European
Commission

JRC TECHNICAL REPORTS

Level(s) – A common EU framework of core sustainability indicators for office and residential buildings

User Manual 1: Introduction to the Level(s) common framework
(Publication version 1.1)

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January 2021




European Commission
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How to cite: Dodd N., Donatello S. & Cordella M. 2021. Level(s) – A common EU framework of core sustainability indicators for office and residential buildings, User Manual 1: Introduction to the Level(s) common framework (Publication version 1.1)

Title
Level(s) – A common EU framework of core sustainability indicators for office and residential buildings, Part 1: Introduction to the Level(s) common framework (publication version 1.0);

Abstract

Developed as a common EU framework of core indicators for assessing the sustainability of office and residential buildings, Level(s) can be applied from the very earliest stages of conceptual design through to the projected end of life of the building. As well as environmental performance, which is the main focus, it also enables other important related performance aspects to be assessed using indicators and tools for health and comfort, life cycle cost and potential future risks to performance.

Level(s) aims to provide a common language of sustainability for buildings. This common language should enable actions to be taken at building level that can make a clear contribution to broader European environmental policy objectives. It is structured as follows:

1. Macro-objectives: An overarching set of 6 macro-objectives for the Level(s) framework that contribute to EU and Member State policy objectives in areas such as energy, material use, waste management, water and indoor air quality.

2. Core Indicators: A set of 16 common indicators, together with a simplified Life Cycle Assessment (LCA) methodology, that can be used to measure the performance of buildings and their contribution to each macro-objective.

In addition, the Level(s) framework aims to promote life cycle thinking. It guides users from an initial focus on individual aspects of building performance towards a more holistic perspective, with the aim of wider European use of Life Cycle Assessment (LCA) and Life Cycle Cost Assessment (LCCA) methods.

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Figure 1. The Level(s) document structure

How this Level(s) user manual works

Level(s) is a framework of core indicators of sustainability for buildings. It can be used to report on and improve the performance of new-build and major renovation projects. The supporting documentation has been designed to be accessible to all actors that may be involved in this process.

We recommend reading this user manual in order to have an introduction to the basic concepts behind Level(s) and how you can apply it to a building project. This material provides the following information:

1. What is Level(s) and how can it be used: The main aspects of performance addressed by Level(s), as well as the types of buildings and professionals it is aimed at.
2. The common language of sustainability: The basic concepts of the macro-objectives and indicators that form the basis for the common language and how they can be used.
3. How Level(s) works: What the levels are and how they can be used to compare, analyse and optimise performance
4. Thinking sustainability: Short briefings which can be used to learn about each of the following key concepts that underpin Level(s):
    - Whole life cycle and circular thinking.
    - Closing the performance gap.
    - How to achieve sustainable renovation.
    - How sustainability can influence value.

1. Introductory briefing 1: What is Level(s) and how can it be used?

Level(s) is the common EU framework of core sustainability indicators for buildings. In this briefing, the main aspects of performance addressed by Level(s), as well as the types of buildings and professionals it is aimed at, are described.

Level(s) is designed to enable professionals that play a role in the planning, design, financing and execution of building projects to make a clear contribution to broader environmental improvements at European level. It aims to establish a common language of sustainability for buildings by defining core indicators for the sustainability of office and residential buildings.

The Level(s) framework provides a set of indicators and common metrics for measuring the sustainability performance of buildings along their life cycle, assessing the following aspects:

- environmental performance
- health and comfort,
- life cycle cost and value, and
- potential risks to future performance.

1.1. Who can make use of it?

The Level(s) common framework has been designed with three main project actors in mind and has the potential to offer a range of advantages (see Table 1):

- Project design teams, including architects, engineers, quantity surveyors and specialist consultants.
- Clients and investors, including property owners, developers, managers and investors.
- Public policy makers and procurers, at national, regional and local level.

These actors encompass both public and private clients and managers of building projects. Throughout the guidance on use of the Level(s) common framework, instructions are provided which are orientated towards these target groups.

Table 1. Potential advantages of using the Level(s) framework

Project actors	Potential advantages of using Level(s)
Project design teams *(including project managers, architects, engineers and quantity surveyors)*	✓ It provides a simple structure that can be presented to clients in order to prioritise attention on sustainability aspects. ✓ It supports the user at each stage in a project, with guidance notes on how to make accurate performance assessments. ✓ It has a focus on the performance of the completed building, and the steps to be taken at design stage to ensure high performance. ✓ It provides flexibility in the level of detail at which sustainability aspects can be addressed in the design process
Clients and investors *(including property owners, developers and investors)*	✓ It provides a clear set of priority aspects of performance to focus attention on, forming a basis for instructing design professionals. ✓ It ensures transparency in the reporting of performance assessment, and the associated data, calculation methods and assumptions. ✓ It focusses on minimising the gap between design and occupied performance.

Project actors	Potential advantages of using Level(s)
	✓ It identifies how the <u>costs and risks associated with a building's performance</u> can be future proofed and managed to deliver long-term value. ✓ It provides <u>tools to identify opportunities</u> to extend the lifespan, improve the internal environmental quality and enhance the long term value of building assets.
Public policy makers and procurers *(at local, regional and national level)*	✓ It provides <u>a clear set of prioritised aspects of performance</u> to focus attention on, together with a standardised basis for setting requirements for new and renovated buildings to meet. ✓ It provides <u>the basis for actions and requirements</u> that can contribute to Member State, regional and local government carbon reduction targets as well as broader sustainability objectives. ✓ It focusses on <u>performance aspects that are of direct ongoing financial interest to public authorities</u> and agencies, such as operating and maintenance costs; ✓ It includes <u>indicators that measure comfort and wellbeing aspects of a building</u> and its internal environment, e.g. indoor air quality, thermal comfort. ✓ It provides recommendations on <u>how the performance of an occupied building can be monitored and surveyed</u>.

1.2. What can it be used for?

Level(s) is intended to provide you with a valuable set of information and data which can enable you to understand, improve and optimise the sustainability performance of a building. To report on the performance of a building project using Level(s) involves gathering, handling and processing a wide range of data relating to the performance of a building. Examples of data relevant to Level(s) includes those listed in the table below.

Table 2. Data points associated with building resource use and the indoor environment

Resource use	Associated data points
Energy and water use	- Consumption (calculated and monitored) - Related CO_2 equivalent emissions - Related costs
Building elements and materials	- Quantities (design and as-built) - Related CO_2 equivalent emissions - Related costs - Related service life estimates
Building designs and structures	- Adaptability features (contributing to an overall score) - Deconstruction features (contributing to an overall score) - Related costs
Maintenance plans	- Maintenance and replacement cycles - Related costs
The indoor environment	- Ventilation rates (calculated and monitored) - Tested building product emissions (design and as-built) - Air quality monitoring and sampling results - Thermal conditions (calculated and monitored) - Lighting and visual comfort conditions - Noise levels and acoustic comfort conditions

In addition to reporting your results, each building's performance can, for example, be analysed in order to support, amongst other options, the following:

- Design features and specifications that can improve performance.
- Hot spots of environmental impact along the life cycle.
- Scenarios for future performance that may be influenced by decisions at the design stage.
- Design decisions and choices that may influence indoor environmental quality.
- Short, medium and long term costs along the life cycle of the building.

The extent to which design performance estimates have been achieved when compared to as-built or measured performance.

2. Introductory briefing 2: The common language of sustainability

In this briefing, the strategic priorities of Level(s) – its 6 macro-objectives – are introduced and described. The 16 indicators that in turn allow the contribution of individual building projects to each of these macro-objectives are then introduced.

2.1. The 6 macro-objectives

The Level(s) common framework is based on 6 macro-objectives, which describe what the strategic priorities should be for the contribution of buildings to EU and Member State policy objectives in areas such as energy, material use and waste, water and indoor air quality. An overview of the macro-objectives is shown in Figure 1 below.

Figure 2. The 6 macro-objectives of Level(s)

For each of these strategic priorities, it is important that the contribution and performance of individual building projects can be measured. Indicators have therefore been developed that enable the measurement of performance under each macro-objective. Table 3 provides further information about their definition and scope.

Table 3. The definition and scope of each of the Level(s) macro-objectives

Macro-objective		Definition	Scope and focus
Macro-objective 1 **Greenhouse gas and air pollutant emissions along a buildings life cycle**		Minimise the total greenhouse gas emissions along a buildings life cycle[1], from cradle to grave, with a focus on emissions from building operational energy use and embodied energy.	Action at building level with a focus on the objectives of: • Near zero energy consumption during the use phase, supplemented by the contribution of cost effective and low/zero emission energy technologies and infrastructure. • Embodied greenhouse gas emissions along the buildings whole life cycle, including those associated with product manufacturing, maintenance, repair, adaptation, renovation and end of life. In assessing a building's performance, there shall be specific attention paid to the potential trade-offs between embodied emissions and use stage (operational) emissions, in order to enable the minimisation of total greenhouse gas emissions along the life cycle.
Macro-objective 2: **Resource efficient and circular material life cycles**		Optimise the building design, engineering and form in order to support lean and circular flows, extend long-term material utility and reduce significant environmental impacts.	Actions at building level with a focus on material efficiency and circular utility. This shall encompass actions along the life cycle relating to: • building design, • structural engineering and construction management, • construction product manufacturing, • replacement cycles and flexibility to adapt to change, and • the potential for deconstruction. The overall objective shall be to optimise material use, reduce waste and introduce circularity into designs and material choices.

[1] Life cycle greenhouse gas emissions are sometimes also referred to as '*whole life carbon*' or a '*carbon footprint*'

Macro-objective		Definition	Scope and focus
Macro-objective 3: **Efficient use of water resources**		Make efficient use of water resources, particularly in areas of identified long-term or projected water stress.	Actions at building level, in particular for buildings located in areas of continuous or seasonal water stress. This could combine efficiency measures to minimise water use, as well as supply-side measures such as grey water reuse and rainwater harvesting, designed to make use of alternative sources.
Macro-objective 4: **Healthy and comfortable spaces**		Create buildings that are comfortable, attractive and productive to live and work in, and which protect human health.	Actions at building level to address critical aspects of indoor environmental quality that influence occupier health, comfort and productivity, the first four of which have been identified being: • the quality of the indoor air for specific parameters and pollutants, • the degree of thermal comfort during an average year, • the quality of artificial and natural light and associated visual comfort, and • the capacity of the building fabric to insulate occupiers from internal and external sources of noise.
Macro-objective 5: **Adaptation and resilience to climate change**		Futureproof building performance against projected future changes in the climate, in order to protect occupier health and comfort and to minimise long-term risks to property values and investments.	Actions at building level to adapt and ensure resilience to the following risks: • increased overheating in summer and inadequate heating in winter, which could lead to discomfort and be detrimental to health, • increased risk of extreme weather events, which could compromise the security and integrity of building elements, and • increased risk of flood events, which could overwhelm drainage systems and damage structures and materials.
Macro-objective 6: **Optimised life cycle cost and value**		Optimise the life cycle cost and value of buildings to reflect the potential for long-term performance improvement, inclusive of acquisition, operation, maintenance, refurbishment, disposal and end of life.	Actions and decision-making at building level that are based on a long term view of the whole life costs and market value of more sustainable buildings, including: • achieving lower life-cycle costs and more productive and comfortable spaces to live and work in, and • having a positive influence on property market value appraisals and risk ratings.

2.2. The core indicators

The Level(s) common framework consists of 16 core indicators. Each indicator has been selected to measure the performance and contribution of a building towards a specific macro-objective. An overview of the indicators and their units of measurement is provided in the table below.

Table 4. Overview of the macro-objectives and their corresponding indicators and units of measurement

Macro-objective	Indicator	Unit of measurement
1: Greenhouse gas and air pollutant emissions along a building's life cycle	1.1 Use stage energy performance	kilowatt hours per square metre per year ($kWh/m^2/yr$)
	1.2 Life cycle Global Warming Potential	kg CO_2 equivalents per square metre per year (kg CO_2 eq./m^2/yr
2. Resource efficient and circular material life cycles	2.1 Bill of quantities, materials and lifespans	Unit quantities, mass and years
	2.2 Construction & demolition waste and materials	kg of waste and materials per m^2 total useful floor area
	2.3 Design for adaptability and renovation	Adaptability score
	2.4 Design for deconstruction, reuse and recycling	Deconstruction score
3. Efficient use of water resources	3.1 Use stage water consumption	m^3/yr of water per occupant
4. Healthy and comfortable spaces	4.1 Indoor air quality	Parameters for ventilation, CO2 and humidity Target list of pollutants: TVOC, formaldehyde, CMR VOC, LCI ratio, mould, benzene, particulates, radon
	4.2 Time outside of thermal comfort range	% of the time out of range during the heating and cooling seasons
	4.3 Lighting and visual comfort	Level 1 checklist
	4.4 Acoustics and protection against noise	Level 1 checklist
5. Adaptation and resilience to climate change	5.1 Protection of occupier health and thermal comfort	Projected % time out of range in the years 2030 and 2050 (see also indicator 4.2)
	5.2 Increased risk of extreme weather events	Level 1 checklist (under development)
	5.3 Increased risk of flood events	Level 1 checklist (under development)
6. Optimised life cycle cost and value	6.1 Life cycle costs	Euros per square metre per year (€/m2/yr)
	6.2 Value creation and risk exposure	Level 1 checklist

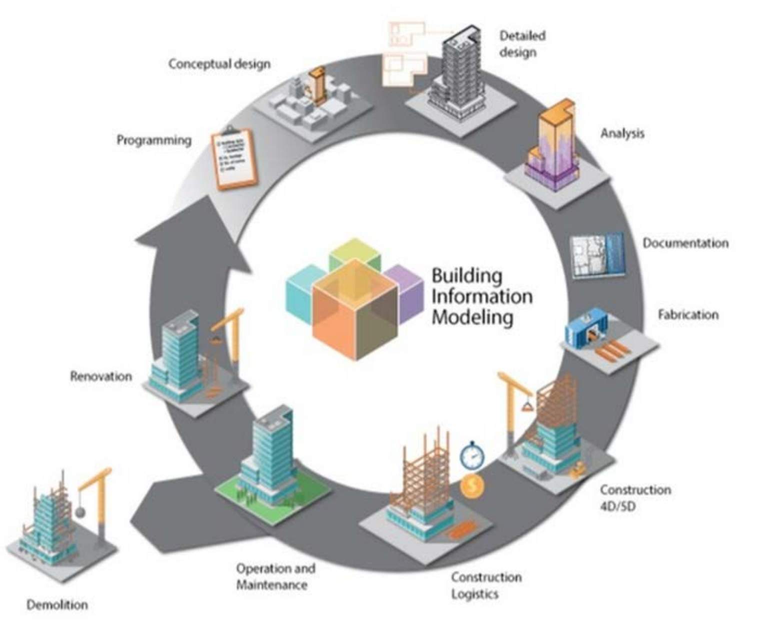
The majority of the core indicators have a single unit of measurement. However, there are some important exceptions, for which performance must be assessed and reported in a different way:

- Composite indicators (1.2, 2.2, 4.1): These indicators are more complex and difficult to reduce to a single unit of measurement. Instead they consist of several related units of measurement that must be read together to understand a building's performance.
- Qualitative assessments (4.3, 4.4, 5.2, 5.3, 6.2) These indicators do not currently have an agreed quantitative unit or units of measurement, so instead the results of a qualitative assessment can be reported.
- Information reporting (2.1): This indicator is designed to encourage users to handle and process specific items of data about their building as an aid to life cycle thinking.

2.3. A whole Life Cycle Assessment (LCA)

The Level(s) common framework takes a whole life cycle approach to the sustainability of buildings. To fully support this approach, the core indicators of macro-objectives 1, 2 and 3 are complemented by a holistic assessment of a building's environmental impact - a full Life Cycle Assessment (LCA) of a building. By making a LCA, the environmental impacts associated with a building can be quantified and the most significant areas – commonly referred to as "*hot spots*" – can be identified and used as the starting point for improving performance.

Table 5. The environmental macro-objectives and the Life Cycle Assessment (LCA) indicators

<table>
<tr><th>Macro-objectives 1-3: Full Life Cycle Assessment (LCA)</th><th>Cradle to grave Life Cycle Assessment (LCA): Impact categories</th></tr>
<tr><td>
</td><td>- Climate change
- Ozone depletion
- Acidification
- Eutrophication aquatic freshwater
- Eutrophication aquatic marine
- Eutrophication terrestrial
- Photochemical ozone formation
- Depletion of abiotic resources - minerals and metals
- Depletion of abiotic resources – fossil fuels
- Water use</td></tr>
</table>

3. Introductory briefing 3: How Level(s) works

In this briefing, the structure and way that the common framework is organised are introduced and described. A particular focus is on the three levels, which allows users to choose how advanced their assessment and reporting on the sustainability of a building can be.

3.1. The three 'levels'

The common framework is organised into three **levels**. The levels provide a choice as to how advanced the reporting on sustainability for the project will be. The three levels represent the following stages in the execution of a building project:

- **Level 1.** The **conceptual design** for the building project – the simplest level as it entails early stage qualitative assessments of the basis for the conceptual design and reporting on the concepts that have or are intended to be applied.
- **Level 2.** The **detailed design and construction** performance of the building – an intermediate level as it entails the quantitative assessment of the designed performance and monitoring of the construction according to standardised units and methods.
- **Level 3.** The **as-built and in-use** performance of how the building performs after completion and handover to the client – the most advanced level as it entails the monitoring and surveying of activity both on the construction site and of the completed building and its first occupants.

The basic idea is that the levels represent a professional journey from the initial concept through design, construction and then, after handover, to the reality of the completed building. Progression up the levels also represents an increase in the accuracy and reliability of the reporting – the higher the level, the closer the reported results will be to providing you with data that reflects the performance of the building as-built and in-use.

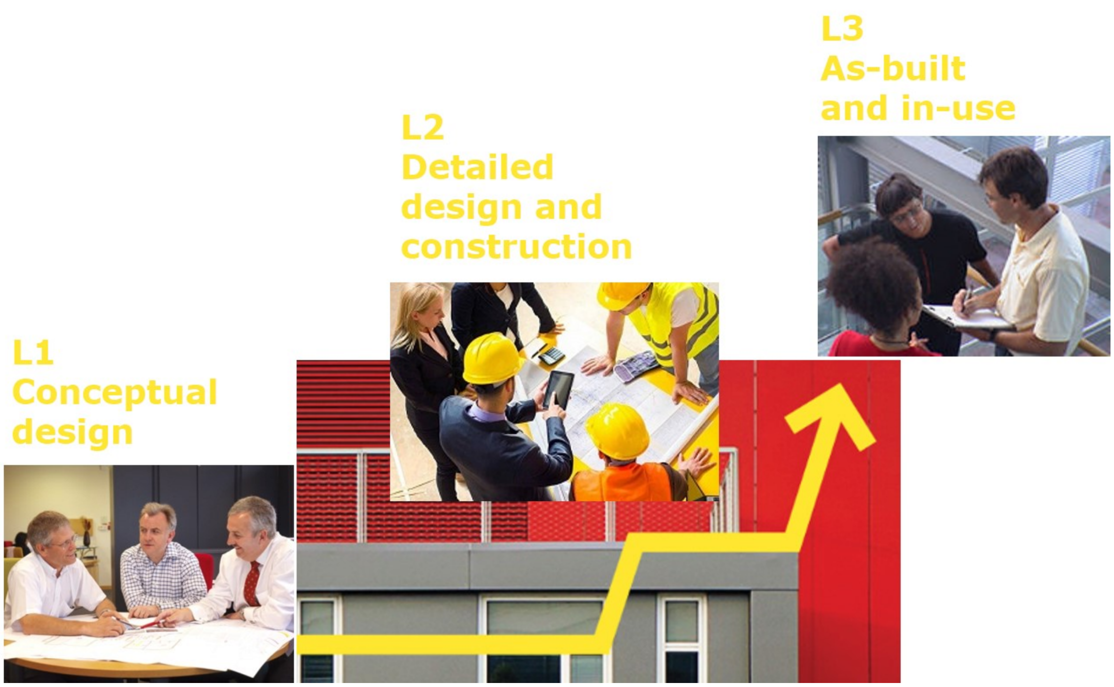


Figure 3. The levels – from conceptual design to in-use performance

3.2. Ensuring comparability

Level(s) has been designed to ensure a minimum level of **comparability** between functionally equivalent buildings. In order to ensure that meaningful comparisons can be made based on quantitative results, specific instructions and guidance are provided for each indicator. These require adherence by users to the points in the box below.

To support the use of Level(s) across the EU, a **'principle of equivalence'** is also followed. In practice, this means that national tools and methods, as well as certain private tools and methods, may be used if they are explicitly accepted by Level(s) in the instructions for each indicator. In the case that one of these tools or methods is used, their use shall always be reported alongside the results.

Learn more
How comparability is supported by using Level(s)

- Use of the common units of measurement
- Completion of the Level(s) building description
- Use of the cited reference standards and methods
- The required reporting on key parameters, assumptions and data quality, in order to ensure transparency
- The rules stipulated that are specific to Level(s) and which:
    - fix key parameters,
    - provide default data and
    - define calculation assumptions

3.3. Going a step further to optimise performance

Level(s) recognises that once building professionals have reached a basic level of competence in using the indicators, there can still be significant potential to **optimise performance**. They may want to go a step further in their professional development by using more advanced tools, methods and data.

For each indicator, opportunities are provided to go this step further and to optimise performance. Some of the main types of opportunities are identified in the box below.

Learn more about:

Steps that can be taken to go a step further and optimise performance using Level(s)

- The use of input data with a higher granularity
- The use of more advanced calculation methods and tools
- The definition and testing of more elaborate and comprehensive scenarios
- Taking into account additional design and performance aspects in calculations and estimates
- The use of monitoring systems that provide a higher granularity of data

4. Thinking sustainability: short briefings on key Level(s) concepts

In this part of Level(s), 4 (sub) briefings are provided on the key concepts and thinking that underpin the common framework, its macro-objectives and the indicators. The briefings can be used to help all the actors involved in a building project to apply sustainability concepts, providing further orientation and learning about how to get the most out of using Level(s) to assess a project.

4.1. Thinking sustainability 1: Whole life cycle and circular thinking

Level(s) takes a whole life cycle approach to the sustainability of buildings. In this briefing, we look at what this means in practice and how building design can address a full range of environmental impacts along the whole life cycle of a building. This applies not just to the use stage but also to how choices relating to the design configuration, construction and renovation of buildings can be just as important.

By taking a life cycle approach, the full range of environmental impacts associated with a building can be analysed and the most significant impacts – the so-called 'hot spots' – can be identified. Linked to this is also the concept of circularity, which seeks to ensure, by design, long-term resource efficiency. By understanding these interlinked concepts, all the actors involved in a project can become involved in minimising the whole life cycle impact of a building.

The concept of the life cycle of a building is significantly wider than the current approach of focussing on the design and the construction of buildings. In simple terms, it is about understanding and quantifying the environmental impact of a building from the 'cradle' – the extraction of the raw materials that are used in the construction the building - through to the 'grave' – the end of the service life and deconstruction of the building and how to deal with its building materials (recovery, reuse, recycling and waste management).

Level(s) has been designed to encourage building professionals to, as far as possible in each of their capacities and in teams, think about the whole life cycle and circularity of a building design from cradle to grave. Buildings are a significant material bank, being a repository for resources over many decades, and so it is important to design, construct, maintain and renovate using circular thinking.

<u>The basic concepts and terminology behind a whole life cycle approach</u>

The environmental impacts of relevance along a building's life cycle are varied and depend very much on the activities during each life cycle stage. They are mainly quantified in the form of estimates for emissions that can cause damage to the environment, which are calculated and reported as 'impact categories'. These impact categories include the contribution to climate change of gases such as CO_2, the contribution to acidification of gases such as sulphur dioxide and the contribution to human and ecosystem toxicity of substances such as heavy metals. Some impact categories also characterise the contribution of buildings to the depletion of minerals, metals and fossil fuel resources. An impact category that is directly relevant to buildings is the loss of soil caused by land use change and surface sealing.

In seeking to understand the life cycle environmental impacts of a building, the most important concepts to get started with are the following:

- **Life cycle stages**: These are the distinct stages in the life of a building to which environmental impacts are assigned. For example, impacts associated with the manufacturing of a brick will be assigned to the '*production stage'*. Energy consumed by occupiers of a building will be assigned to the *'use stage'*. Level(s) is based on the life cycle stages described in the standard EN 15978, which are in turn split into modules for the purpose of analysing and reporting in more detail on what causes the impacts (see Figure 4).
- **Impact categories**: Each category of environmental impact that will be assessed along the life cycle of a building has an indicator with a distinct unit or units of measurement. These units of measurement are associated with the underlying choice of modelling and calculation method. The environmental impacts

assessed in Level(s) are mainly what are referred to as 'midpoint' impact categories that measure emissions to the environment, such as CO_2, or the use of resources extracted from the environment, such as metals. For each impact category, the relative contributions of each type of emission or resource use are then each weighted according to their impact – so for example, each molecule of methane gas has 25 times the global warming potential of a molecule of CO_2.

- **Functional unit**: The reference unit of comparison between building designs or projects. In Level(s), results are normalised to the use of 1 m^2 of useful floor area of the given building type and function averaged for 1 year of a reference study period of 50 years.

- **Life cycle inventory data**: This is the building block of a life cycle assessment and is compiled in two stages. Raw data is first needed for the mass of material resources used along the life cycle – referred to as the 'bill of materials' - as well as other resources such as energy, fuel and water, as well as any direct emissions (e.g. refrigerants, VOCs from finishes). The emissions to the environment and resource consumption associated with this resource use are then estimated. This inventory flow is associated with processes of material extraction, processing, manufacturing and energy generation. This data can be 'primary', being real data from representative production sites, or 'secondary' and 'generic', being averaged for several representative production sites at regional, national, EU or international level. Care needs to be taken with this data to ensure that, as far as possible, it is representative of the processes and resources that are associated with the design, construction and use of the building – particularly in terms of the age of the data and the technology used in that geographical location.

- **Hot spots**: These are most important points in the life cycle of a building which have the highest influence on the overall result. They may be related to a building's life cycle stages or modules (e.g. B: Use stage, module B2: Maintenance), specific processes (e.g. cement manufacturing), specific components (e.g. façade panels, structural columns, internal fixtures and finishes) or an elementary flow (e.g. emissions of CO_2 from a boiler).

- **Scenarios**: These represent descriptions and projections into the future of how the building will be used, as well as how the environment may change and influence the impacts associated with the building along the life cycle. For example, Level(s) highlights, amongst others, the importance of developing scenarios to represent:

  - how long the building may be used before requiring a major renovation,
  - how climate change may influence heating and cooling needs,
  - how CO_2 emissions from EU and national electricity generation may reduce over time,
  - how design for adaptability may influence the useful lifetime,
  - how design for deconstruction may influence utilisation of the material bank.

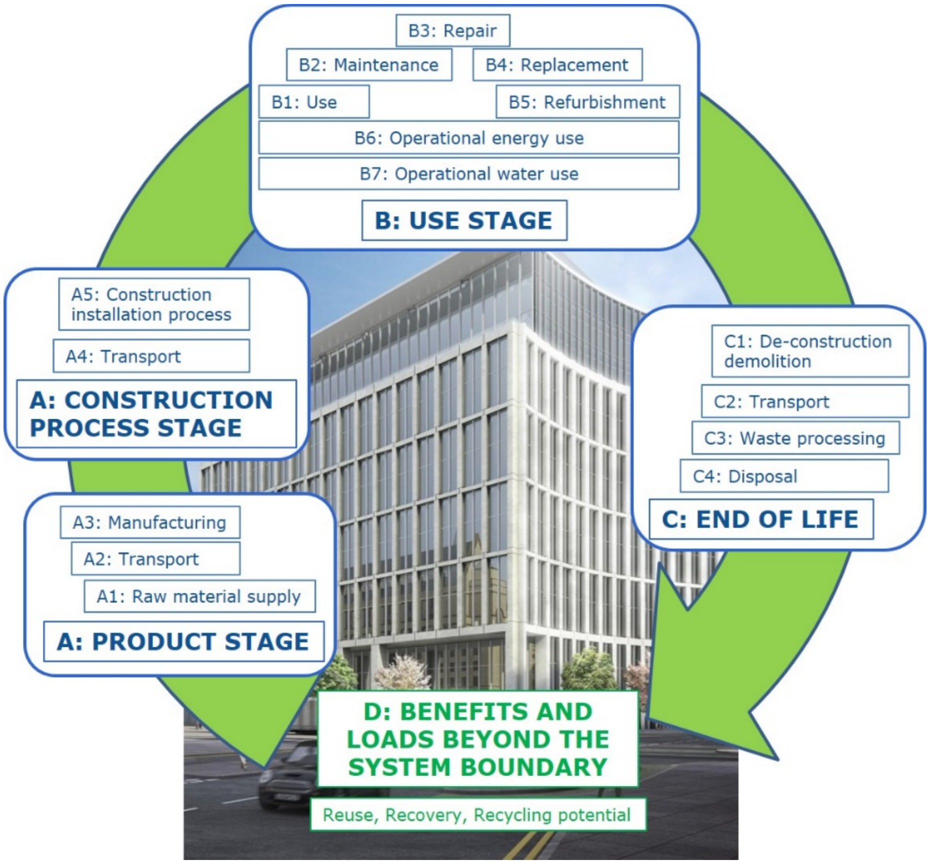


Figure 4. The stages in a buildings life cycle

Adapted from CEN (2011)

<u>What do life cycle assessments of buildings already tell us?</u>

Whilst environmental impacts related to the use phase of buildings remain important, the move towards highly energy efficiency Nearly Zero Energy Buildings (NZEB) is now shifting the balance towards impacts associated with construction materials. Evidence from life cycle assessments already carried out provides insight into where the 'hot spots' for environmental impacts associated with the construction materials are:

- Load bearing structures, external walls and facades appear as the main hot spot for material impacts across the majority of the impact categories used in the Life Cycle Assessment (LCA) of buildings.
- Addressing these impacts entails a focus on the contributions to life cycle impacts of the most significant material flows, which comprise concrete, brick, ceramic, steel and timber.

The environmental impacts associated with each of these materials and elements are distinct and cannot be addressed by a focus on one impact category or a single design aspect. Although material efficiency can sometimes be a proxy for design improvements, a comprehensive approach is preferable in order to address the distinct impacts associated with the non-metallic mineral, metal and wood-based materials used.

Significant impacts associated with building materials and elements may also arise during the use phase. For example:

- Scheduled major repairs and maintenance may result in materials and elements being replaced (e.g. roofs, facades).

- Renovations may also result in the replacement of fit out materials and other major elements such as windows and facades. Distinct impacts associated with fit out materials, such as toxicity to humans, might not be identified and quantified if these indicators are not included in the impact categories selected.
- The efficiency and intensity of use of building structures, space and land is an important focus for improvement.
  - For homes, design for more compact building forms are more land, material and energy efficient.
  - For commercial buildings such as offices, design for adaptability and extension of the life span of structures can reduce material impacts.
  - The choice of functional unit is critical in defining how the intensity of resource use is measured. For example, measuring impacts per workstation or resident can be more informative than measuring impacts per square metre of useful floor area.

How can Level(s) be used to assess the whole life cycle?

The Level(s) common framework encourages users to think about the whole life cycle of a building, providing a basis for quantifying, analysing and understanding the life cycle. Linked to this, it seeks to address a number of aspects of circularity by providing indicators that can help understand how to extend the utility of the building - not just in terms of its service life and value in the property market, but also in terms of the future potential for recovery, reuse and recycling of the materials it is composed of.

Reporting is encouraged for all life cycle stages in order to obtain a full picture of the environmental impacts. Moreover, Level(s) is designed in such a way that users can start by learning about the different steps that are necessary to conduct a life cycle GWP (Global Warming Potential) assessment and, if they choose to, extend the analysis to a full ‘cradle to grave’ Life Cycle Assessment (LCA).

This learning process starts with a set of design concepts that can aid with life cycle thinking (see the box below). Other Level(s) indicators also contribute to this learning process by addressing aspects of an LCA – including:

- 2.1, which gathers information on the building bill of quantities, materials and service lives
- 2.3 and 2.4, which allow scenarios to be developed for adaptability and deconstruction
- 5.1, 5.2 and 5.3, which assess the risks of possible future changes in climate to buildings

The findings from existing life cycle assessments of buildings presented in this briefing have been brought together into a set of Level(s) life cycle design aspects which form the starting point for project-based solutions based on life cycle thinking (see the box below).

Learn more about
The Level(s) life cycle design concepts

- Efficient building shape, form and utilisation: The surface area to volume ratio of a building, also referred to as its density or compactness, as well as its height, influences the material efficiency and energy use. A more compact building form may use more than 20% fewer materials in construction and in the use stage consume more than 20% less heating and cooling energy. The intensity of use of a building, both in terms of occupation density and overall utilisation can also influence the life cycle performance.
- Optimised NZEB construction: Applying to both new-build and major renovation projects, in which the trade-off between the following two stages should be considered:
  - Use stage energy consumption: The use phase of buildings is strongly influenced by primary energy use for, in particular, space heating, hot water and lighting;
  - Production stage energy consumption: Whilst reducing energy consumption, the transition to nearly zero energy buildings (NZEBs) has also required more embodied energy to be used to manufacture

higher performance insulation, windows, façade systems, thermal mass and renewable energy technologies.

- Optimised material use cycles: The structure of a building in most cases accounts for over half of the embodied greenhouse gas emissions associated with construction.
    - New structures: Evidence suggests that by optimising structural designs, material use can be reduced by around a third whilst still maintaining the required technical characteristics.
    - Reused structures: By reusing the structure of an existing building, significant reductions in material use and associated GHG emissions can be made.
- Design for adaptability: The potential for buildings to adapt and be flexible to changing market and occupier needs can extend the life of a building, including importantly its structure and main elements, which are life cycle hot spots.
- Extending building and component service lives: The lifespan of the building, sometimes also referred to as its service life, and the lifespan of its components, are important factors influencing construction and use phase impacts. In general, the more replacement and renovation cycles needed, the greater the embodied impact. This is particularly the case for the renovation of building services, including wiring and piping, as well as finishes such as paints.
- Design for deconstruction: Waste generated during product manufacturing, construction on-site and demolition processes can account for a significant proportion of the overall material flows on a construction site and, if not reused or recycled, can lead to wasted resources and thereby increased life cycle impacts at a sectoral level.

4.2. Thinking sustainability 2: Closing the gap between design and actual building performance

The majority of sustainability performance assessments are made at the design stage. Only in very few cases is the performance of the completed building monitored. There is increasing evidence that there may be the risk of there being a gap between design estimates and the real performance of a building and that in some cases this gap can be significant, in some cases as much as 50%. This may be due to a number of factors, which are important to understand and learn from.

To ensure that goals like the efficient use of energy and water, or occupant satisfaction with the interior environment, are actually met, Level(s) seeks to ensure that from the outset there is a clear objective to check how a building performs as-built and in-use. This can be done by planning to check on the as-built specifications of the building, to monitor the performance of a building once completed and to consider surveying occupant satisfaction.

To ensure that goals like the efficient use of energy and water, or good quality indoor air, are actually met, it is important to monitor the performance of a building once completed – both in terms of in-use performance data and the final as-built specifications. There can be a range of reasons why a building does not perform as envisaged:

- Quality is in general an ongoing challenge in the construction sector and requires attention along the process of delivering a project;
- New and innovative forms of design and construction required to fulfil sustainability objectives may require the use of, at first, new and unfamiliar techniques, materials and systems;
- Assumptions made in the calculation and simulation of performance may rely on default values to describe the use patterns of the potential occupants and may additionally not take into account all energy demands in the occupied building;
- Gaps in the communication, co-ordination and responsibilities within a project may lead to design details and specifications not being taken forward; and
- The project team may lack the appropriate expertise to translate each sustainability objective into detailed designs and constructed projects.

By addressing these at an early stage and looking at how the project will be executed, it is possible to minimise the risk of performance gaps. Ultimately, buildings are also created for people to use and so occupant satisfaction is an important complement to monitoring. This will entail the surveying of those living and working in a building. Such a survey will allow for other aspects of performance to be analysed – for example, satisfaction with the level of control over the internal environment.

All post-occupancy monitoring and survey activities require careful planning and, in order to obtain the most value from the exercise, a commitment on the part of all those involved to learn from and use the findings. This process of professional learning can be of value not just to the client side but also the design team members, project managers and contractors. Level(s) users are therefore encouraged to carry out post-completion and post-occupation monitoring and surveying, with the aim of assessing the performance of the completed building.

How can Level(s) be used to close the gap?

To provide a complete picture of how a building performs, it is important to carry out accurate monitoring of the performance of a completed building. This step will provide measured data for reporting purposes. This data can then be analysed to see how well the building has performed in practice. If there is any performance gap, the data can be used as the starting point for diagnosing and remedying any problems or defects. The as-built specifications of the building should also be checked, as significant changes may have been made along the process.

For those indicators which can be monitored, Level(s) provides basic instructions on how to do this. Monitoring activities are specified, as well as accompanying reference standards. This includes a focus on:

- testing of the building fabric,
- testing of the HVAC systems,
- metering of energy and water consumption,
- measurement of indoor air, both at handover and occupation,
- thermal conditions upon occupation, and
- the contribution and quality of daylight and artificial light.

The monitoring shall also include data relating to the as-built quantities and costs – including the building materials used. This data is important because a variance in the final bill of quantities and materials could influence the life cycle inventory used for calculating indicators such as 1.2 Life cycle GWP (Global Warming Potential) as well as the service life and maintenance assumptions recorded in 2.1 Bill of materials, quantities and lifespans and used in 6.1 Life Cycle Cost.

Surveys of occupant satisfaction

Occupant satisfaction is also a critical parameter for the success of a building. Although not a core part of the Level(s) common framework, it is recommended as a complement to the monitoring of quantitative parameters and general guidance is provided. The evaluation of occupant satisfaction requires a process of structured interviews and surveys, using methodologies such as those provided by ISO standards 10551 and 28802, and with a focus on specific performance aspects considered to be important for achieving healthy and comfortable buildings. This process may be referred to using different terminology, including Post Occupancy Evaluation (POE), occupant Indoor Environmental Quality (IEQ) survey or a Building User Survey (BUS). For the purposes of Level(s), the process is referred to as a Post Occupancy Evaluation (POE).

Indicators 4.1 (Indoor air quality) and 4.2 (Time outside of thermal comfort range) are the main indicators within Level(s) for which a standardised survey method are specified. For example, in the case of 4.2, a method exists to assess occupant satisfaction with thermal comfort. A survey format can be used that has been statistically calibrated to real thermal comfort conditions.

Those project teams wishing to make a broader assessment of occupant satisfaction should record this objective in their Level(s) project plan. It is then recommended to consult the methods identified in the box below as a starting point.

Learn more about:

Post Occupancy Evaluation (POE) of comfort and satisfaction

A POE is typically carried out a minimum of one year after the building has been fully occupied. They normally consist of interviews with occupiers to evaluate qualitative aspects related to the building performance indicators. The POE should generally be carried out by a third party using a standardised methodology.

A number of evaluation methods and standards have become standard references for Post Occupancy Evaluations. These methods and standards each provide a toolkit of guidance on how to carry out combinations of quantitative and qualitative evaluations, as well as providing model survey questions that can be used. A non-exhaustive list of the most referenced methods and standards is as follows:

- Building User Survey (BUS) method which was developed from the experience of evaluating low energy buildings in the 1980's and 1990's [2].

[2] Arup, *BUS methodology*, http://www.busmethodology.org/

- CBE (Berkeley) occupant Indoor Environmental Quality (IEQ) survey, which is a web-based format addressing seven aspects of indoor quality[3].
- Soft Landings process, which is a multi-stage approach to delivering better buildings that includes a final stage of extended after care and POE[4].

In addition, a number of building assessment schemes and reporting tools provide for Post Occupancy Evaluations:

- as a fundamental requirement of the scheme (e.g. Miljöbyggnad in Sweden; SSO in Spain),
- as an optional indicator, criterion or credit (e.g. BREEAM New Construction, LEED Building Operations & Maintenance, Finland GBC Building Performance Indicators).

[3] University of California Berkeley, *Occupant Indoor Environmental Quality (IEQ) Survey and Building Benchmarking*, Centre for the Built Environment, https://www.cbe.berkeley.edu/research/briefs-survey.htm

[4] BSRIA, *Soft landings process*, https://www.bsria.co.uk/services/design/soft-landings/

4.3. Thinking sustainability 3: How to achieve a sustainable renovation

The new European Green Deal seeks to create the impetus for a 'renovation wave' to improve the existing building stock in order to future-proof it against climate change, reduce energy poverty and create new employment. The need to address other sustainability aspects of the indoor spaces in which we live and work, such as health, comfort and adaptability, is also becoming increasingly important and major renovation projects create opportunities to address these design aspects.

Level(s) encourages a comprehensive approach to major and deep renovation projects, based on an understanding of the characteristics and qualities of each building, an evaluation of the potential to improve performance and a life cycle approach to the design of renovation projects.

Approximately 85-90% of the building stock that is projected to still exist in 2050 has already been constructed and this stock composes a vast, continent-wide material bank of resources. For example, estimates from Germany suggest that the country's built environment forms a repository of approximately 50 billion tonnes of materials.

Life cycle evidence suggests that by making high performance, deep renovations of existing buildings, we can indicatively reduce life cycle environmental impacts associated with both the use of energy and water by building occupants and construction products by 60-80%. Across the EU, deep renovations that reduce energy consumption by at least 60% are estimated to be carried out only in 0.2% of the building stock per year. This rate will have to rise significantly if the EU is to meet its climate change targets.

The extended deep confinement of the population as a result of the Covid-19 pandemic has also recently brought a new focus of attention on the health, comfort and adaptability of the spaces in which we live and work in for sustained periods of time. Major renovation can therefore also create opportunities to address aspects of a building that may be detrimental to quality of life and productivity of occupiers.

How can Level(s) be applied to major renovations?

Level(s) integrates design principles and assessment steps that are tailored towards making major renovation projects more sustainable. The first step in making a sustainable renovation of a building is a comprehensive survey of the construction of the original building and, if possible, the experience of occupiers. This first step is critical in improving performance because every renovation has to be tailored to the existing conditions and technical characteristics of the building, the intended patterns of occupation and its local context.

Sometimes existing features can be exploited further, such as light wells and patios to provide ventilation, but there may also be inherent problems to diagnose that were not originally foreseen, such as thermal bridges, water ingress or air leakage, caused by certain materials and structures such as balconies, wall panels. Occupiers' experience of using the building may also highlight aspects of performance that could be addressed.

Once this information has been compiled, it can be used to make accurate simulations of the baseline performance of the building and to develop design options. The Level(s) framework then provides tailored instructions on how to address the 6 macro-objectives from a renovation perspective. The box below summarises some of the main areas of opportunity to improve performance by using Level(s).

Learn more about:

Addressing the macro-objectives and indicators from a major renovation perspective

Macro-objective	Key performance improvement opportunities
Macro-objective 1: Greenhouse gas and air pollutant emissions along	✓ Improving the thermal efficiency of a buildings envelope, as well as addressing other uses of energy such as lighting, heating and cooling, can contribute to improving the overall quality of an existing building.

a buildings life cycle	✓ Renovation of the building fabric, layout and technical services can at the same time address aspects that may make buildings uncomfortable to occupy, such as: - Cold, damp or overheating, and - High running costs. ✓ Assessment can be made of the potential for the self-generation and self-consumption of renewable energy. ✓ Assessment of the potential for a low embodied CO_2 renovation by evaluating options for, amongst other building elements, the windows, insulation, the internal fit-out, finishings and renewable energy equipment.
Macro-objective 2: Resource efficient and circular material life cycles	The remodelling of buildings, internal spaces and servicing may create opportunities to: ✓ Address any shortcomings in providing for occupier needs, now and into the future – such as the need for more flexible space distribution, better accessibility, communal space and teleworking. ✓ Make properties more affordable to run, in the present and into the future.
Macro-objective 3: Efficient use of water resources	The upgrading and replacement of sanitary fixtures and fittings, as well as new external landscaping, are likely to create opportunities to: ✓ Specify water efficient taps, showers and baths. ✓ Introduce water saving systems, making use of grey and rain water. ✓ Introduce water metering and monitoring. ✓ Design new low water irrigation systems and select drought resistant plants.
Macro-objective 4: Healthy and comfortable spaces	Some of the main factors that can affect indoor health – ventilation, indoor pollutants, daylight and noise – have taken on a new significance in a post Covid 19 world, with new and heightened sensitivities to health and hygiene. The remodelling of internal spaces may allow for improvements and modifications to be made to internal layouts and servicing – for example, by introducing: ✓ daylight, ✓ natural cross ventilation, and ✓ new point source mechanical ventilation.
Macro-objective 5: Adaptation and resilience to climate change	The resilience of an existing building to environmental change will partly depend on the original design characteristics, but there may also be opportunities to improve: ✓ internal layouts, ✓ ventilation pathways, ✓ the performance of the building fabric, and ✓ HVAC systems. Nature-based solutions (green infrastructure) could be introduced on/around a building.
Macro-objective 6: Optimised life cycle cost and value	By encouraging a dialogue between design teams, clients and property valuers, the long-term value of sustainability features can be better taken into account in market valuations of properties. The ability of well designed, healthy and sustainable buildings to hold and create value, whether through minimising overheads, creating attractive properties or minimising future risks, is increasingly becoming a differentiator between properties on the market.

4.4. Thinking sustainability 4: How sustainability can have a positive influence on the market value of a property

Level(s) seeks to ensure that the value of more sustainable buildings is captured and reflected in the economic valuation of a building. This is with the aim of ensuring that the anticipated improvements in the long-term performance of a more sustainable building will reduce life cycle costs and have a positive influence on property market values, lending conditions and lettings.

As well as providing the tools to prioritise and measure performance, Level(s) therefore encourages building professionals to consider how a sustainable building could have a positive influence on market valuations and reduce exposure to future risks.

For many building professionals, their main contact with the world of property valuation will be via their client, who is likely to communicate what the main drivers of value for the project are. The methods used to make a market valuation may appear from the outside to be a black box, the contents of which are only known to the client, their property market advisors and valuation professionals.

For members of design teams, it is therefore important to understand how sustainability can be taken into account in some of the leading valuation standards used across the EU. It is notable that the three leading publishers of valuation standards - the Royal Institute of Chartered Surveyors (RICS), the European Group of Valuer's Associations (TEGoVA) and the International Valuation Standards Council (IVSC) - have already integrated sustainability into their valuation standards and risk rating criteria. This means that, in principle, sustainability should already be a consideration in the process.

In practice, the starting point on most projects for considering sustainability aspects will relate to the energy performance of the property, driven by regulatory requirements to provide information in the form of an Energy Performance Certificate. Figure 5 illustrates how this can form the starting point for dialogue on a range of sustainability features that can also have economic effects including, potentially, the market value of the building.

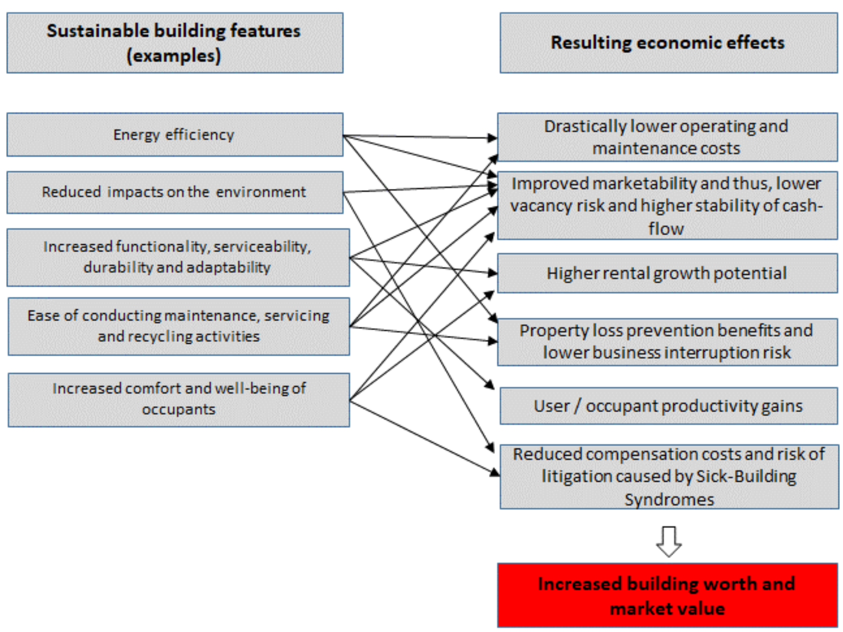


Figure 5. Inside the black box of property market valuation. Adapted from Lutzkendorf and Lorenz (2005)[5]

[5] Lutzkendorf T., Lorenz D., 2005. Sustainable property investment: valuing sustainable buildings through property performance assessment. Building Research & Information, 33(3), p.212-234.

How can Level(s) be applied to property valuations?

Property valuation and risk rating standards have significant potential to capture the benefits of more sustainable buildings and support long-term investment decisions. Level(s) indicator 6.2 allows users to report on the potential for better performance across the Level(s) common framework that would have an economic influence in three key areas:

1. Reduced overheads (by minimising operational costs)
2. Increased revenues and more stable investments (by making properties more attractive)
3. Reduced risk (by anticipating potential future exposure)

Table 6 identifies for each indicator in the Level(s) common framework where improved performance may have the potential to have an influence in some or all of these three areas. In this way, Level(s) users can be better informed at the point of engaging with valuation professionals, particularly in understanding and communicating how design decisions that improve sustainability can create value.

Table 6. Potential influence of each Level(s) indicator on a property valuation or risk rating

Level(s) core indicators	Potential influence on future revenue and exposure to risk		
	1. Increased revenues due to market recognition and demand	**2. Reduced operation and maintenance costs**	**3. Future exposure to the risk of increased overheads or loss of income**
1.1 Use stage energy consumption	✓	✓	✓
1.2 Life cycle Global Warming Potential	✓		
2.1 Bill of quantities, materials and service lives		✓	✓
2.2 Construction & demolition waste and materials		✓	
2.2 Design for adaptability and refurbishment	✓		✓
2.3 Design for deconstruction, reuse and recyclability			✓
3.1 Use stage water consumption		✓	✓
Cradle to grave Life Cycle Assessment (LCA)	✓	✓	
4.1 Indoor air quality	✓		✓
4.2 Time out of thermal comfort range	✓		
4.3 Lighting and visual comfort	✓	✓	
4.4 Acoustics and protection against noise	✓		
5.1 Protection of occupier health and thermal comfort	✓	✓	✓
5.2 Increased risk of extreme weather events		✓	✓
5.3 Increased risk of flood events		✓	✓
6.1 Life cycle costs		✓	✓
6.2 Property market value and risk exposure	✓		✓