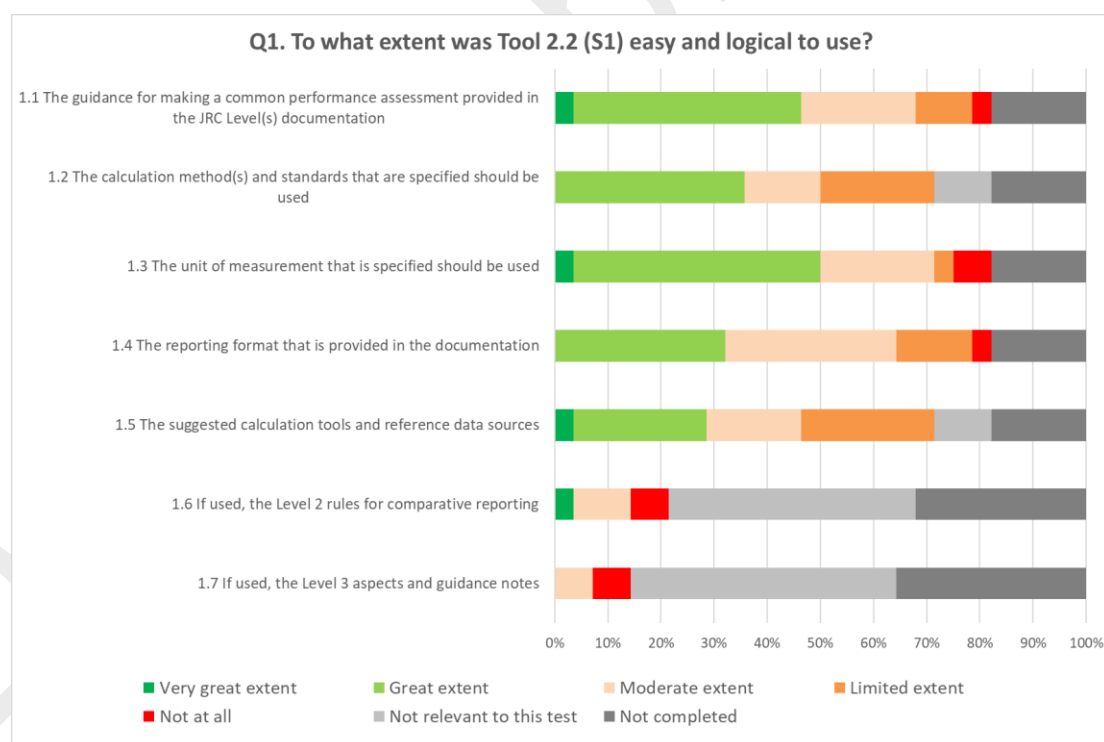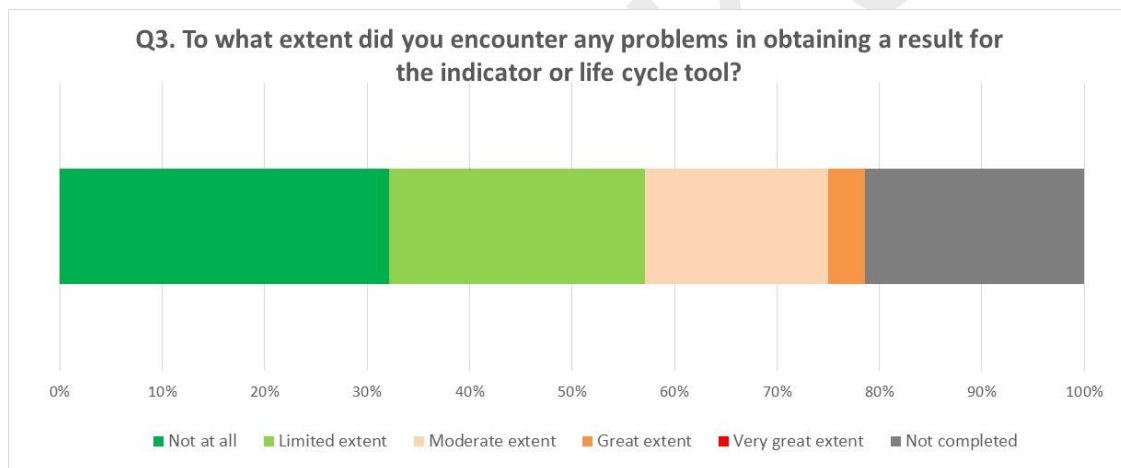

Q2. _If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?_

Of the 10 testers that responded the majority considered that it helped to a moderate/limited extent. A notable proportion were not sure.

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Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Legend: Very great extent | Great extent | Moderate extent | Limited extent | Not at all | Not sure | Not completed

Q3. _To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?_

Of the 22 testers that responded the majority (16) did not encounter problems and if they did, only to a limited extent.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Legend: Not at all | Limited extent | Moderate extent | Great extent | Very great extent | Not completed

Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

In total only a small number of testers (6) identified the problems they had encountered. In Table their responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also any workarounds put forward,.

It can be seen that main concerns (cited by 4 testers) related to the calculation of results, with 2 additional testers pointing out the need to improve the reporting tool.

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Table 45. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of problems cited (*)	Problems and workarounds identified by testers
Calculation of results	4	– High workload requested – Difficulties in finding typical lifespan of building elements (2) – Need of LCA support
Reporting tool	2	- Lack of flexibility (for elements made of sub-parts and for differentiating between maintenance and replacement) - Unclear selection options for parts/components, which are also not aligned with the guidance document

(*) some testers identified more than one problem or workaround

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

Of the 22 respondents just over half had found previous assessments to be useful. Amongst the 15 that identified what they had used (see Table), the majority referred to information from the literature and assessment tools for buildings (9) and to building certifications (4).

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

■ Yes ■ No ■ No reponse
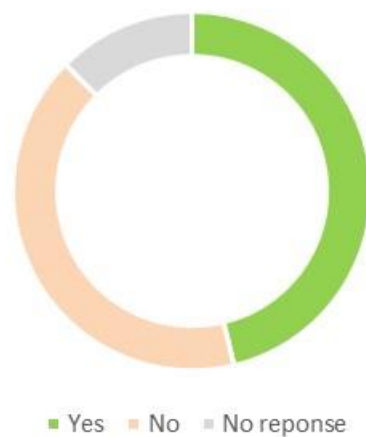
*Please specify useful resources from previous projects*

Table 46. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of resources cited	Specific resources identified
Literature and assessment tools for buildings	9	– Totem (LCA tool) – One Click (LCA tool) – RICS – INIES database – EPD/FDES/LCA – BNB catalogue for building parts and VDI 2067 service life for HVAC systems – Nutzungsdauer nach BNB 2017, database – Steligence (ArcelorMittal assessment tools) – Other not specified
Building certification	4	– HQE (2) – DGNB (2)
Others	2	– Internal software – Technical specifications of the building project

Q5. To what extent did you already have access to the required results from other assessments of the building?

Reflecting the response to Q5, the majority of the 23 respondents considered they already had access to the required results to moderate or greater extent. However, a substantial proportion of testers responded 'not at all', highlighting the need to consult new sources and data.

Of the 13 that identified their sources (see Table), the majority referred to data obtained for building certification purposes.
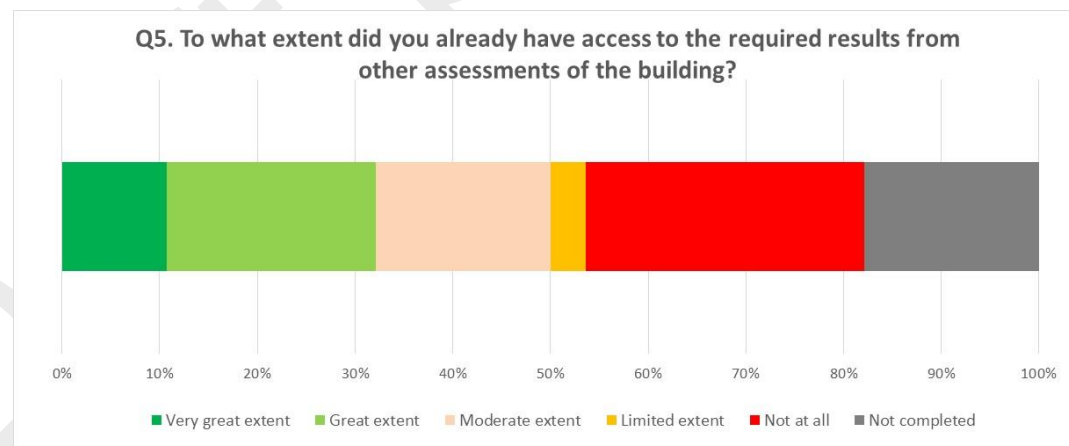
Please identify the source of results that were already available

Table 47. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of resources cited	Specific resources identified
Building certification	**4**	– DGNB (2) – E+C- (2)
Literature and LCA calculations for buildings	**3**	– TCQi 2019 – PEF – Nutzungsdauer nach BNB 2017, database
Level(s) calculations	**2**	– Information from other indicators (2)
Others	**3**	– Facility manager – Other building projects (2)

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Amongst the 21 respondents who had to obtain one or more of the three items in order to make their assessment, the standards, data and tools appear to have been readily available or already in their possession. There no cases where testers cited that they were not possible to obtain.
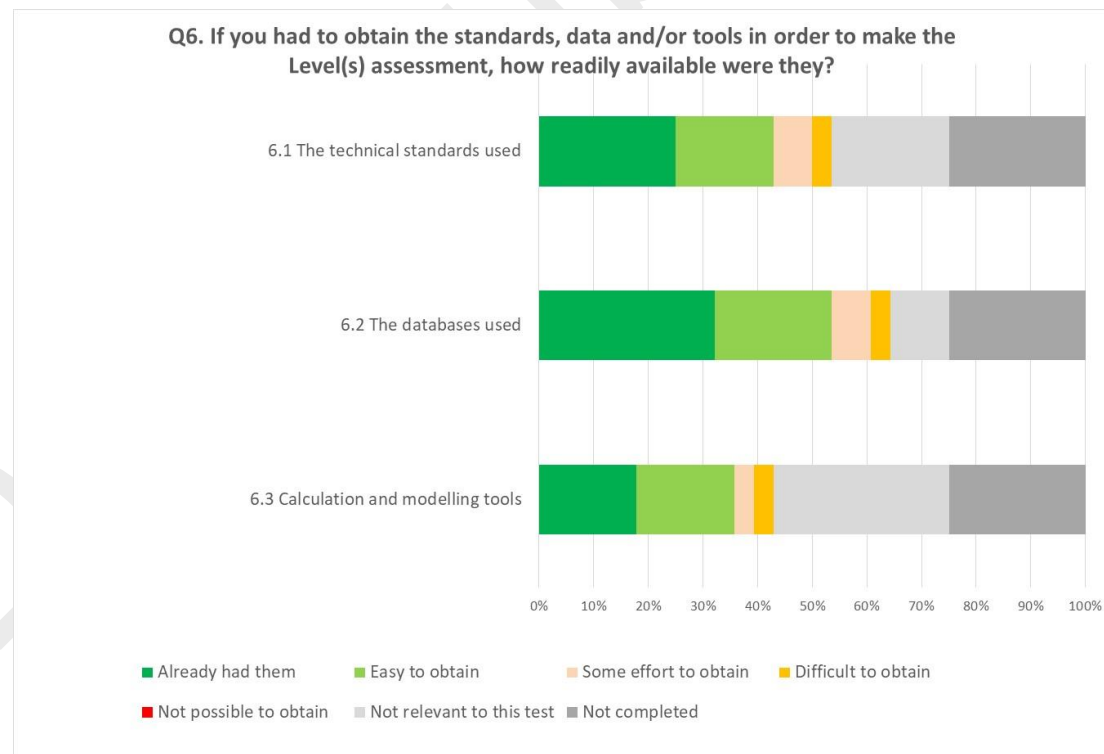
Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Of the small number of testers that had to purchase one of the items (10), for the majority cost was either only one factor seen as a barrier or not seen as a barrier at all. Only in the case of technical standards were there more responses citing cost as the main barrier to their use.
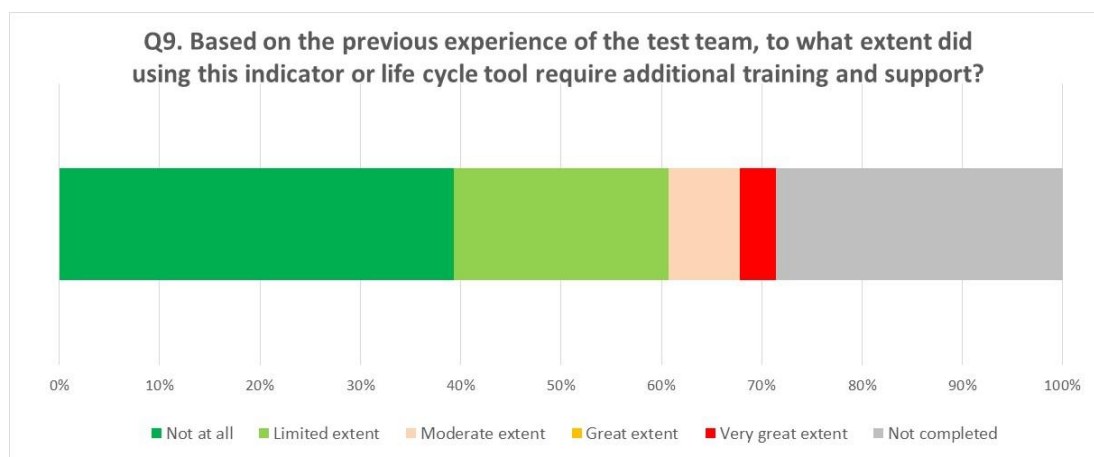

Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

Amongst the 22 respondents, this indicator was considered to be relatively familiar, with most citing some/extensive previous experience.
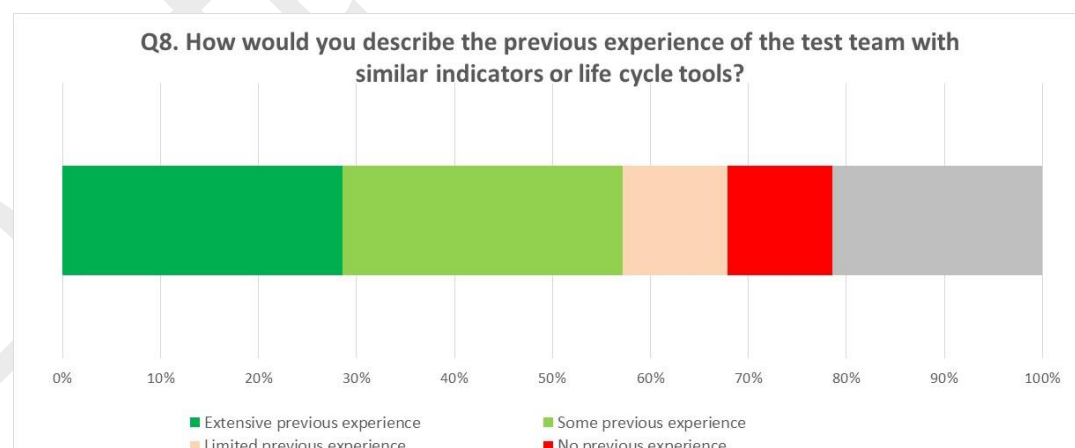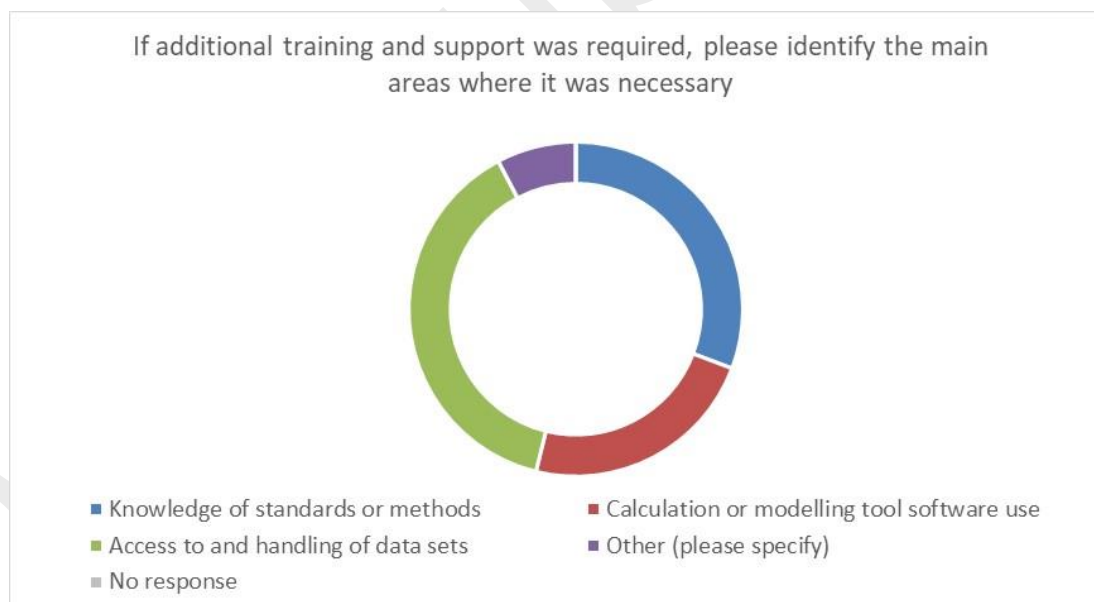

Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

Of the 20 respondents to this question the majority considered that additional training and support was not required and if so only to a limited extent. Only a small proportion required training and support to a very great or moderate extent, likely reflecting those who responded in Q8 that they had no previous experience.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?


If additional training and support was required, please identify the main areas where it was necessary:

Of the 13 testers that cited areas where training and support were necessary, 5 cited 'access to and handling of data set', 4 cited 'knowledge of standards or methods' and 3 cited 'calculation or modelling tool software use'. The open question asking for further suggestions on the training and support necessary only received two responses.


If additional training and support was required, please identify the main areas where it was necessary

Q10. If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.

Of the 16 testers that provided time estimates it can be seen that 50% required up to 1 person days and 75% up to 2.3 days. The maximum was 20 person days and the average was 2.8 person days.
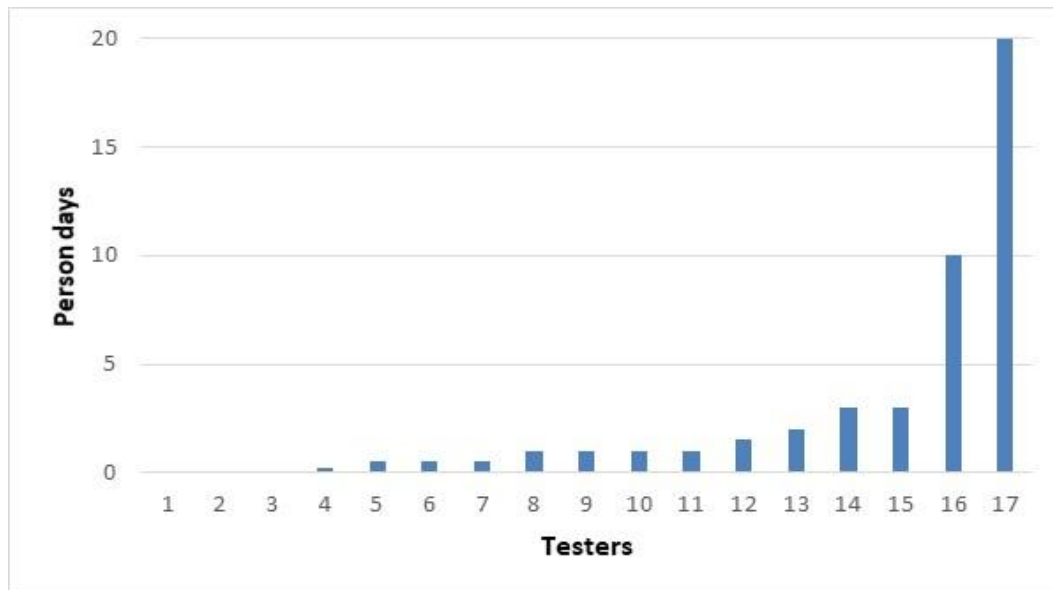
Of the 15 testers that provided cost estimates, 50% assigned up to € 400 and 75% up to € 562. The maximum was € 5000 and the average was € 855.
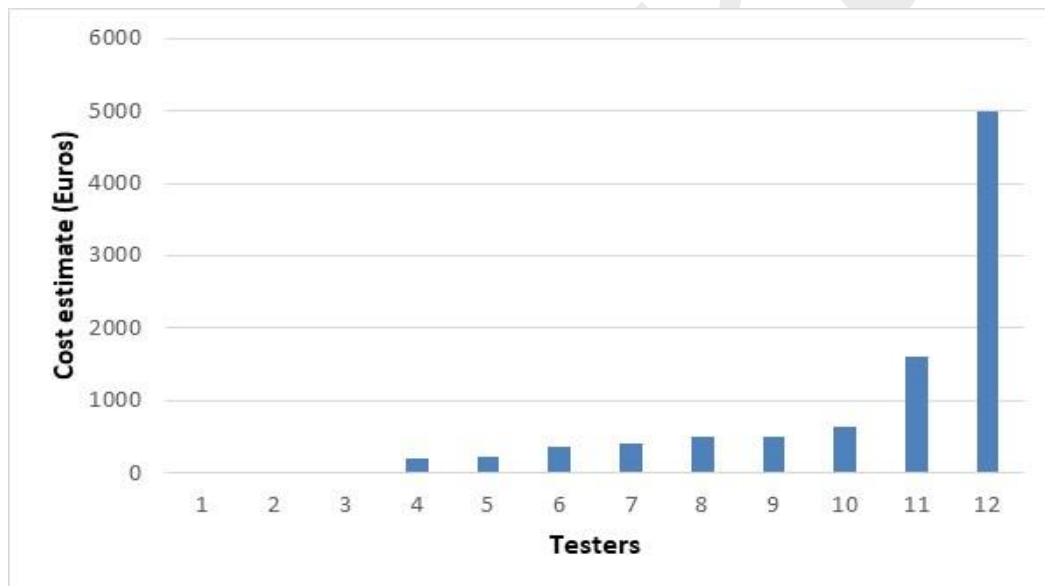
Q11. *Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.*

Amongst the 10 testers that made suggestions for improvements, the majority made reference to the guidance, whilst some testers referred also to the reporting tool.

In respect to the guidance, most of the respondents called for clarifications about:

- The rules to apply at different levels
- The definition of "lifespan" and "useful life" and which of them should be used
- The differentiation that should be made between real and theoretical data
- How to account for the life span of a building component, since it is not clear if this should be calculated as the lowest life span of the materials and parts that make up the component
- How to address service life spans in the context of assessing a major renovation.

It was, moreover, suggested to:

- Provide catalogues of building parts
- Think in terms of 'numbers of replacements in a period of 60 years' instead of lifespans

Other testers asked for some simplifications, such as:

- Aligning with national building component classifications (e.g. France)
- Making the link to dedicated tools and databases (e.g. the BNB service life list).

In respect to the reporting tool, it was suggested that it should be more detailed and better connected to building practices. An additional column should be added with the possibility to enter the specific name of the materials. An extra column 'maintenance' would also useful, as replacements can form part of a maintenance activity.

Table 48. Q10 open response to suggest improvement that would make the indicator easier to use

| Source of the results/data	Number of resources cited (*)	Specific resources identified
Guidance	**8**	– Clarifications are needed – The division into levels is not clear – It must be clearly defined whether the time periods to be reported for the building component are "lifespan" or "useful life", as these definitions can have different time periods – Actual replacement data reveal performance in practice and real life spans. For an existing building, it may be easier to report actual replacements instead of theoretical product life span data. – How to account for the life span of a building component, since it is not clear if the life span of a building component should be calculated as the lowest material life span in the component – How to cope with service life spans in the case of a mayor renovation – Provide catalogues for building parts – It would be more relevant to think in 'numbers of replacements in a period of 60 years instead of lifespans. – Too long, to be simplified – Not aligned with national classifications (e.g. France) – A demanding work is required to compile the tool without LCA data. Dedicated software databases are needed to obtain the required values (2) – Direct link with BNB service life list
Reporting tool	**3**	– An additional column should be added to enter the specific name of the materials – An extra column 'maintenance' may be useful, as replacements can be part of a maintenance activity. – More detailed way of reporting which is better connected to practice

(*) some testers identified more than one resource

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

Q1. To what extent was the indicator or life cycle tool easy and logical to use?

Overall, 19 testers reported that they had tested scenario tool 2. In general, just under half considered that the guidance, method and reporting format were to a great or very great 'easy and logical to use'. A substantial majority considered this to be the case to a moderate or greater extent.

The response to questions 1.6 and 1.7 on Levels 2 and 3 was lower. Of those that responded, the majority of those that responsed for Level 2 considered it easy and logical to use to a moderate of greater extent. Level 3 appears from the response to have been more challenging, with a greater proportion of the testers considering this to a limited extent or not at all.
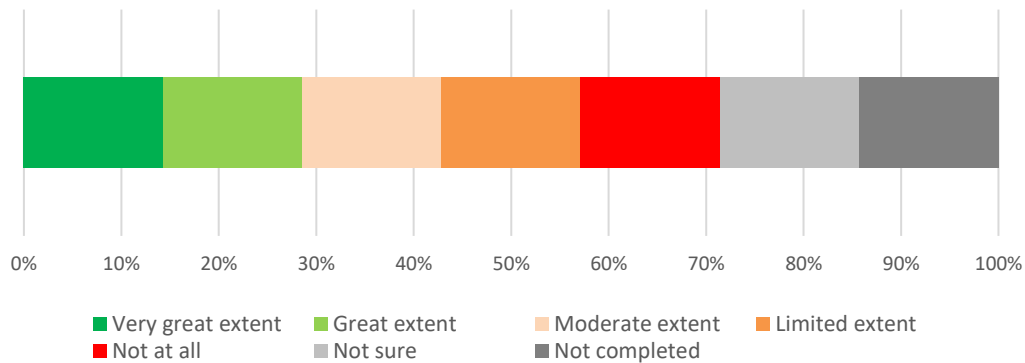

Q1. To what extent was Scenario tool 2 easy and logical to use?
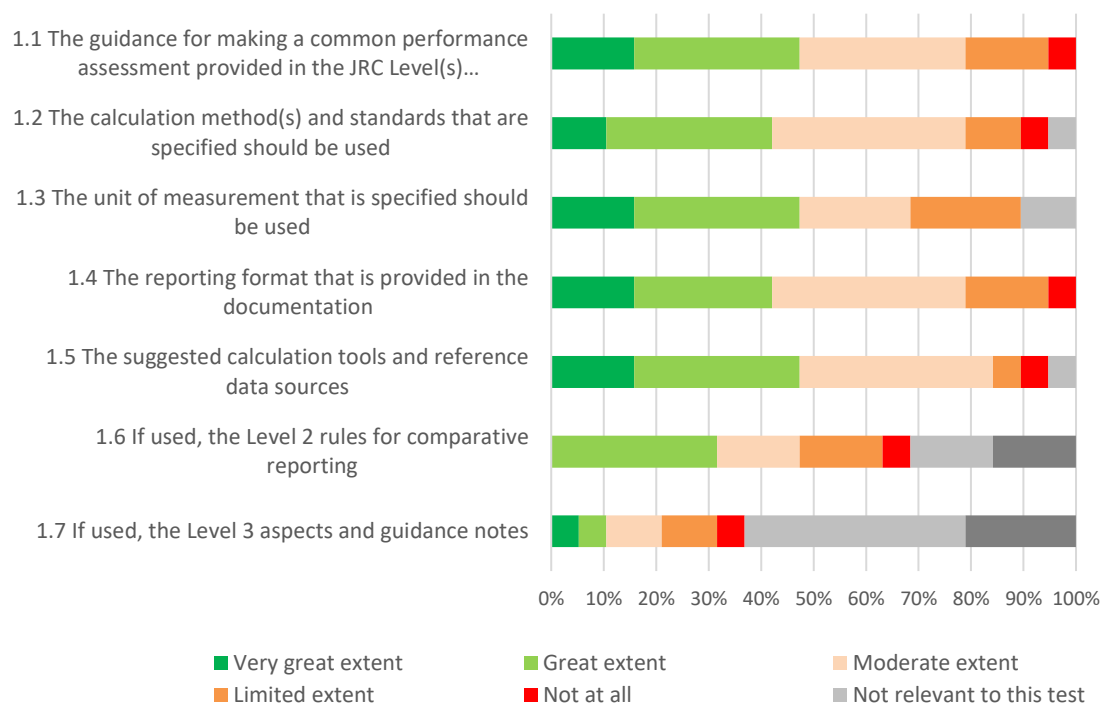
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Of the 10 testers that responded, they were evenly split between those that considered that it had helped to a moderate or greater extent and those that were either not sure or considered that it had only helped to a limited extent or not at all. A notable proportion considered that it had not helped, likely reflecting the late stage in the project at which the test took place.
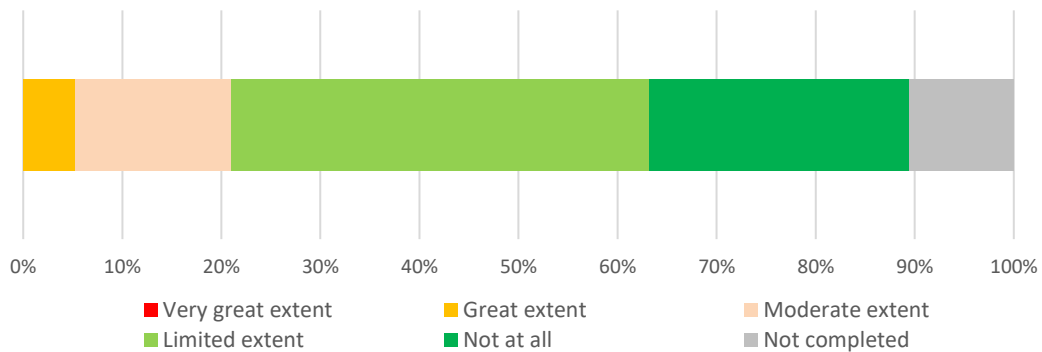
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not sure
- ■ Not completed

Q3. ***To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?***

Of the 17 testers that responded, the majority did not encounter problems and if they did, only to a limited extent.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?


Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

Open response *: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.*

Not enough responses (3) were received to support a valid analysis for this response.

Q4. ***When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?***

The majority of the 17 respondents had found previous assessments to be useful. This is likely because they used a semi-quantitative score from an assessment scheme, as can be seen from Table , which analyses and clusters the open responses to this question.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- Yes
- No
- No response
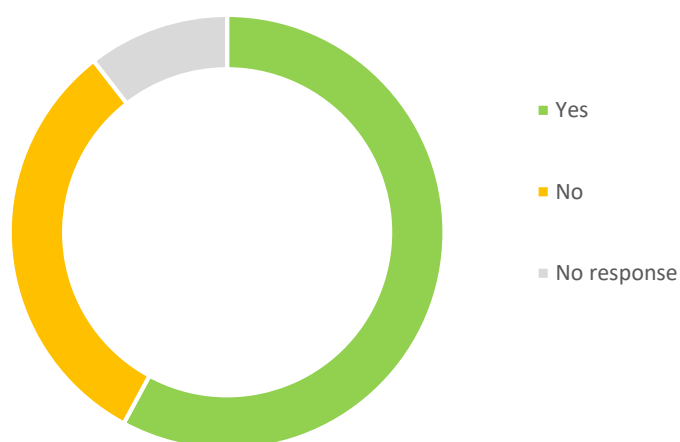
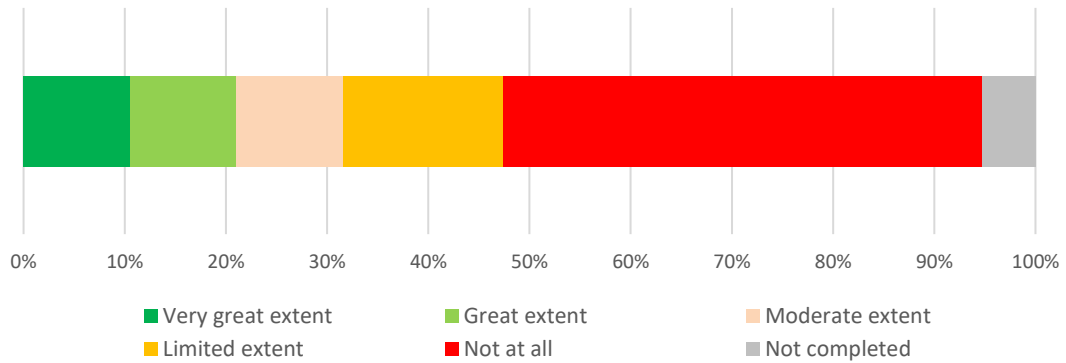### *Please specify useful resources from previous projects*

Table 49. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of resources cited	Specific resources identified
Semi-quantitative tool	**7**	− DGNB criterion (5) − DGNB pre-certification − GRO indicator TOE1 "Circulair en toekomstgericht ontwerpen" (Flemish Government)
Plans and designs	**2**	− Architect and engineers − Previous building concept
Assessment schemes	**1**	− Some elements of HQE

Q5. To what extent did you already have access to the required results from other assessments of the building?

Although in the response to Q4 resources from other assessments were useful, for the test new results had to be obtained for a significant proportion of the 18 respondents to this question – suggesting that this aspect of performance is relatively new to be addressed. 6 testers went on to identify the previous sources of results and data that they had used and these are clustered in Table 50.

Q5. To what extent did you already have access to the required results from other assessments of the building?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

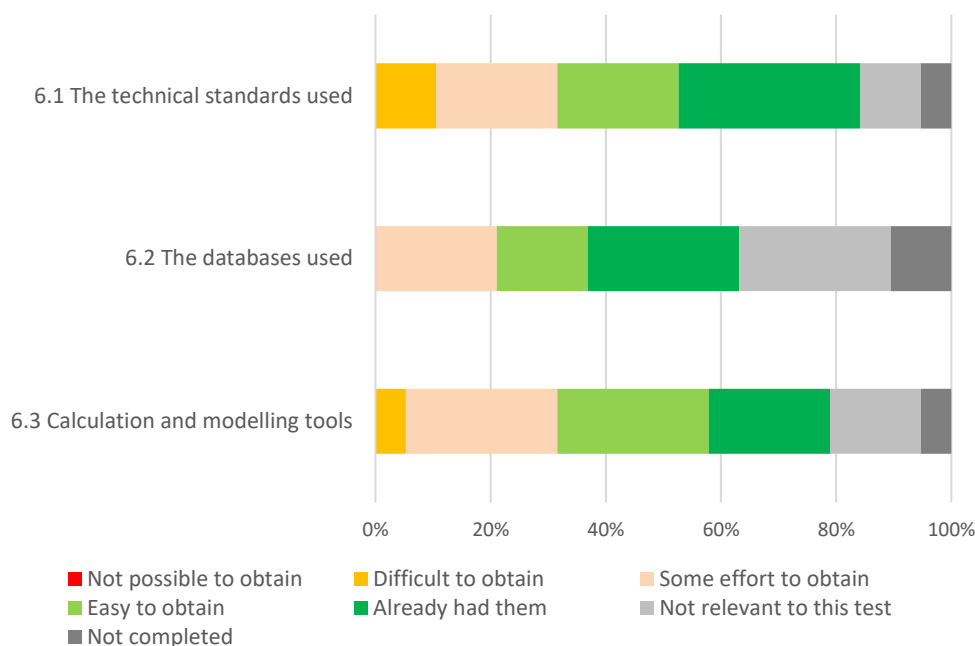### Please identify the source of results that were already available

Table 50. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of testers	Specific resources identified
Plans and designs	3	– Architect and engineers – Design documents – Design team (from earlier in the process)
Semi-quantitative assessment tools	3	– DGNB criterion – DGNB pre-certification – DGNB results

Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

Of the 18 respondents to this question, for just over half the standards, data and tools appear appear to have been readily available or already in their possession. No testers cited that they had been unable to obtain.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Legend:
- Not possible to obtain
- Difficult to obtain
- Some effort to obtain
- Easy to obtain
- Already had them
- Not relevant to this test
- Not completed

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Of the 10 respondents to this question who had had to purchase one of the items, in the majority of cases their cost was one of the factors acting as a barrier and, in a smaller but notable number of tests, purchase of calculation and modelling tools had been the main factor acting as a barrier.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Legend:
- Not at all
- One of the factors
- The main factor
- Not completed
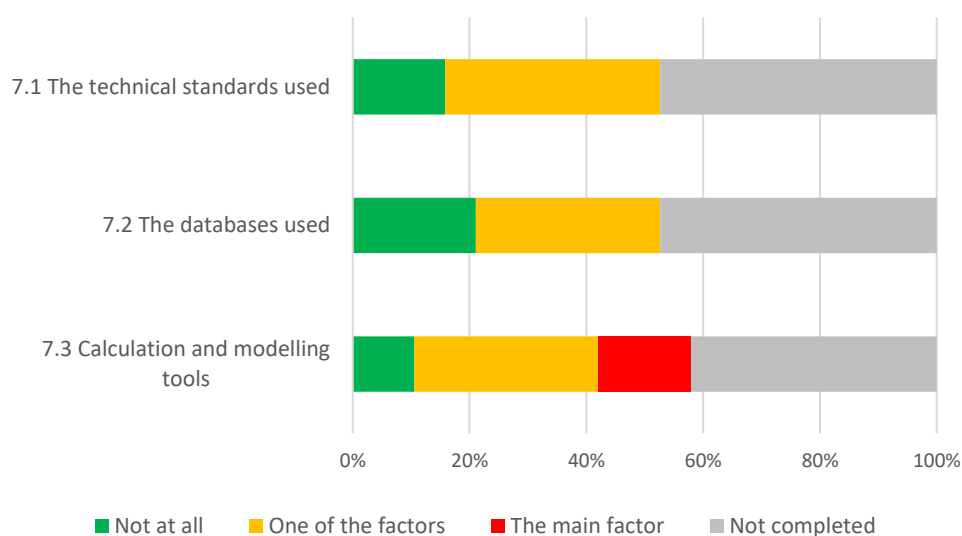
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

This indicator was relatively familiar to most of the 16 testers that responded, with extensive previous experience some or extensive experience being cited in nearly half of the cases. A small but notable number of testers stated that they had no previous experience, likely because they had not used an assessment scheme that addresses this scenario.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend:
- No previous experience
- Limited previous experience
- Some previous experience
- Extensive previous experience
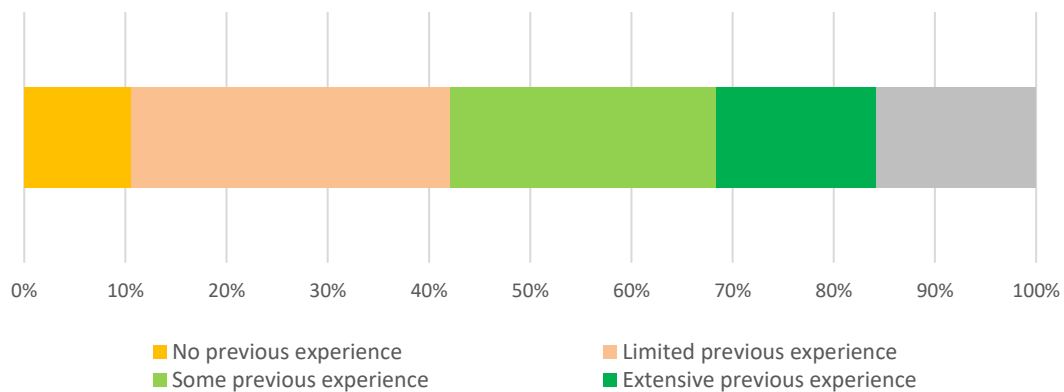
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

The majority of the 18 testers that responded considered that additional training and support was not required or, if so, only to a limited extent.
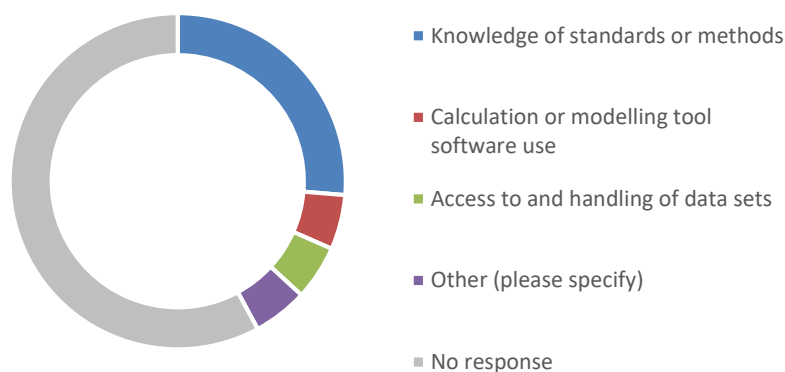
Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
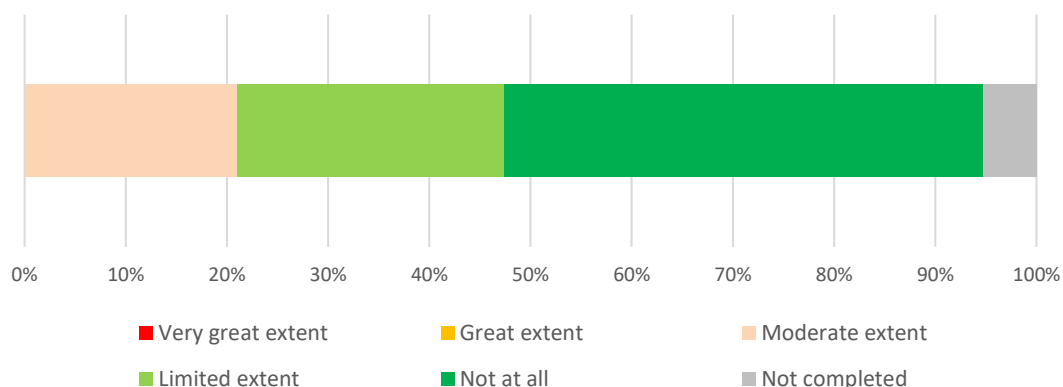
If additional training and support was required, please identify the main areas where it was necessary:

Of the 8 testers that cited areas where training and support were necessary, most (5) cited '*knowledge of standards and methods',* likely reflecting the implied dependence of the result for (in part) Level 1 on reference standards for residential buildings and Level 2 on the use of tool that generates a score.

If additional training and support was required, please identify the main areas where it was necessary

- ■ Knowledge of standards or methods
- ■ Calculation or modelling tool software use
- ■ Access to and handling of data sets
- ■ Other (please specify)
- ■ No response

Please identify the type of training and/or support that was needed

The majority of testers considered that additional training and support was not required or, if so, only to a limited extent. The limited number of open responses received (3) meant that there was not enough information to make a valid analysis and clustering.

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of those testers that provided time estimates (12) it can be seen that a third required up to 1 person days and there were then three testers that required 2 person days. The average was 1 person day.
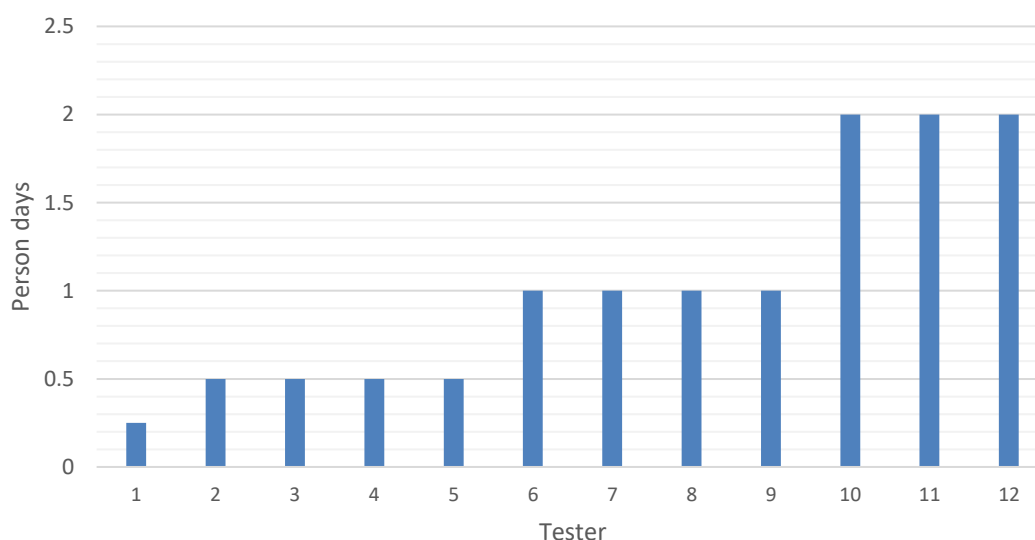
Of the 10 testers that provided cost estimates, the majority assigned up to €800, with only one assigning €1.600. The average was €533.
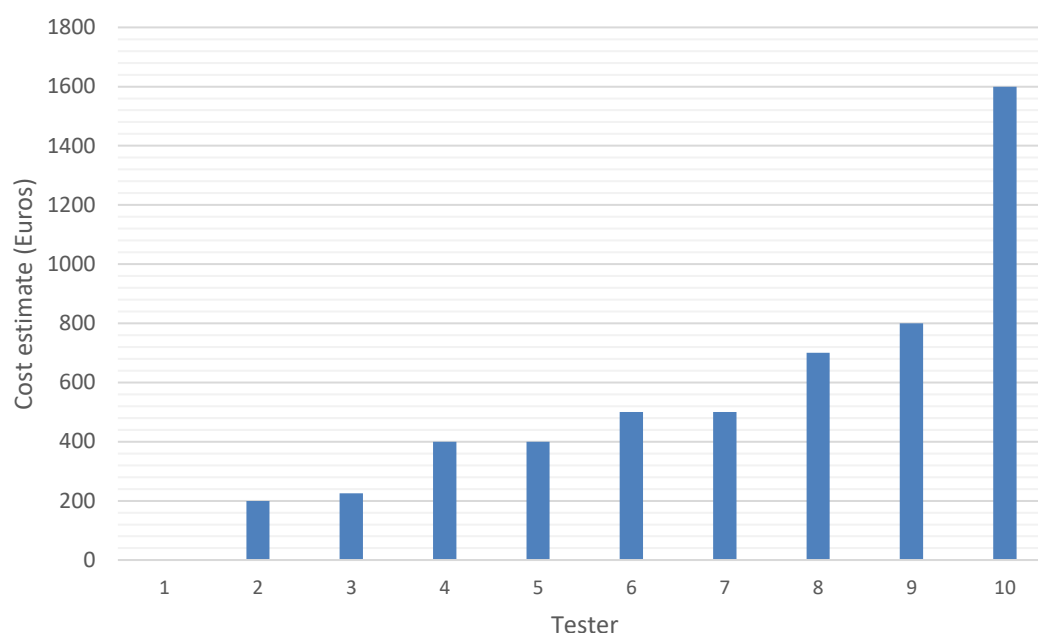
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Amongst the 12 testers that made suggestions for improvements, the majority of the suggestions received were clustered around the use of semi-quantitative tools (5). Suggestions also related to the design aspect checklists, other methods and example practices.

In regards to semi-quantitative tools, which form the basis for the use of Level 2, the tools referred to in the guidance should be made readily available and, if possible, a tool should be integrated into Level(s). The specific tools and versions should also be specified in the guidance, as there are different versions and in some cases different parts/sub-criteria. One of the tools that forms the basis for the residential checklist (Lifetime Homes) requires further consideration as it may not be appropriate/useable in all cases.

Table 51. Q11 open response to suggest improvement that would make the indicator easier to use

| Source of the results/data	Number of resources cited	Specific resources identified
Semi-quantitative tools	5	− They should be accessible to and usable by everyone − Embed the best tool for quantifying adaptability in the Level(s) guidance. − Level(s) should have it's own assessment tool to ensure comparability − It is possible to choose criterion ECO 2.1 and TEC 1.4 from DGNB - please specify which − Lifetime Homes is more appropriate for individual houses than collective dwellings
Design aspects	2	− Allow for new innovations − Support renovation decisions versus demolition
Standards and methods	1	− Provide references for other useful methodologies
Examples of practices	1	− Provide more examples and reference cases

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

Q1. *To what extent was the indicator or life cycle tool easy and logical to use?*

Overall, 19 testers reported that they tested scenario tool 3. In general, just under half of the testers considered that, to a great or very great extent, the guidance, method and reporting format were 'easy and logical to use'. In the majority of cases, they considered the tool easy and logical to use to a moderate or greater extent. However, a notable proportion of those who responded considered that only to a limited extent was it easy and logical to use, likely corresponding to those testers for whom this aspect was new to assess.

The response to questions 1.6 and 1.7 Levels 2 and 3 was more limited. The response for Level 2 was less positive than the overall response and Level 3 appears from the response to have been the most challenging to use.
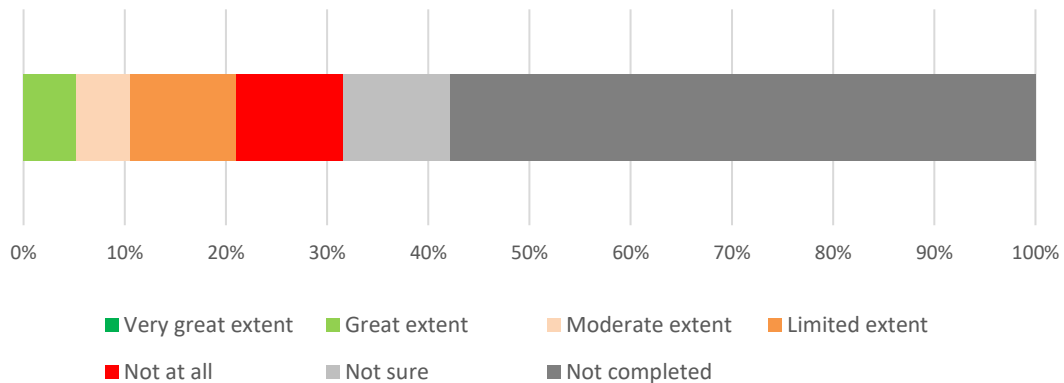
Q1. To what extent was Scenario tool 3 easy and logical to use?
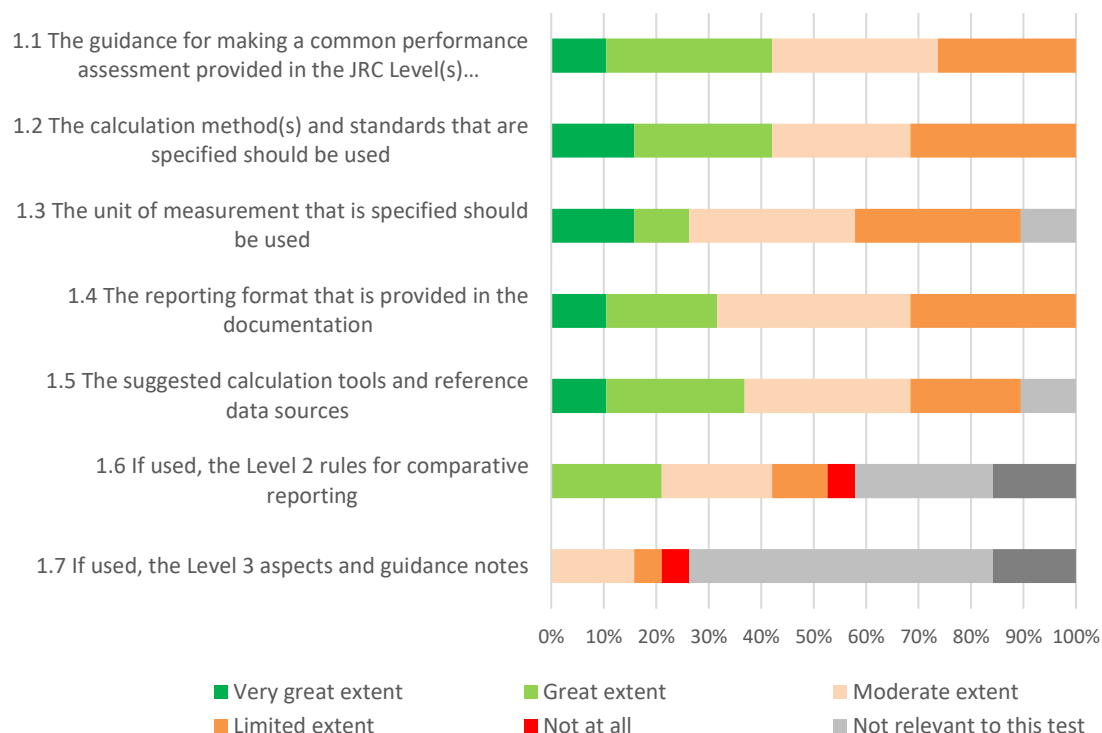
Q2. *If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?*

Only 8 testers responded to this question, likely reflecting the fact that design decisions had already been made before making the test. Of those that responded for the majority it provided limited or no help.
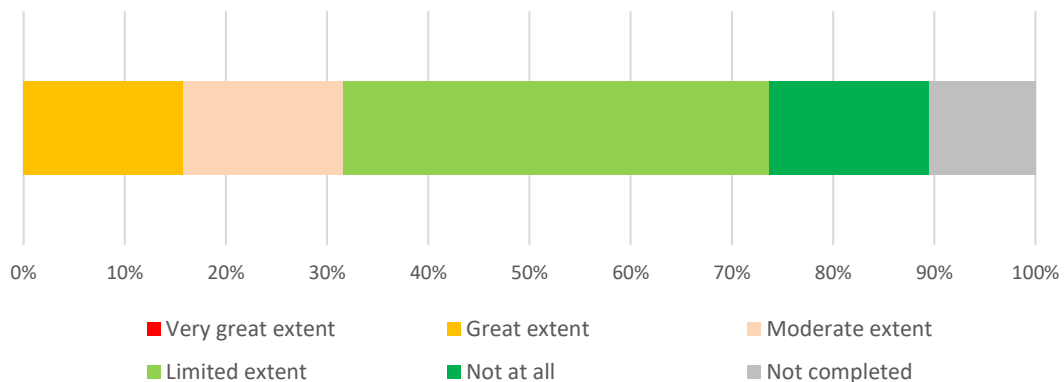
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

■ Very great extent ■ Great extent ■ Moderate extent ■ Limited extent

■ Not at all ■ Not sure ■ Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 17 testers that responded the majority appear not to have encountered problems of any significant extent.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?


0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

■ Very great extent ■ Great extent ■ Moderate extent

■ Limited extent ■ Not at all ■ Not completed

Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

Not enough responses (3) were received to support a valid analysis for this response.

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

The majority of the 17 respondents had found previous assessments to be useful. This may be because they had used a semi-quantitative score from an assessment scheme, as can be seen in Table , which analyses and clusters the open responses to this question.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- Yes
- No
- No response
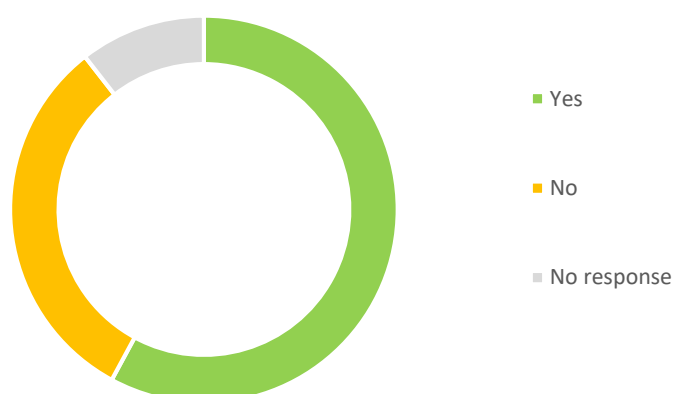
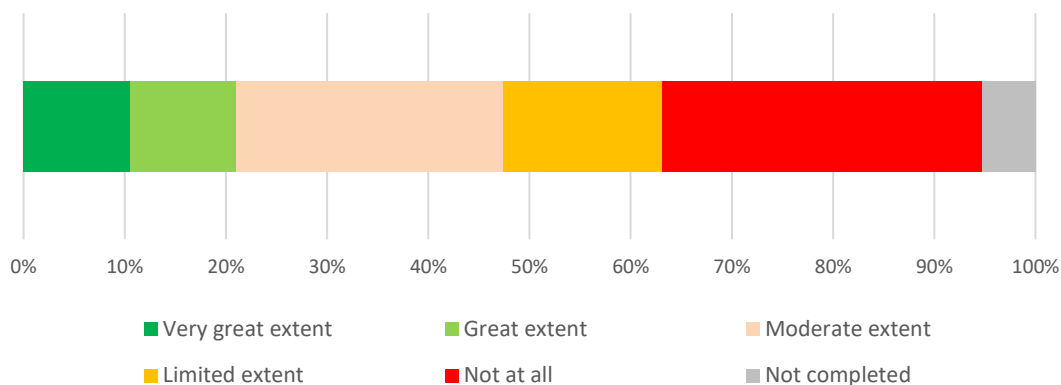## Please specify useful resources from previous projects

Table 52. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of resources cited	Specific resources identified
Semi-quantitative tool	4	− DGNB tool (2) − DGNB results for TEC1.6 − ÖGNI TEC 1.6 Tool
Assessment schemes	4	− DGNB 2014 criteria TEC1.6 & PRO1.3 and LCA − DGNB certification or pre-certification (2) − Some elements of HQE
Quantitative tools	1	− LCA software (GaBi) − LCA model from the project 'EFIResources'
Scenario descriptions	1	− NBN/DTD B 08-001:2017 Table 6 – Default end-of-life scenarios
Literature and studies	1	− Reference studies

Q5. To what extent did you already have access to the required results from other assessments of the building?

Although in the response to Q4 resources from other assessments were found to be useful, for the test new results had to be obtained for a significant proportion of the 18 respondents to this question – suggesting that this aspect of performance was relatively new to be addressed for most. 11 testers identified sources they had used and these are analysed and clustered in Table 53.

Q5. To what extent did you already have access to the required results from other assessments of the building?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed

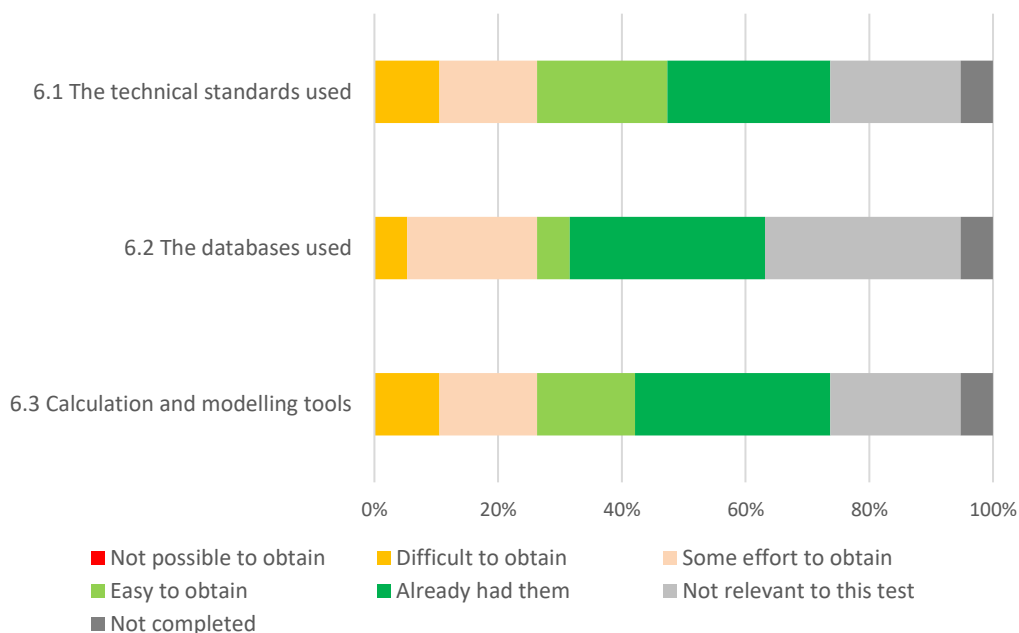### *Please identify the source of results that were already available*

Table 53. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of sources cited	Specific sources identified
Semi-quantitative tool	**4**	– Construction material provider tool – DGNB criterion (2) – DGNB pre-certification
Plans and designs	**4**	– Design documents (2) – Design team (from earlier in the process) – Precedents from similar building types on other projects
Quantitative studies	**1**	– LCA had already been carried out
Research project	**1**	– The outcome of the project EFIResources

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Amongst the 18 respondents to this question, in just over half of the tests the standards, data and tools appear to have been easy to obtain or they already had them. In no cases was it cited that it had not been possible to obtain that was needed for the test.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

- ■ Not possible to obtain
- ■ Difficult to obtain
- ■ Some effort to obtain
- ■ Easy to obtain
- ■ Already had them
- ■ Not relevant to this test
- ■ Not completed

Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

Only 9 of the testers had had to purchase one of the items listed in the question. Of those 9, in the majority of cases cost had been one of the factors considered to create a barrier to scenario 3's use.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

- ■ Not at all
- ■ One of the factors
- ■ The main factor
- ■ Not completed
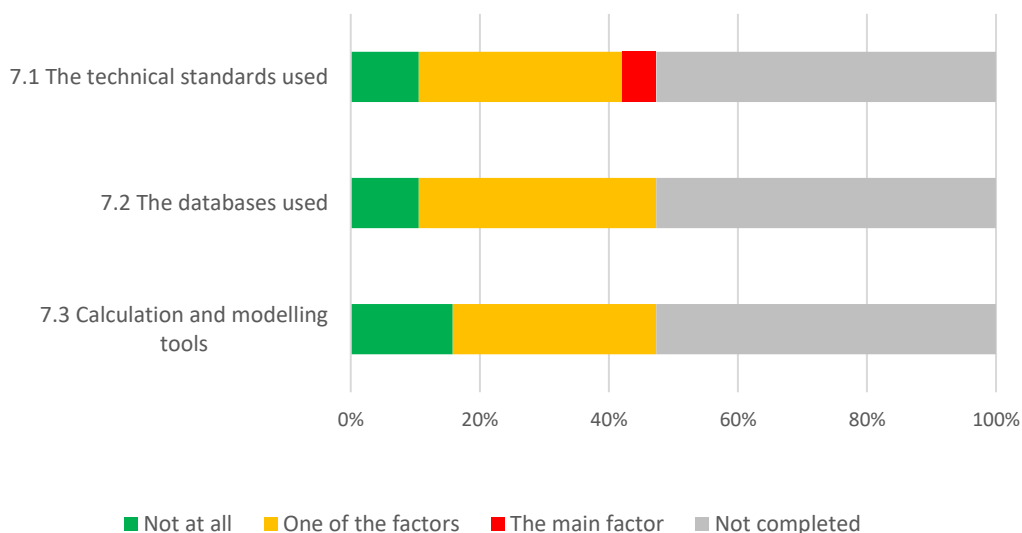
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

Of the 17 testers that responded to this question, scenario 3 was relatively familiar to only half of them, with some or extensive previous experience being cited. This could reflect the relatively new focus of attention on the end of life of buildings, although notably a notable proportion of respondents considered that they had some limited experience with some aspect of the scenario, likely relating to present day demolition or waste handling.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

- No previous experience
- Limited previous experience
- Some previous experience
- Extensive previous experience
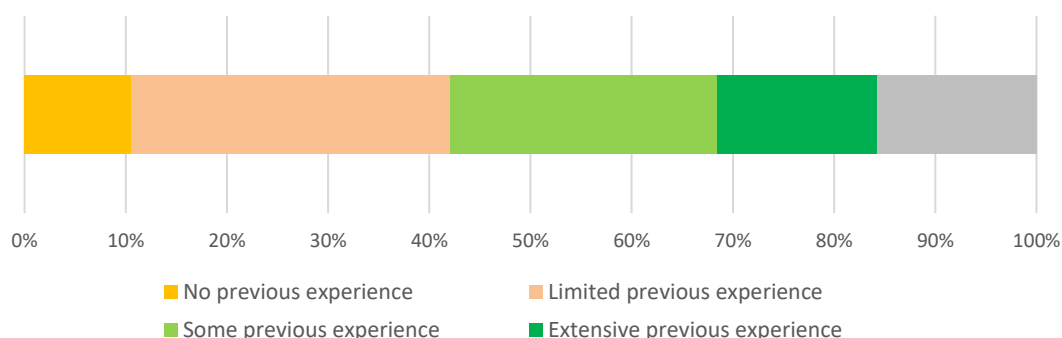
Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

The majority of the 16 testers that responded to this question considered that additional training and support was not required or, if so, only to a limited extent.
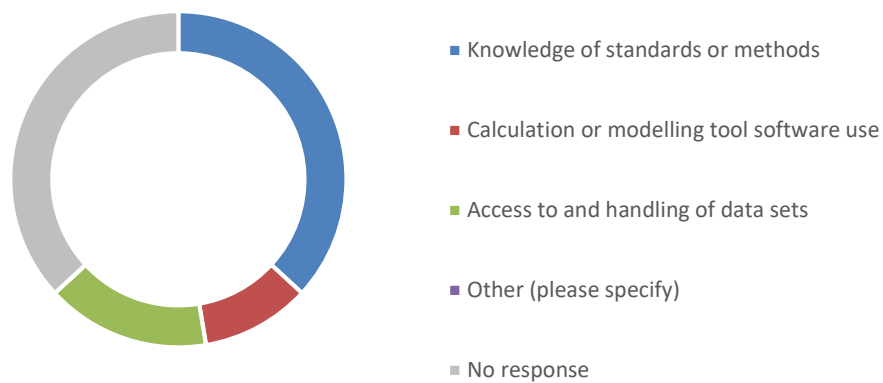
Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
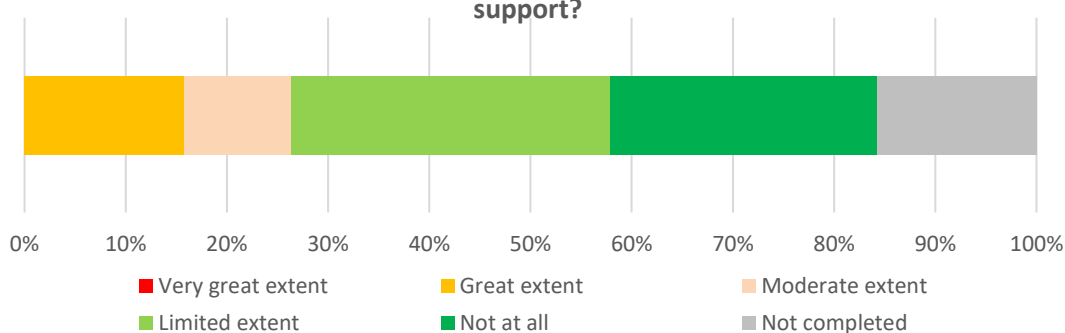
If additional training and support was required, please identify the main areas where it was necessary:

Of the 12 testers that cited areas where training and support were necessary, 7 cited '*knowledge of standards and methods'*, likely reflecting the implied dependence of the result for (in part) Level 1 on reference standards for residential buildings and in the case of Level 2 on the use of tool that generates a score.

If additional training and support was required, please identify the main areas where it was necessary

- Knowledge of standards or methods
- Calculation or modelling tool software use
- Access to and handling of data sets
- Other (please specify)
- No response

Please identify the type of training and/or support that was needed

Not enough responses were received to support a valid analysis for this open response.

Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of those testers that provided time estimates (12/19) it can be seen that a third required up to 2 person days and there were then three testers that required 3-4 person days. The average was 1.7 person days.
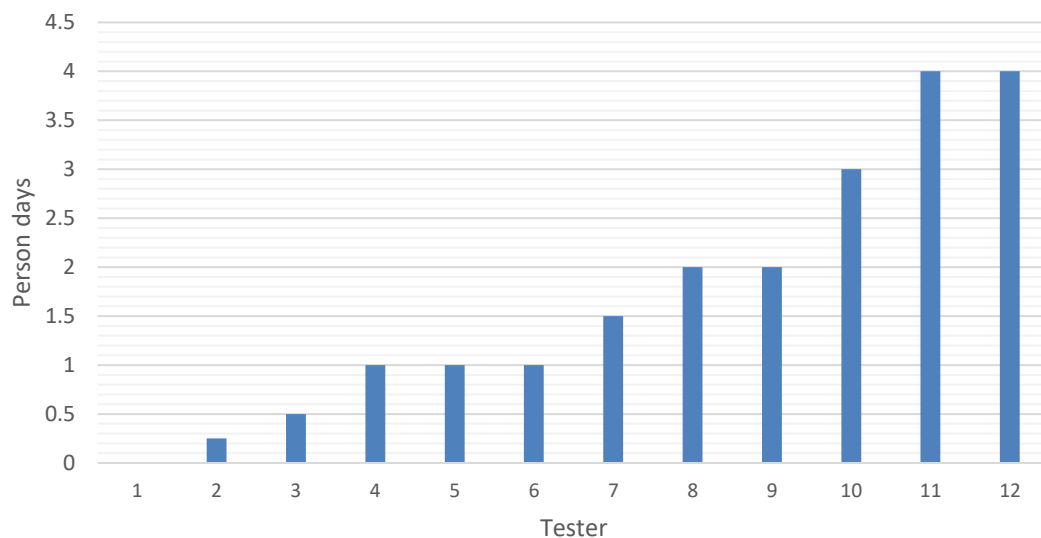
Of the 9 out of 19 testers that provided cost estimates, the majority assigned up to €1.600, with only one assigning a very high estimate of €4.000. The average was €1.025.
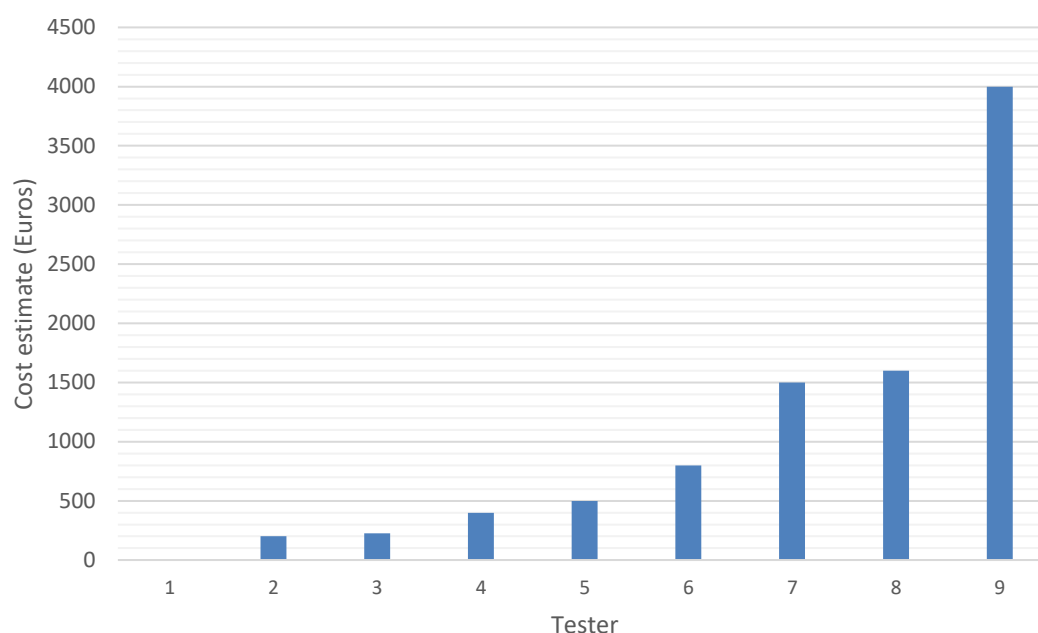
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Q11. _Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use_.

Amongst the 11 testers that made suggestions for improvements, most suggestions were clustered around the use of semi-quantitative tools (3) and the design aspects for which checklists were provided (2). Suggestions also related to the quantitative tools, design tools, other methods and the applicability to existing buildings.

In regards to semi-quantitative tools, which form the basis for using Level 2, it was felt that such a tool should be integrated somehow into Level(s). How the design aspects checklists should be used appears to also require some clarification.

In regards to the other suggested improvements, these included reference to the new ISO standard 20887, which was referred to in the guidance as being under development at the time of publication in 2017.

Table 54. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of suggestions cited	Specific suggestions made
Semi-quantitative tools	3	– Level(s) should have it's own assessment tool to ensure comparability – Integrate an assessment tool to try to standardise the approach based on the best available tools. – The scoring system for the DGNB tool is complex, instead a simpler tool should be developed for Level(s)
Design aspects	2	– Clarify if the checklists must also be used at Level 2 – What should be the response to the aspects?
Quantitative tools	1	– There should be a closer link to LCA and building component catalogues
Design tools	1	– What is the definition of a design tool that can be used?

| Standards and methods	1	– Further alignment with existing standards and guides could be of help, for example ISO 20887 Design for disassembly and adaptability of buildings and civil engineering works
Existing buildings	1	– Reporting for existing buildings should include the option "not possible"

Indicator 2.4: Life Cycle Assessment

Q1. *To what extent was the indicator or life cycle tool easy and logical to use?*

In total 31 testers reported that they tested indicator 2.4. The majority of these testers considered that the indicator was 'easy and logical to use' to a moderate or greater extent. The calculation method, standards and unit of measurement received the highest positive approval from the testers. A notable number of testers considered that there to have been an issue with the reporting format.
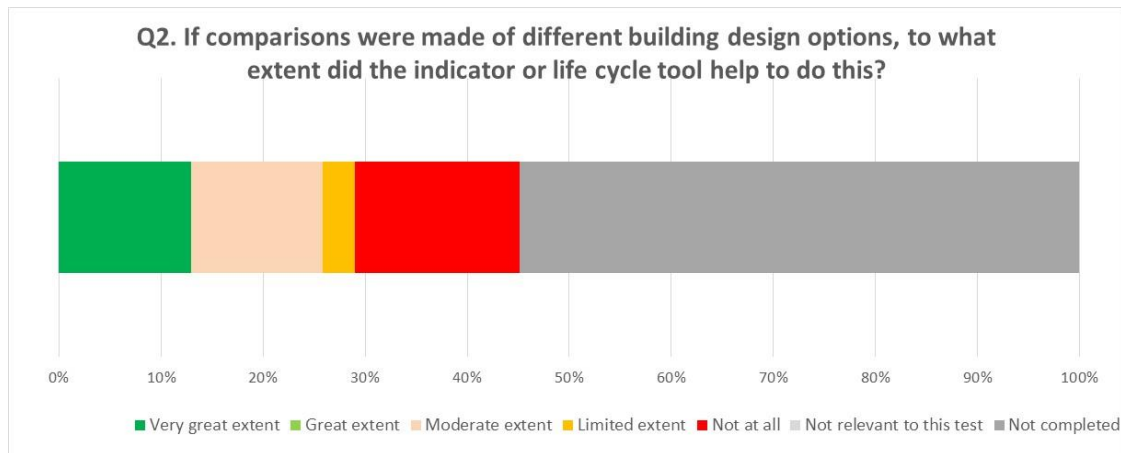
The response to questions 1.6 and 1.7 on Levels 2 and 3 was much lower. Feedback from those that tested at these levels and that responded was in general that the indicator was easy and logical to use to a moderate of greater extent. There were, however, more testers that responded that it was '*not at all*' easy or logical to use.

Q1. To what extent was indicator 2.4 easy and logical to use?
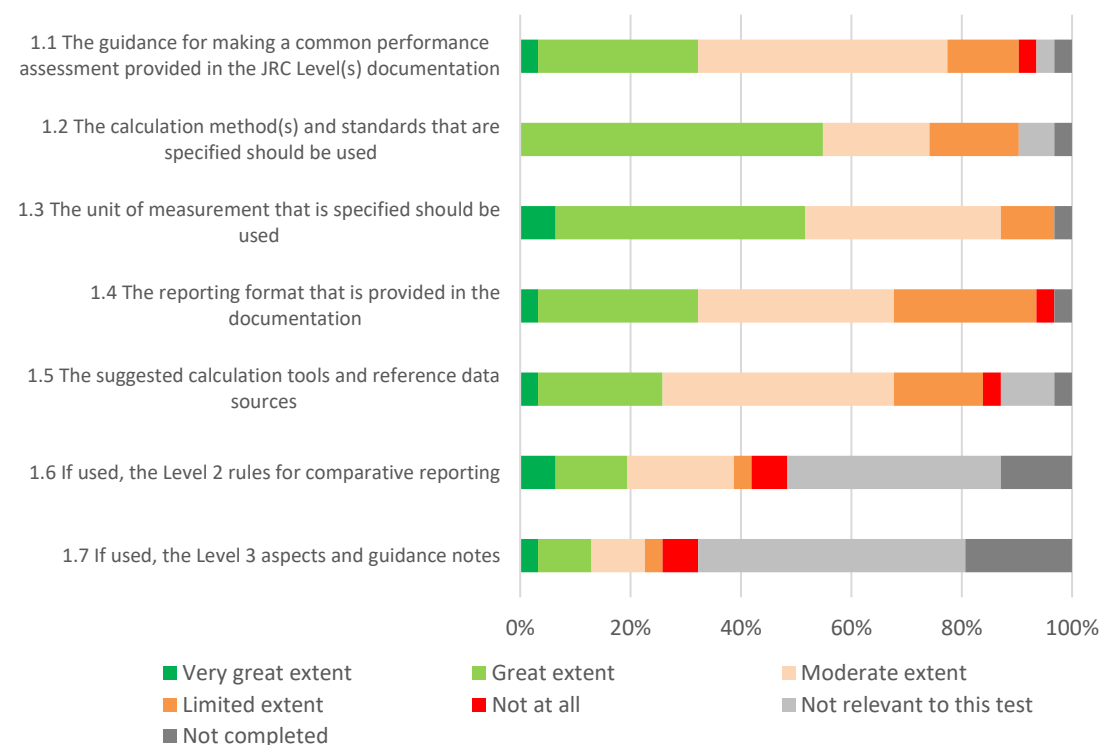
Q2. *If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?*

Of the 14 testers that responded to this question about 30% considered that it helped to a very great extent, another 30% to a moderate extent, and the rest that it helped to a limited extent or not at all.
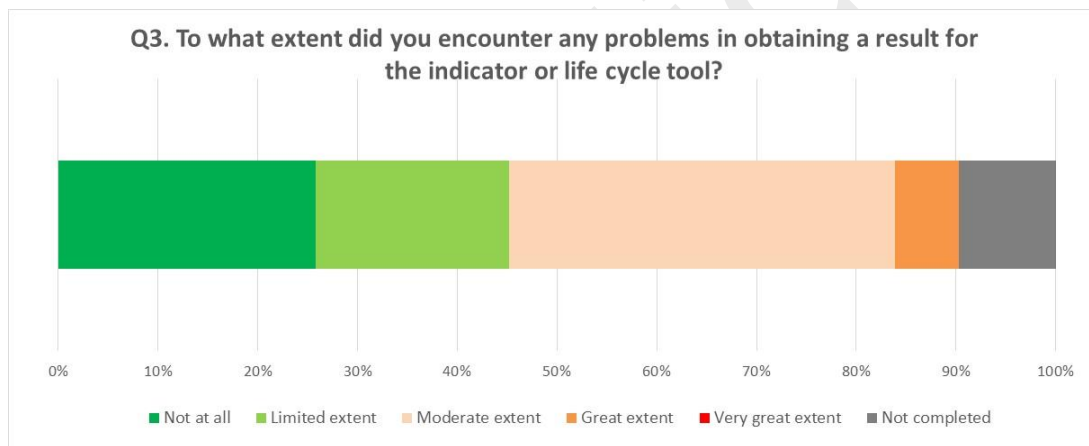
Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 28 testers that responded to this question, just under half only encountered problems to a limited extent or not at all. This fraction was proportionally similar to those who encountered problems to a moderate extent.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

In total 13 testers identified the problems they had encountered. In Table 55 their responses have been clustered under the main themes that could be identified, together with a summary of the main problems and also the workarounds put forward.

It can be seen that main problems related to data collection, calculations and the reporting of results.
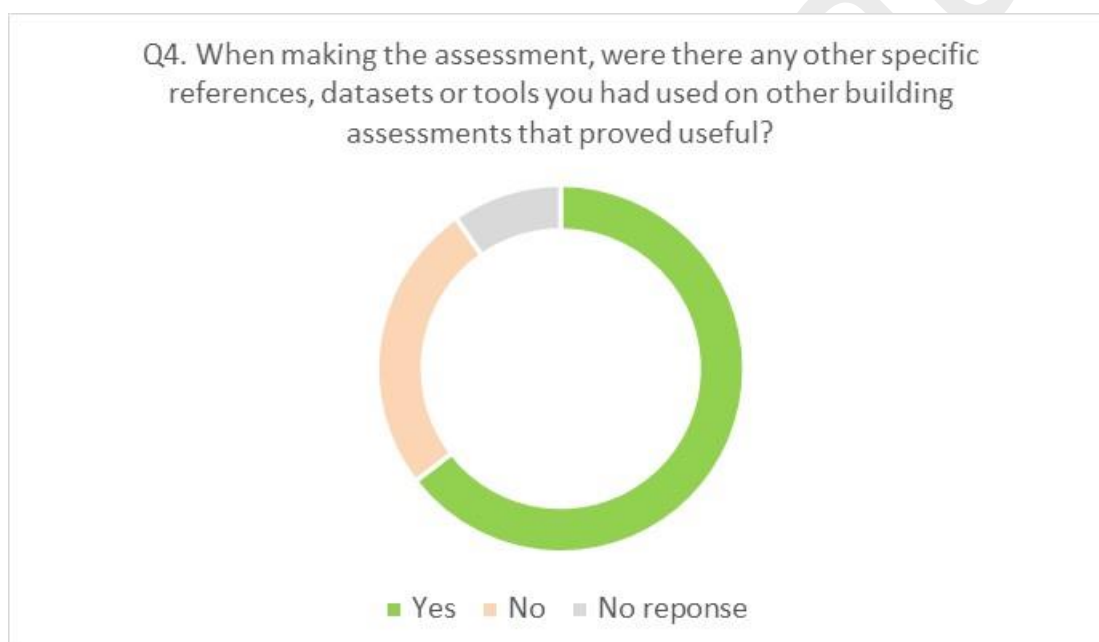
Table 55. Q3 open response to identify the main problems encountered and how they were overcome by testers

Theme that could be identified	Number of testers	Problems and workarounds identified by testers
Data	**5**	– Lack of data – Reliability of information (2) – Biogenic GWP – Mismatch with previous study

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Environmental indicators	4	– Mismatch with standards and workload to quantify them (3) – Mismatch with LCA tools
Reporting of results	4	– Missed alignment with existing LCA tools – Insertion of negative values – Reference to IPMS B3 (2)
Guidance	2	– Terminology (CtC) – Reference time (50 years v. 60 years)

Q4. *When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?*

More than 70% of the 28 respondents to this question had found previous assessments to be useful. Amongst those that identified what they had used (see Table), the majority referred to LCA tools and studies.

Please specify useful resources from previous projects

Table 56. Q4 open response to identify the extent to which testers already had access to the required results and data

Source of the results/data	Number of resources cited	Specific resources identified
LCA tools and databases	12	– One Click (4) – GaBi (3) – LCA byg – MMG+ – EQUER – Bionova – ökobaudat
Other tools	7	– Energy simulation tools – Internal software – Steligence

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Building certification	**6**	– HQE (2) – DGNB (2) – E+C- (2)
Methods and data	**4**	– EN 15978 – PEF4Buildings Project (DOI: 10.2779/23505) – IEA EBC Annex 72 (DOI: 10.1088/1755-1315/323/1/012037) – Previous studies (2)

Q5. *To what extent did you already have access to the required results from other assessments of the building?*

The majority of respondents considered that they already had access to the required results to a great or very great extent. A smaller but notable proportion responded 'not at all'. Of those that identified their sources (see Table), the majority referred to data obtained from energy reports of various types followed by building certifications.
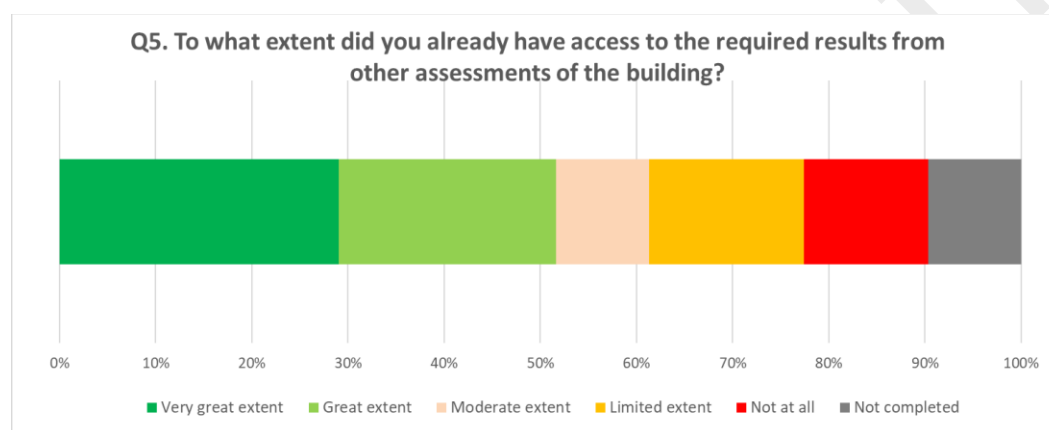
Please identify the source of results that were already available

Table 57. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of testers	Specific resources identified
LCA resources	**9**	– Bionova – LCA Byg (2) – SimaPro, – MMG+ – Previous studies (6), including PEF and IEA EBC Annex 72
Building certification	**4**	– DGNB (2) – E+C- (2)
Information relating to other indicators	**5**	– Building description – Energy consumption data (3) – BOM (3)
Other	**2**	– Steligence – EFIR project

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Q6. *If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?*

27 testers responded to this question. In the majority of cases the standards, data and tools appear to have been readily available to a great or very great extent. Some effort was only required in a small but notable proportion of cases.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

Legend:
- Already had them
- Easy to obtain
- Some effort to obtain
- Difficult to obtain
- Not possible to obtain
- Not relevant to this test
- Not completed
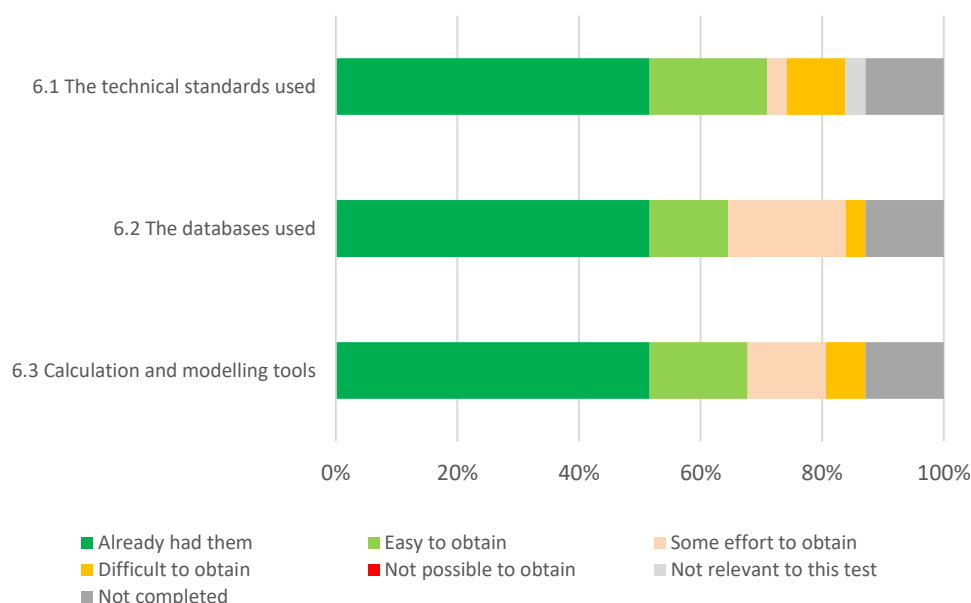
Q7. *If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?*

17 testers responded to this question as having had to purchase something. In the majority of cases the cost of the standards, tools and/or data purchased was not considered a barrier. However, there were a small but notable proportion of respondents that considered them as the main factor acting as a barrier, particularly for calculation and modelling tools.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?

Legend: Not at all | One of the factors | The main factor | Not completed
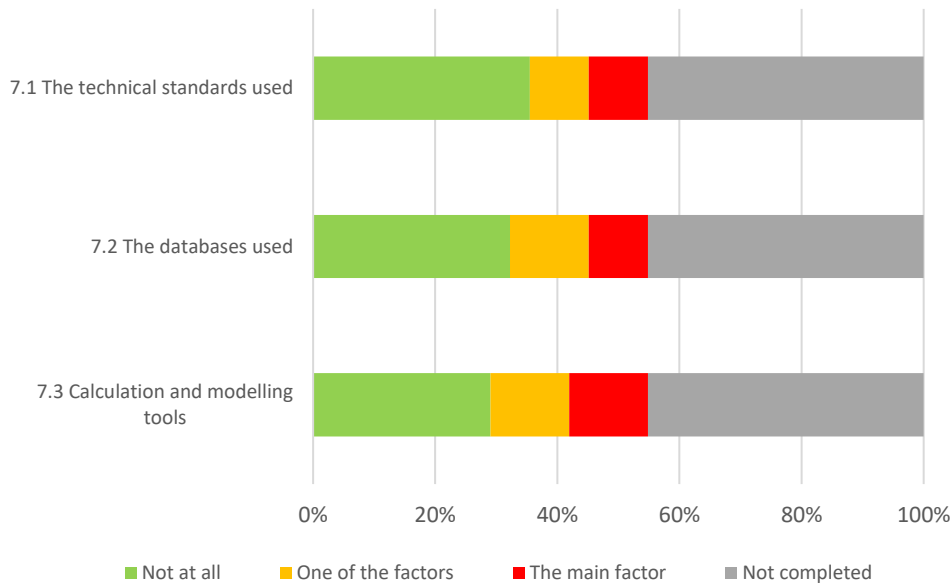
Q8. _How would you describe the previous experience of the test team with similar indicators or life cycle tools?_

There were 27 testers who responded to this question. This indicator was relatively familiar to most testers, with extensive previous experience being cited in the majority of cases. A small but notable number of testers stated that they had no previous experience.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend: Extensive previous experience | Some previous experience | Limited previous experience | No previous experience
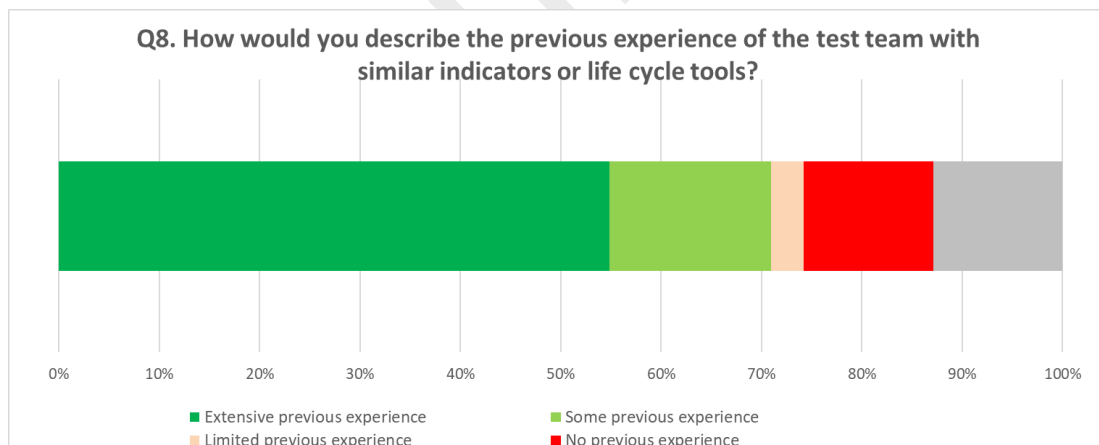
Q9. _Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?_

The majority of the 28 testers that responded to this question considered that additional training and support was not required or only to a limited extent. A small but notable proportion required training and support to a moderate or great extent, likely reflecting those who responded in Q8 that they had no previous experience.

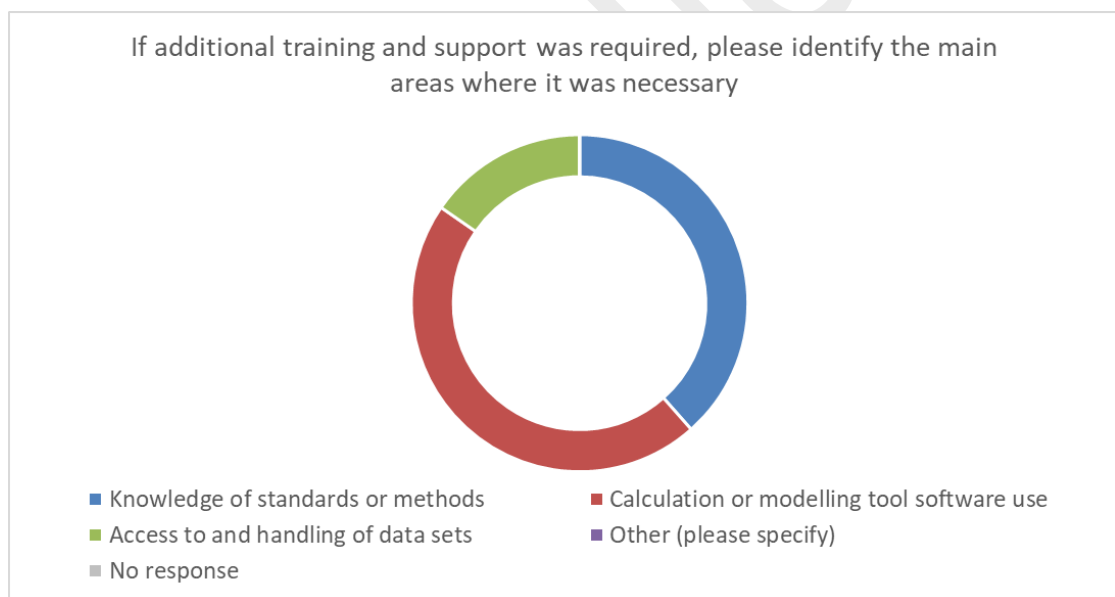Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend: Not at all · Limited extent · Moderate extent · Great extent · Very great extent · Not completed
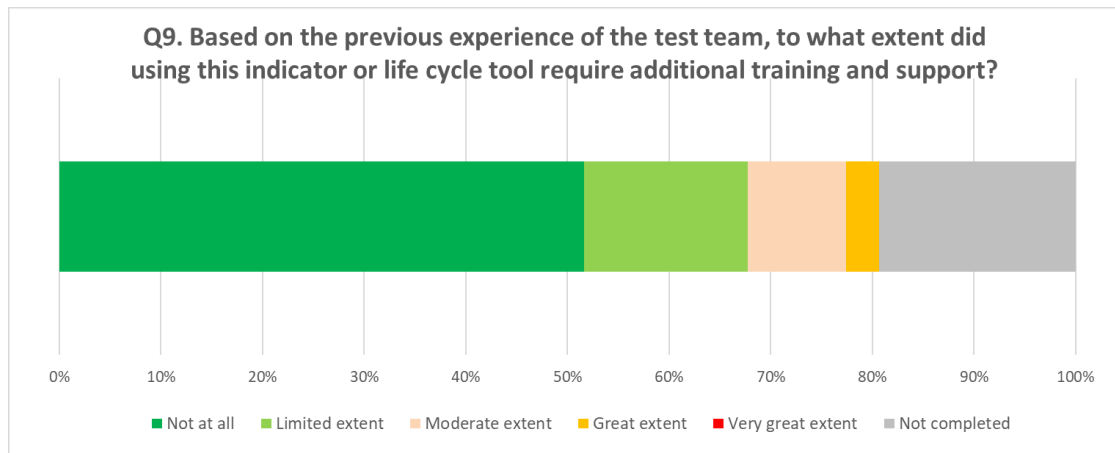
If additional training and support was required, please identify the main areas where it was necessary:

Of the 13 testers that cited areas where training and support were necessary, the majority cited 'calculation or modelling tool software use' followed by 'knowledge of standards or methods'. Further suggestions for the training and support necessary are clustered in Table . Training needs mainly related to familiarity with reference standards and to the use of LCA tools.

If additional training and support was required, please identify the main areas where it was necessary

Legend: Knowledge of standards or methods · Calculation or modelling tool software use · Access to and handling of data sets · Other (please specify) · No response

### Please identify the type of training and/or support that was needed

Table 58 Q9 open response to identify training and support needs

| Broad type of training or support	Number of needs cited	Specific need identified
Software use	**3**	– Not specified
Standards	**3**	– Introduction to the basics of the LCA methodology – General studying of literature (2)

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Q10. *If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool.*

Of the 17 testers that provided time estimates it can be seen that 50% required up to 5 person days and 75% up to 8.5 person days. The maximum was 14 person days and the average was 5.6 person days.
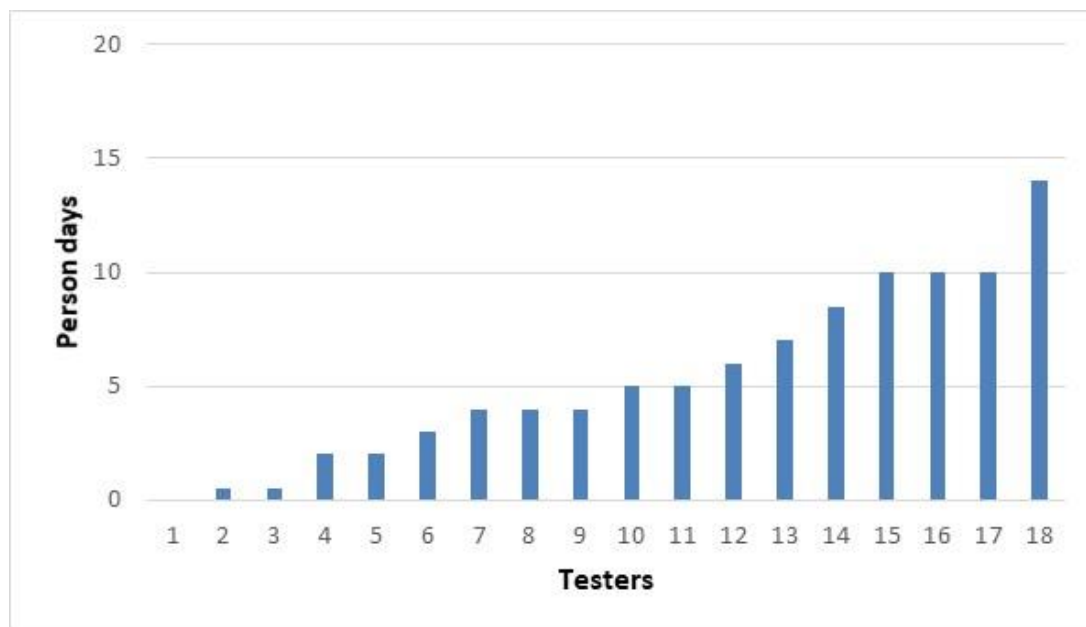
Of the 12 testers that provided cost estimates, 50% assigned up to € 2460 and 75% up to € 5000. The maximum was € 8000 and the average was € 3172.
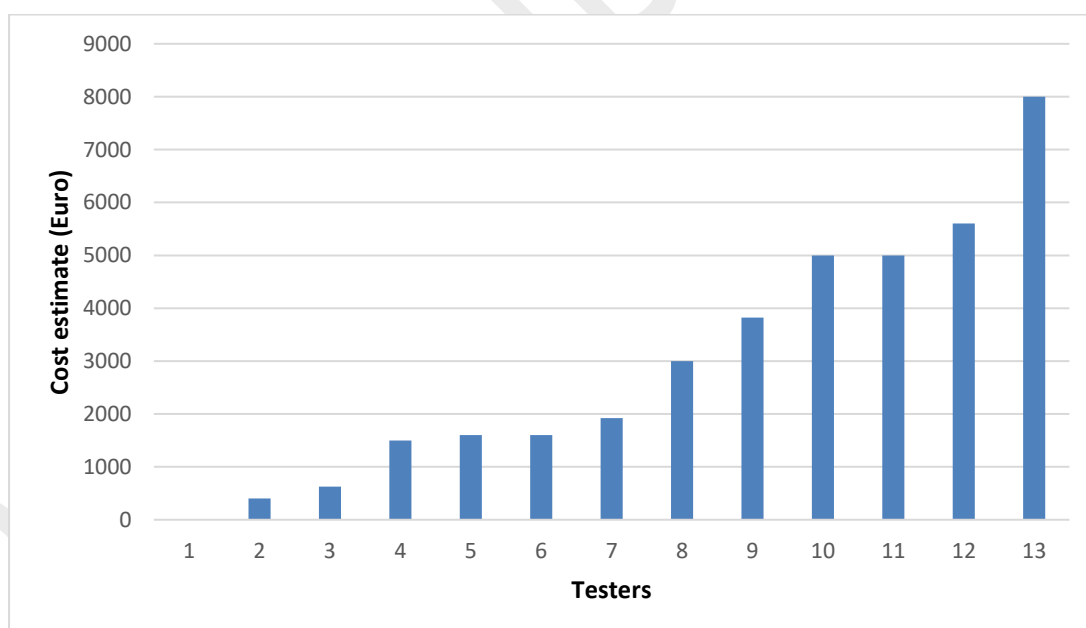
Q11. *Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use.*

Amongst the 17 testers that made suggestions for improvements, the majority made reference to the concept itself of the indicator and to the guidance provided.

First of all, it was indicated that "Cradle to cradle" represents a protected label scheme. A revision to a more neutral wording (e.g. "Full LCA", "Comprehensive LCA", "Cradle-to-grave"-LCA or something similar) would prevent a labelling conflict.

Many testers also requested to clarify and harmonise rules and called for a broader consideration of benchmarks of performance for all Level(s). It was also pointed out that indicator 1.2 is redundant if a full LCA is carried out, so that there should be the option to neglect it.

One tester referred to the revised EN 15804 standard, which encourages a whole cradle to grave approach, and suggested not to neglect important life cycle stages through the promotion of simplified approaches. Other testers highlighted that the inclusion of external works leads to impaired comparability of results on building level and that what really matters for building is to have a comprehensive and accurate BoM. Moreover, a certain flexibility in the selection of reference service lives of buildings might be necessary.

An observation was also made with respect to the data quality evaluation, which was considered not trivial and subjective since it depends on the expertise of the applicant.

A significant amount of suggestions also addressed methods, tools and data. Many testers called for:

- An alignment with the environmental metrics used in EN 15804
- The provision of information about the availability and robustness of tools and databases and facilitation of the access to them.

Some testers also suggested to make Level(s) compatible with existing LCA tools and to refer to BIM processes.

Finally, suggestions for improving the reporting of results included:

- Aligning the numbering of the life cycle tools in the guidance and reporting tool
- Specifying the reporting needs depending on the Level of assessment
- Splitting the results into sub-stages (e.g. B1-B5, B6, B7), also to allow comparison between embodied and operational impacts.

Table 59. Q10 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	*Number of improvements cited*	*Specific resources identified*
Concept and guidance	**22**	– Provide clearer guidance for calculating and reporting results for Level(s) 1, 2 and 3 (x4) – In Level 1 there should be the possibility to perform either a full or simplified LCA because benchmarks and comparison between design options are needed to make the assessment meaningful (also for Level 1) (x2) – The reporting of indicator 1.2 is redundant if a full LCA is carried out and there should be the option to neglect it (x2) – "Cradle to cradle" represents a protected label. A revision to a more neutral wording such as "Full LCA", "Comprehensive LCA", "Cradle-to-grave"-LCA would prevent labelling issues (x2). – The revised EN 15804 standard encourages a whole cradle to grave approach. Important life cycle stages should not be neglected through simplified approaches – Point out that LCA is most useful in the pre-design phase as decisions made at this stage have the most influence on the environmental performance of a project. The details of some components (external works, guardrails, gutters, ducts...) are

		unknown at this stage and have little influence on the LCA results.
		– Align reference service life to the current DGNB practice (generally speaking are 50 years reference service life of office buildings more probable than 60 years)
		– The analysis duration of 60 years is short compared to the life of the structure (designed with safety factors to exceed 200 years). This can lead to errors in the evaluation.
		– Allow flexibility in the selection of reference service lives
		– Exclude "external works" from the scope of the LCA. Inclusion of external works leads to impaired comparability of results on building level.
		– Focus on what matters for building LCA: a comprehensive, accurate, complete BoM including a very detailed list of all installed materials. Without that the quality of the building LCA cannot be assessed.
		– Data quality evaluation is not a trivial task since depends on i) data quality of background datasets, ii) representativeness of background datasets, iii) precision and accuracy of data collection, iv) uncertainty of the environmental indicator addressed. A method similar to that of the Environmental Footprint methodology would require significant effort. Moreover, the data quality rating always represents a subjective valuation strongly dependent on the expertise of the applicant.
		– Set benchmarks for comparability and motivation for improvement (x4).
Methods, tools and data	16	– Align the environmental metrics to EN 15804 (x6) – Provide information about availability and robustness of tools and databases and facilitate access to them (x6) (e.g. compliance with EN 15804 to ensure consistent EoL modelling; or refer to EF-database with distinct EoL-formula) – PEF compliant data is more accurate reference in comparison to EN 15804 compliant EPDs – Make Leve(s) compatible with existing LCA tools (x2) – A multi-disciplinary knowledge and the involvement of the whole team are needed. Applying the BIM process with specific rules for exporting data in an LCA calculation software would make the analysis easier.
Reporting of results	7	– Align the numbering of the tool between guidance and reporting tool – Specify reporting needs depending on the Level of assessment – Split results in sub-stages (e.g. B1-B5, B6, B7) (x3), also to allow comparison between embodied and operational impacts (x2)

Q12. *To what extent did Level 2 prove to be useful in making comparisons between buildings?*

4 testers indicated that Level 2 was useful in making comparisons between buildings to a limited extent or not at all. 1 tester considered this Level useful to a very great extent.

If the value was moderate or higher, please identify how its use influenced the results

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A tester reported that very interesting outcomes were obtained since the building was not performing as expected. Further investigation by the building owner would be very much justified because of this study.

The following issues were also identified:

- A critical review cannot really be performed within a reasonable budget;
- Elementary flows are not covered in a harmonised way in different databases. This causes some bias in the evaluation of impacts which should be handled in Levels 2 and 3, particularly if building performance is compared in different countries.

Q13. To what extent did Level 3 prove to be useful in making comparisons between buildings?

3 testers indicated that Level 3 was useful in making comparisons between buildings to a very great or to a great extent. Another tester considered this Level useful to a limited extent.

If the value was moderate or higher, please identify how its use influenced the results

The same considerations made for Indicator 1.2 were made by testers. Moreover, since LCA provides decision support it must be as precise as possible.
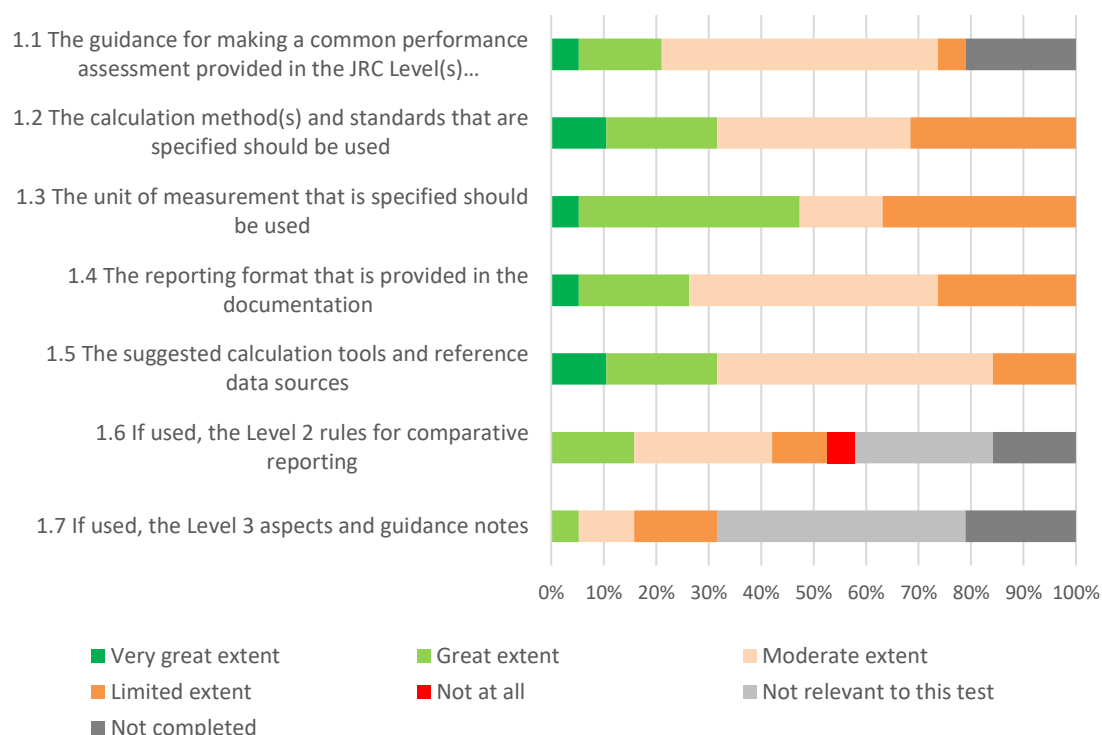
Indicator 6.1 Life Cycle Cost (LCC)

Q1. To what extent was the indicator or life cycle tool easy and logical to use?

Overall, 19 testers reported that they had tested indicator 6.1. In general, the majority of the testers considered that to a moderate or greater extent the guidance, method and reporting format were 'easy and logical to use'. The unit of measurement received the highest overall positive response. However, a notable proportion of testers considered this only to a limited extent for the calculation method, unit of measurement and the reporting format – highlighting a potential barrier for a subset of testers.

The response to questions 1.6 and 1.7 in relation to Levels 2 and 3 was lower. The response for Level 2 was on balance positive. Level 3 appears from the response to have been the most challenging to use.
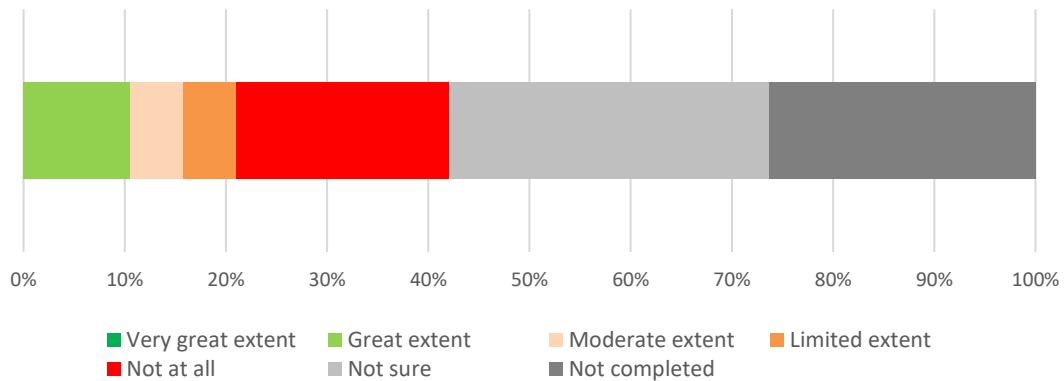
Q1. To what extent was indicator 6.1 easy and logical to use?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not relevant to this test
- Not completed

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Only 14 testers responded, which may have been because design decisions and costings had already taken place before making the test. Of those that responded it provided, for the majority, limited or no help at all.

Q2. If comparisons were made of different building design options, to what extent did the indicator or life cycle tool help to do this?

Very great extent · Great extent · Moderate extent · Limited extent
Not at all · Not sure · Not completed

Q3. *To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?*

Of the 18 testers that responded, the majority only encountered problems to a limited extent, if at all.

Q3. To what extent did you encounter any problems in obtaining a result for the indicator or life cycle tool?

Very great extent · Great extent · Moderate extent
Limited extent · Not at all · Not completed
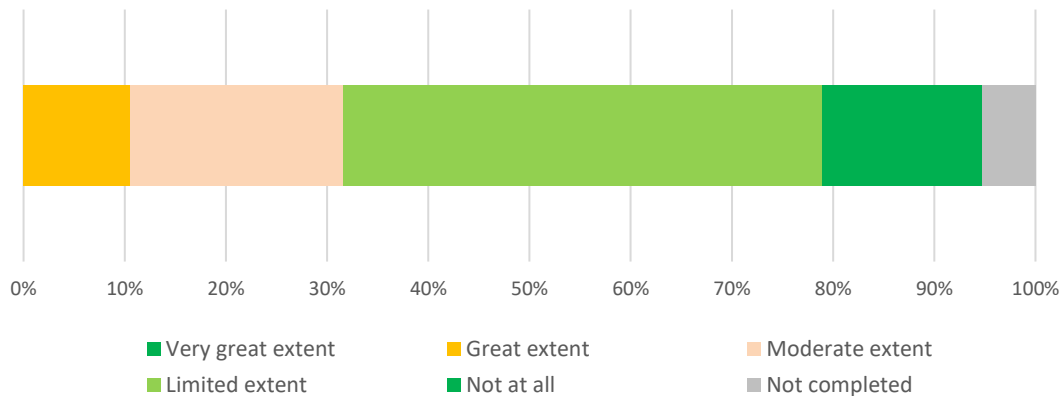
Open response: If the problems were moderate or higher, please identify the main problems encountered and, if relevant, how you overcame them or got around them.

There were only 7 tester responses to this open question.

3 issues were cited relating to the assumptions required to make calculations. The assumptions to use should be consistent and the default rates to use clearer. It was queried whether using 2015 as the reference year made sense if there was no intention to compare performance with other buildings.

2 issues were cited relating to the use of existing calculation tools. In one case, a national tool did not provide all of the output figures required. In another the discount rate and assumptions were different.

1 further issue cited was that a tester had experienced a problem understanding which data or results were needed in which field.

Q4. _When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?_

There were 18 respondents to this question. The majority found previous assessments to be useful. This may be because they used an existing calculation tool from an assessment scheme or tool developed at national level, as can be seen from Table , which categorises the 14 open responses to this question.

Q4. When making the assessment, were there any other specific references, datasets or tools you had used on other building assessments that proved useful?

- Yes
- No
- No response
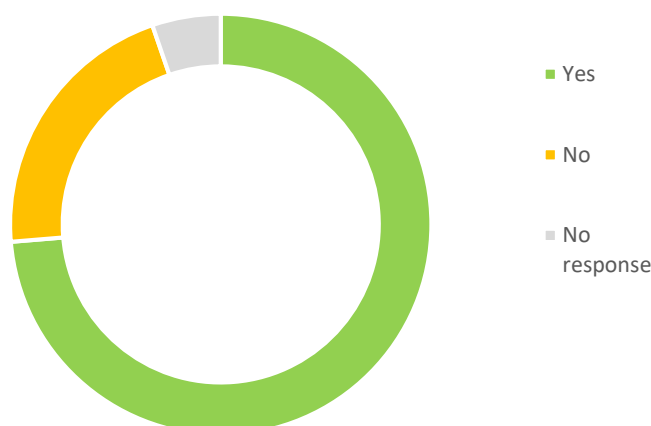
Please specify useful resources from previous projects

Table 60. Q4 open response to identify the extent to which testers already had access to the required results and data
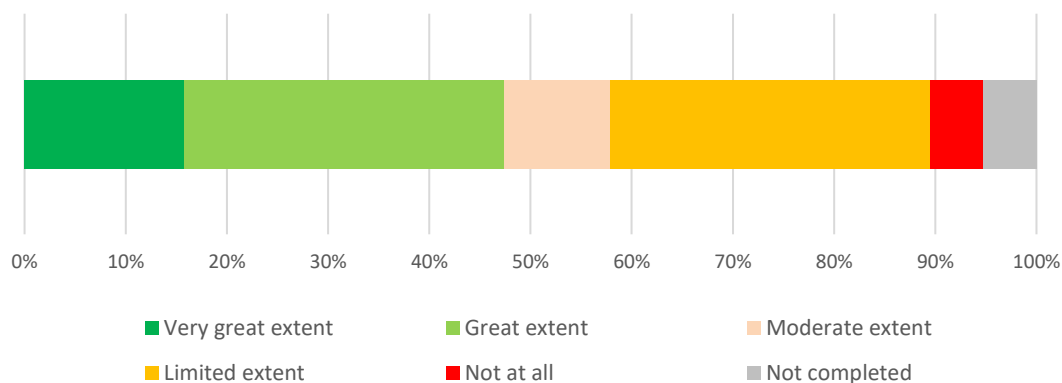
Source of the results/data	Number of resources cited	Specific resources identified
Assessment scheme LCC tool	**7**	– DGNB ECO1.1 – Life cycle cost tool (5) – DGNB certification – DGNB standard conditions
National LCC tool	**5**	– LCC byg (Denmark) (5)
Private LCC tool	**3**	– DGNB method – One Click LCA software – Propietary tool

Q5. _To what extent did you already have access to the required results from other assessments of the building?_

There were 18 respondents to this question. Although in the response to Q4 resources from other assessments were found to be useful, for the test around 30% of respondents appreared to have had to obtain new results – suggesting that in the tests where the results were already available the source was a tool such as the DGNB calculator.

Q5. To what extent did you already have access to the required results from other assessments of the building?

Legend:
- ■ Very great extent
- ■ Great extent
- ■ Moderate extent
- ■ Limited extent
- ■ Not at all
- ■ Not completed

### *Please identify the source of results that were already available*

Table 61. Q5 open response to identify the source of existing results and data

Source of the results/data	Number of testers	Specific resources identified
Drawings and cost plans	5	− Structural and architectural drawings, maintenance and budgeted upkeep cost from the owner (2) − Documentation from the overall building design − From the building project − Project costs from the tender offer
Assessment scheme	3	− Similar building assessed using DGNB LCC criterion (2) − DGNB LCC criterion and tool
National LCC too	2	− LCCbyg (2)

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?

There were 16 responses to this question. In just over two thirds of the responses the standards, data and tools appear to have been easy to obtain or testers already had them. In no cases was it not possible to obtain what was needed for the test.

Q6. If you had to obtain the standards, data and/or tools in order to make the Level(s) assessment, how readily available were they?
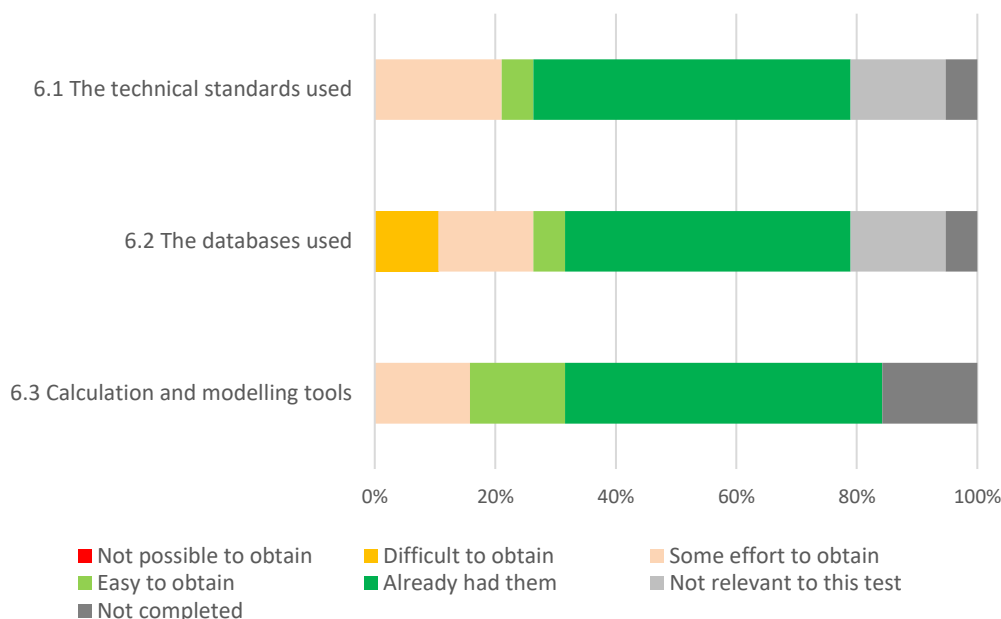
Q7. _If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?_
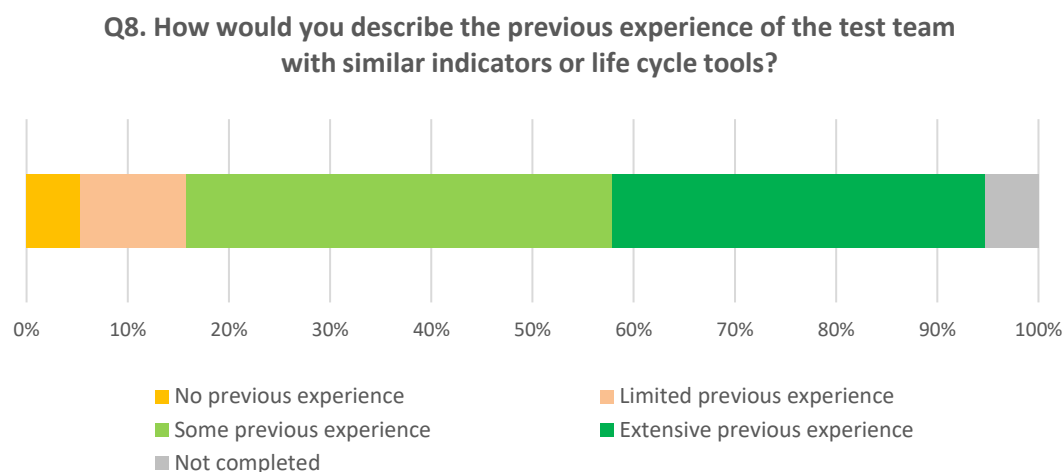
The response was lower to this question (12). For those that had to purchase something in support of their test, in the majority of cases cost was not considered to have created a barrier to their use. In the cases where cost was cited as a factor, it was only one amongst others.

Q7. If you had to purchase the standards, data and/or tools, to what extent was their cost a barrier to using them?
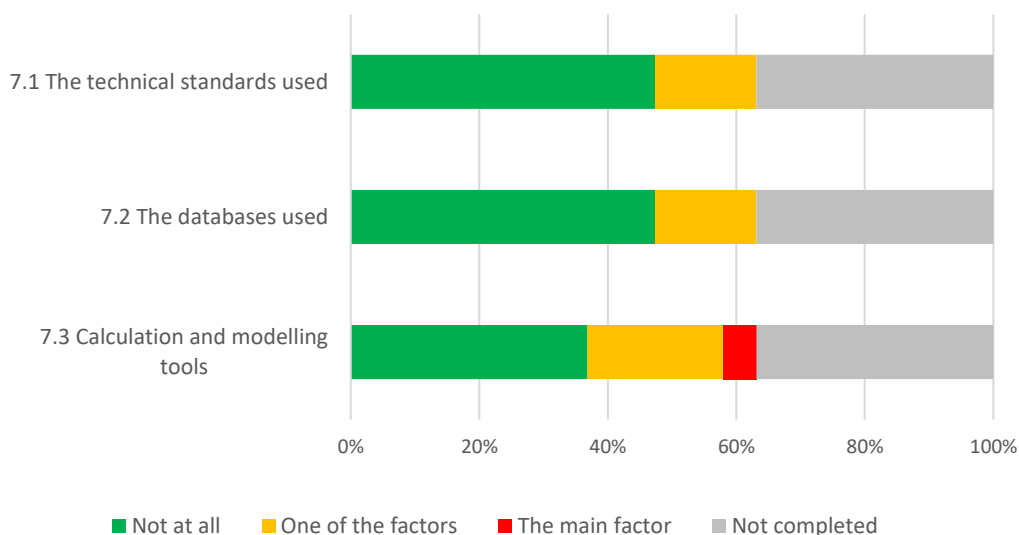
Q8. *How would you describe the previous experience of the test team with similar indicators or life cycle tools?*

There were 18 respondents to this question. The response clearly shows that for those that tested it this indicator was relatively familiar to the majority, with some or extensive previous experience being cited.

Q8. How would you describe the previous experience of the test team with similar indicators or life cycle tools?

Legend:
- No previous experience
- Limited previous experience
- Some previous experience
- Extensive previous experience
- Not completed

Q9. *Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?*

There were 18 respondents to this question. The response clearly shows that for those that tested it majority considered that additional training and support was not required or, if so, only to a limited extent.

Q9. Based on the previous experience of the test team, to what extent did using this indicator or life cycle tool require additional training and support?

Legend:
- Very great extent
- Great extent
- Moderate extent
- Limited extent
- Not at all
- Not completed
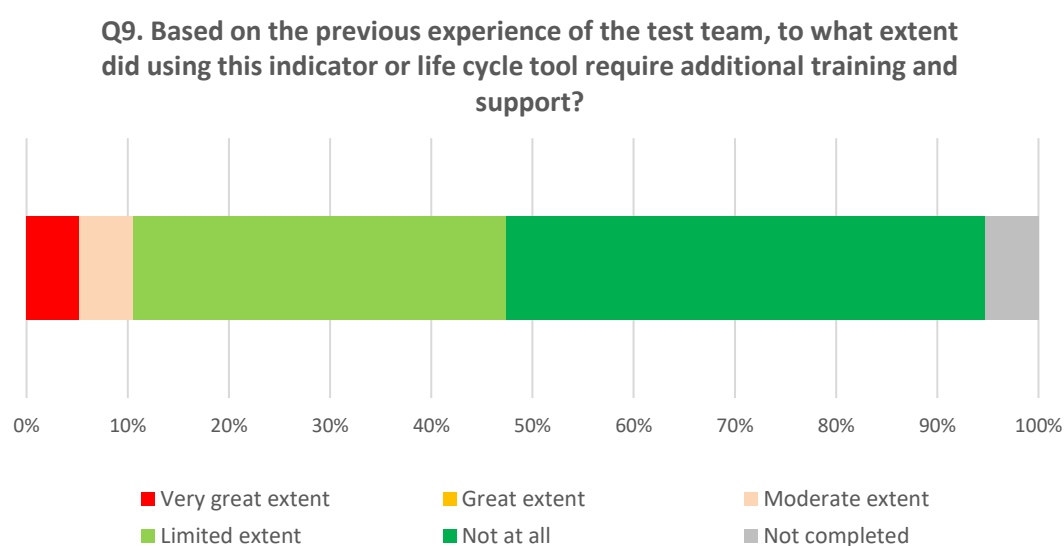
If additional training and support was required, please identify the main areas where it was necessary:

Of the 12 testers that cited areas where training and support were necessary, 5 cited '*access to and handling of datasets*' reflecting the dependence of the result on compiling quality and comprehensiveness of the underlying cost data. 3 testers cited training in '*calculation or modelling tool software use*'.

Only limited (6) further suggestions for training and support were made in the open response box.

If additional training and support was required, please identify the main areas where it was necessary


- Knowledge of standards or methods
- Calculation or modelling tool software use
- Access to and handling of data sets
- Other (please specify)
- No response
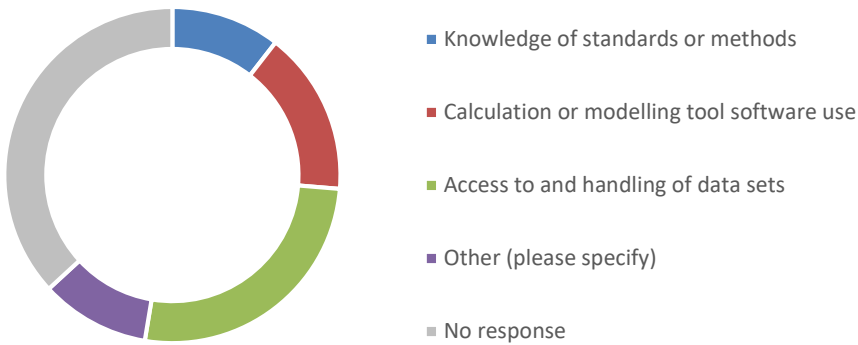
**Please identify the type of training and/or support that was needed**

Not enough valid responses were received to allow for an analysis for this response.

Q10. _If possible please provide an estimate of the cost and/or time that were required to use this indicator or tool_.

Of the 8 testers that provided time estimates it can be seen that five required up to 3 person days and there were then three further testers that required between 7-10 person days. The average was 4.1 person days.
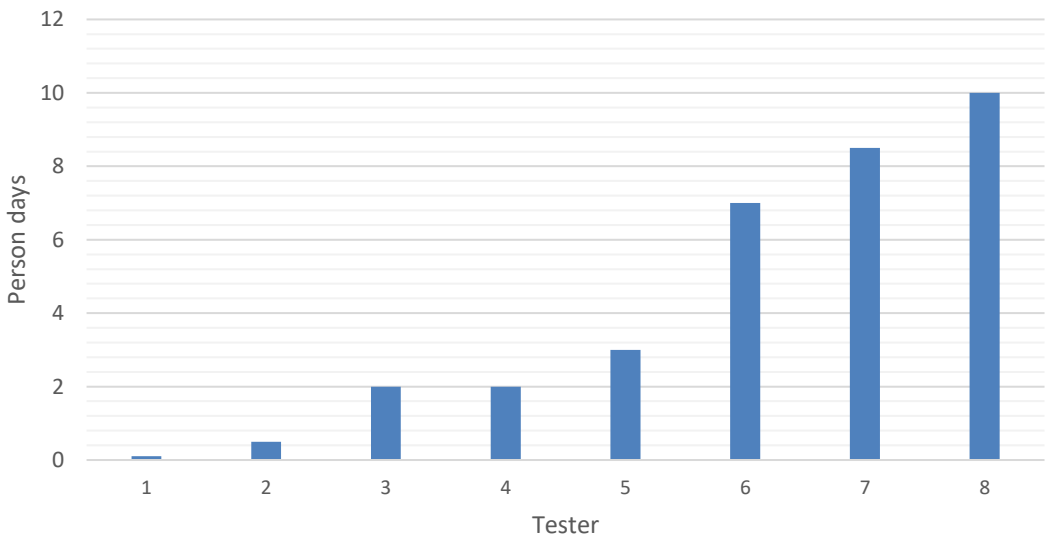
Of the 6 testers that provided cost estimates, one assigned no cost, three assigned up to €1.000, and two assigned higher estimates of €3.825 and €5.000. The average was €1.808.
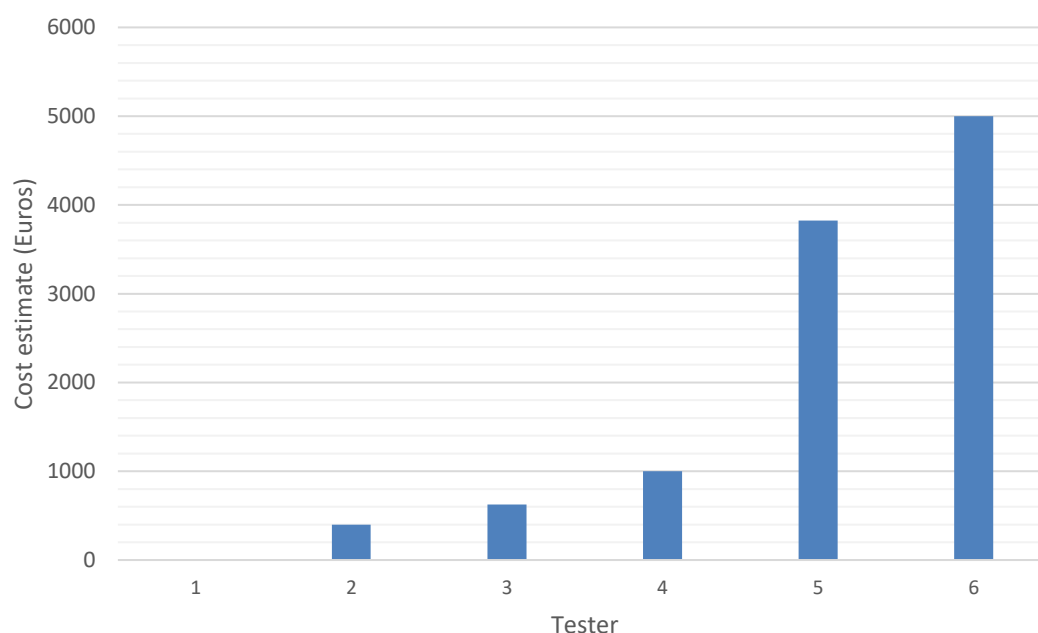
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Q11. _Now that you have tested the indicator/life cycle tool, please make any suggestions for improvements that would make it easier to use_.

Amongst the 7 testers that made suggestions for improvements, the most feedback received was clustered around the reference values to be used for calculations (4) and the life cycle stages and costs (3). Suggestions also related to the (Level(s)) reporting tool, other calculation tools and the guidance provided to users.

In regards to the _reference values to be used_, the need for guidance on exchange rates with the Euro was deemed necessary and in general, conventions on price assumptions at a national level as well. The reference study period should be harmonised at 50 years with the LCA indicator and national methods.

In regards to the _life cycle stages and costs_, consideration of refurbishment and EoL costs was problematic and difficult to establish robust estimates. Clearer definitions were considered necessary to support compatibility with national calculators.

In regards to the other suggestions, there is the potential to increase compatibility with existing tools or to even provide/integrate a tool into Level(s). The possibility to provide pre-defined and data and reference values was mentioned. A differentiation between new and existing buildings, as well as greater flexibility to add other types of costs, although not detailed, would be useful.

Table 62. Q11 open response to suggest improvement that would make the indicator easier to use

Source of the results/data	Number of improvements cited	Improvements that would make the indicator easier to use
Reference values to be used	4	– Guidance on exchange rate for Euro to be used (2) – For Level 2 conventions regarding energy prices, discount and interest rates, wages, inflation, etc. on country level are necessary. – Harmonise the reference study period at 50 years

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Life cycle stages and costs	3	– Consideration of refurbishment and EoL costs in LCC is problematic and it is difficult to obtain robust estimates (2) – Provide clear definitions in order to allow for compatability with national calculators
Reporting tool	2	– Differentiation between existing and new buidlings would be useful. – The excel template has to have greater flexibility in adding additional columns for other types of costs.
Calculation tools	2	– Improve the potential to report using existing tools – Provide a calculator tool for the indicator with predefined data and reference values
Guidance	2	– Consistency in guidance and with LCA for reference study period and discount rate – Requires improvement overall