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# Towards an EU framework of core indicators for the environmental performance of buildings

Proposals and discussion points to inform the 2nd Working Group meeting, Brussels, 30th November 2016

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**Summary:**

The aim of this briefing paper is to summarise some of the main messages to have come out of the public consultation, as well as discussions and input from members of the steering group (SG1) and technical sub-group 3 (SG3).

Proposals are then put forward for:

1. How the framework of core indicators as a whole could work, including:
   - its structure;
   - how it relates to project and life cycle stages;
   - reporting, reliability and data quality
   - its orientation around a life cycle approach;
   - how it handles comparability.
2. What the final selection of indicators could be, including
   - points drawn from the consultation and discussions with the sub-groups;
   - revised proposals for the indicators.

The revised proposals for the framework and indicators are put forward as the basis for discussions at the second Working Group meeting on the 30th November 2016 in Brussels, with the aim of finalising the structure and choice of indicators.

*This document should be read in conjunction with the original proposals from July 2016 ('Summary findings and indicator proposals') and the draft public consultation report.*

## 1. How the framework could work as a whole

In this first section the structure of the framework, its relationship to project and life cycle stages, its orientation around a life cycle approach and how its approach to reporting, data quality and comparability are reflected upon.

### 1.1 Structure and relation to project and life cycle stages

***Discussion of the proposed approach based on the findings of the public consultation and discussions with SG1 and SG3:***

- The framework shall consist of a set of core indicators that are either:
    1. Directly related to final performance aspects of a residential or office building, or
    2. LCA indicators that characterise environmental impacts or quantify input or output flows relating to resource use (according to EN 15978).
- The framework and each indicator will be communicated with a strong reference to relevant life cycle stages, and this approach to communication will be extended to life cycle costs as well.
- The core indicators will have the following supporting documentation:
    - *A calculation methodology* which, where possible, shall be with reference to an existing standard(s) and/or EU policy instruments;
    - *Life cycle scenario tools* which will provide users with the best available methods. Semi-quantitative standards and guidance to develop realistic scenarios for performance along the life cycle *(see discussion point 2 for further details)*
    - *A set of guidance notes* that will help users understand the building project/life cycle relevance of each indicator, specify data collection/verification and identify focus points for attention in seeking to improve performance.
- With the aim of improving the link between design and actual performance, it shall be possible to report on the indicators at:
    1. design stage (based on calculations),
    2. completion stage (based on as-built drawings),
    3. post-completion (based on commissioning and testing)
    4. occupation (based on measured performance)
- Some respondents to the public consultant were strongly of the opinion that the framework as proposed did not focus enough on occupiers/end-users of buildings.
- One possibility to address this concern is to include include guidance on post-occupancy surveying to determine occupant/end-user satisfaction.

***Key points for discussion:***

1. Is the overall structure and way the framework is proposed to work suitable?
2. Does it require any further improvement to address the needs of possible end-users? *i.e. design team, contractor, occupier, home buyer, property investor*
3. How could the focus on occupiers/end-users be improved?
4. How should post-occupancy surveys be addressed within the framework?

## 1.2 A graduated and transparent approach to reporting, reliability and data quality

***Discussion of the proposed approach based on the findings of the public consultation and discussions with SG1 and SG3:***

- The framework will not highlight basic and advanced levels of indicators, but, instead for each indicator, there could be a so-called 'graduated' approach. This would enable users to move from simple through to more complex calculation methods and extended reporting, which in turn would be reflected in a rating of the quality/reliability of the reporting.
- The aim would be to encourage modelling and calculations that as closely as possible reflects the local conditions and opportunities to achieve greater resource efficiency. This could include, for example, the 'regionalisation' of results and additional forms of normalisation to better reflect intensity of resource use.
- This could work on several levels to make the link between reporting that is more immediately familiar and accessible to building professionals (i.e. indicators that reflect final building performance), and reporting that is more conceptual
  – *for example*: heating and cooling demand of a building - > primary fuel consumption - > $CO_2$ eq emissions - > GWP impact category of EN 15978 life cycle stage B6
- Transparency and reporting on data quality and the reliability of calculation methods used as the basis for reporting is critical, and would support decisions on comparability and reliability. To this end it is proposed to link reporting indicator by indicator on quality/reliability in order to develop an overall picture of quality/reliability under indicator 6.2 *'value and risk factors*'.
- Such a '*data quality and reliability rating'* for each indicator could be used to encourage/reward more accurate calculations/modelling/reporting. As a starting point, such a rating could indicatively be based on the approaches described in ISO 14044 or the Product Environmental Footprint (PEF) methodology. The PEF provides a specific methodology with which data quality can be evaluated in a semi-quantitative way under the following headings:
  - TeR: Technological Representativeness
  - GR: Geographical Representativeness
  - TiR: Time-related Representativeness
  - C: Completeness
  - P: Precision/uncertainty

  These ratings for each indicator could then provide useful information for investors and valuers as part of reporting on indicator 6.2. A brief overview and comparison of the ISO 14044 and PEF approaches is provided on pages 95-100 of Working Paper 2 [1].

***Key points for discussion:***

1. Would the modular approach described be an appropriate way to resolve the issue of 'basic' versus 'advanced' indicators? (*see also section 1.3*)
2. What should be the key aspects of reliability and data quality which should be reported on/rated?

[1] Working paper 2 can be downloaded from the study home page:
http://susproc.jrc.ec.europa.eu/Efficient_Buildings/documents.html

3. Could current approaches to the evaluation/reporting of data quality used in LCA be suitable for an indicator 'reliability and quality rating'?

### 1.3 A framework based on Life Cycle Assessment (LCA)

***Discussion of the proposed approach based on the findings of the public consultation and discussions with SG1 and SG3:***

- LCA at building level is currently still an advanced tool and whilst on one hand it's appropriateness for a framework of core indicators has been questioned by some, on the other hand there is strong support from a large number of stakeholders for the framework to be based on an and aligned with an LCA approach.
- The aim of the framework as a whole shall therefore be to encourage life cycle thinking by focussing attention on all four of the life cycle stages described in EN 15978:
  - Product (A1-3),
  - Construction process (A4-5),
  - Use stage (B1-7), and
  - End of life (C1-4)

  Additionally, it shall be encouraged to consider reporting on Module D (*'benefits and loads beyond the system boundary'*), where possible in conjunction with consideration at design stage of scenarios of the potential for deconstruction, recyclability and re-use
- The original indicator proposal 2.1 Cradle to grave LCA is proposed to become an overarching reporting option, linked to the other environmental indicators. The majority of consultation respondents preferred reporting not just that an LCA has been carried out, but also on the results according to the EN 15978 indicator set.
- A number of stakeholders have suggested that the framework could be structured in a modular way, recognising that:
  - a number of the proposed indicators that relate to final building performance provide inventory data, calculations, modelling and assumptions that are required to subsequently carry out an LCA and/or to calculate Impact Categories *e.g. building final energy consumption will provide input data on energy sources/fuels and output data on emissions to the calculation of Global Warming Potential.*
  - a number of the proposed indicators rather than measuring performance, support building designers and clients to develop qualitative descriptions of life cycle scenarios *e.g. service life, design for disassembly and recycling, future climate change.*
- Following this approach, it is proposed that all environmental indicators included in the framework shall contribute to, or be in their own right, LCA impact categories or parameters as specified in EN 15978.
- Whilst the majority of stakeholders supported the proposals for indicators addressing service life and design for disassembly and recyclability, as well as requesting an indicator for design for adaptability, it was also highlighted that these aspects were more qualitative and might be better suited to help describe/develop LCA scenarios.
- It is therefore proposed that instead of developing indicators for these three aspects, basic guidance is developed to support building life cycle scenario development. This would be based on best practice from, amongst other sources, assessment methods provided by DGNB, BREEAM Netherlands and ISO 15686-8.

- The potential to narrow the scope of building elements that shall be reported on was supported in the consultation, and would reflect the current practices to support adoption. These building elements could be defined based on life cycle evidence for 'hot spots' as well as known problems with data availability (e.g. building services).
- Data gaps or problems of data quality for each life cycle stage, or for specific building elements, shall be addressed in the reporting, which shall be transparent and shall penalise data of a low quality.
- The use of reference, notional or 'mirror' buildings, as described under EPBD regulations in Member States, was also highlighted by some stakeholders as providing a useful starting point for encouraging building design optimisation using LCA. This approach is already used by some assessment schemes, such as DGNB and LEED, for their LCA criteria.

*An overview of how the framework could be organised following the public consultation is presented in Figure 1.*

***Table 1. Revised proposals for reporting on a cradle to grave LCA***

| **Proposed indicators** | **Environmental indicators** | - As a minimum the environmental indicators identified in EN 15978 (*this was indicator proposal 2.1*) |
|---|---|---|
| **Building scenario tools** | | Guidance is to be developed to support life cycle scenario development around building and component service life (indicator proposal 2.2), as well as design for adaptability, deconstruction, recyclability and re-use (indicator proposal 2.3). |
| Technical improvements and clarifications | | - The carrying out of an LCA and reporting on the results for environmental impact categories is to become an overarching reporting option.<br>- The other indicators in the core framework will link to and/or form part of the LCA reporting.<br>- An option to support users of LCA to optimise designs by comparing performance with notional buildings based on national/regional guidance is to be discussed further with stakeholders. |

***Key points for discussion:***

1. How could professionals be supported to become familiar with/start using LCA and its associated indicators? *examples identified by stakeholders include: start with generic GWP databases, Open LCA, recommended LCA inventory databases, generic end of life scenarios*
2. Would the proposed guidance on life cycle scenarios be a useful tool to complement the indicators?
3. How best could attention be focussed on 'hot spot' building elements? *For example, would minimum reporting requirements be appropriate?*
4. Should the framework encourage/support users to go beyond just reporting on indicator results? *For example, the use of Member State reference buildings as a starting point for optimisation.*

| | Macro-objectives | Core indicators within the framework | LCA indicators directly related to the macro-objective |
|---|---|---|---|
| | Overarching reporting | Indicator 2.1. Cradle to grave LCA | EN 15978 environmental impact categories |
| | | Reliability and data quality (*supporting reporting on indicator 6.2*) | *Potentially based on ISO 14044 guidance and PEF data quality criteria* |
| Life cycle environmental performance macro-objectives | MO1: Greenhouse gas emissions along the buildings life cycle | Indicator 1.1. Operational energy consumption | |
| | | *Reporting component 1.1a Total primary energy consumption (EPBD scope)* | Primary energy (renewable and non-renewable) |
| | | *Reporting component 1.1b Final energy consumption (EPBD scope)* | |
| | | Indicator 1.2. Operational and embodied GWP | GWP |
| | MO2: Resource efficient material life cycles | Indicator 2.1. Service life bill of materials | ADP (elements and fossil fuels) |
| | | Indicator 2.4. Construction and demolition waste | Waste categories (hazardous/non-hazardous), Output flows (re-use, recycling) |
| | MO3: Efficient use of water resources | Indicator 3.1. Mains drinking water consumption | Net use of fresh water |
| Quality, performance and value macro-objectives | MO4: Health and comfortable spaces (initial focus on indoor air quality) | Indicator 4.1. Airborne pollutant levels | |
| | | *Reporting component 4.1a. Quantitative airborne pollutant levels (listed substances)* | |
| | | *Reporting component 4.1b. Qualitative airborne pollutant levels (mould)* | |
| | | Indicator 4.2 Indoor air class (ventilation, $CO_2$ and relative humidity) | |
| | MO5: Resiliience to climate change (initial focus on overheating and thermal comfort) | Indicator 5.1. Occupant thermal comfort | |
| | | Indicator 5.2a. Additional cooling energy required | Primary energy (renewable and non-renewable) |
| | | Indicator 5.2b.Green factor (cooling effect of green features) | |
| | MO6 | Indicator 6.1 Life Cycle Costs | |
| | | *Reporting component 6.1a. Utility costs* | |
| | | *Reporting component 6.1b. Acquisition and maintenance costs* | |
| | | Indicator 6.2 Value and risk factors | |
| | | ***Supporting guidance (with reference to preferred standards and methodologies)*** | |
| | Life cycle scenario tool 1 | Design and service life | With reference to EN 15978 |
| | Life cycle scenario tool 2 | Design for adaptability (B5) | |
| | Life cycle scenario tool 3 | Future climate change (C6) | |
| | Life cycle scenario tool 4 | Design for deconstruction, recyclability and re-use (C1) | |

*Colour code key:*

- Moved to become overarching indicator
- New indicator or reporting component
- Renaming of indicator
- Merged with another indicator
- Moved to become a 'life cycle scenario'
- Discontinued or to be addressed in guidance for another indicator

*Figure 1. How the draft EU framework of core indicators could look following the consultation*

### 1.4. Supporting comparability

***Discussion of the proposed based on the findings of the public consultation and discussions with SG1 and SG3:***

- The consultation findings called, above all, for comparability at EU, national and project level. This creates a potential challenge in seeking to enable data and modelling parameters to be used that support comparability on an absolute basis for functionally equivalent buildings at national level.
- A number of key terms will need to be defined in order to support basic comparability *e.g. internal floor area definition*.
- Assumptions and adjustments for occupation related factors such as *workplace density, occupancy, bed spaces and voids* will need to be reported on.
- Working Paper 2 reported that some EU building assessment schemes rely on normalised product performance data and/or fix a series of input parameters so that local/regional factors are taken out of the calculations *e.g. generic LCA inventory data or EPD ratings, energy costs, building element costs, service life, discount rate*
- The importance of like-for-like reporting to reflect, for example, functionally equivalent types of office (based on market 'segmentation') or residential property and associated ownership structures was highlighted by stakeholders in the consultation.
- Traditionally, performance benchmarking guidance in some Member States has focussed on different typologies of buildings, as reflected in their specification and servicing, *e.g. the UK Energy Efficiency Best Practice programme identifies for offices:*
  - *Naturally ventilated cellular*
  - *Naturally ventilated open-plan*
  - *Standard air-conditioned*
  - *Air-conditioned prestige*
- The use of reference, notional or 'mirror' buildings as described under EPBD regulations in Member States was also highlighted by some stakeholders as providing a useful starting point for comparisons and performance optimisation. This approach is already used by some assessment schemes, such as DGNB and LEED, for their LCA criteria.

***Key points for discussion:***

1. How should the framework support comparability at EU and national level?
2. To what extent should some of the discussed aspects be addressed? *i.e. adjustments, key parameters, like-for-like reporting, reference buildings*
3. Do any standard EU-wide reference points exist for different types of office and residential buildings and their market segmentation?

## 2. Summary findings and revised indicator proposals for each macro-objective

### Macro-objective 1: Greenhouse gas emissions along the buildings life cycle

***Summary findings from the public consultation and discussions with SG1 and SG3:***

- It was highlighted that the title of the macro-objective would exclude important emissions sources such as those arising from cement production or refrigerant leakage from cooling systems. It is therefore proposed to remove *'energy use'* from the title.
- For indicator 1.1, there is a consensus that contributors to total operational primary energy consumption should be reported on in order to incentivise improved fabric performance – *i.e. heating, hot water, cooling, ventilation and lighting demand*. This would also address the link to demand for cooling energy under indicator 5.2a.
- Dynamic simulation appears to be an ambitious basis for the EU Voluntary Certification Scheme (VCS). For example, the position of some Member States is not to go beyond existing EPBD regulatory requirements and associated national calculation methods, some of which are steady state.
- Moreover, according to feedback from SG3 and the findings from DG JRC's background study, experience suggests that compliant input data for entry into national calculation methods is a larger and more important issue to address before moving on to the complexity of dynamic simulation. The latter is understood to imply a greater reliance on assumptions and professional judgement, and feedback suggests that this in turn can create additional risks of the modelled (calculated) performance not being achieved.
- All the life cycle stages should be reported on for 1.2 but questions have been raised about data availability for building services in particular and the quality/meaningfulness of end of life scenarios that are used (see section 1.2).
- The potential to focus on hot spot building elements still exists, as the consultation findings were not as clear cut on this issue.

***Table 2. Revised MO1 proposals for discussion***

| | | |
|---|---|---|
| **Proposed indicators** | **Environmental indicators** | ○ Impact Category: Global Warming Potential ($CO_2$ equivalents/$m^2$) reported separately for all life cycle stages *(this was indicator proposal 1.2)* |
| | **Inventory flow indicators** | ○ Operational primary energy consumption (kWh/$m^2$.yr): Separate reporting of renewable and non-renewable components (*according to prEN 52001*) *(this was indicator proposal 1.1)* |
| | **Final performance indicators** | ○ Operational final energy consumption (kWh/$m^2$.yr): EPBD (recast) *'Minimum aspects of thermal characteristics to take into consideration'* – heating, cooling, hot water, lighting and ventilation - with separate reporting on occupant consumption (internal loads) |
| Technical improvements and clarifications | | ○ Reporting shall be made on the extent to which the calculation is compliant with reporting elements of the proposed EU VCS – for example, calculated or measured performance, time interval |

| | |
|---|---|
| | ○ Reporting shall be made on the reliability of the input data used in National Calculation Methods (*based, for example, on guidance developed by the QUALICHeCK project* [2])<br>○ Include the commissioning/testing of ventilation systems within the 'supporting activities'<br>○ Reporting on final cooling energy consumption provides the baseline for comparison of future scenarios under indicator 5.1 *'risk of overheating'* |

***Key points for discussion:***

1. How could users be incentivised to make calculations that are as accurate as possible?
2. To what extent should the use of dynamic simulation be incentivised?
3. How should the reporting on indicator 1.1 work? *for example, minimum reporting on primary energy consumption, with final energy demand as optional items*
4. How best could attention be focussed on 'hot spot' building elements? *Would minimum reporting requirements be appropriate?*
5. *Common question:* how should indicator use and implementation be supported?

**Macro-objective 2: Resource efficient material life cycles**

***Summary findings from the public consultation and discussions with SG1 and SG3:***

- There was an overall view from a number of stakeholders that some of the indicators under MO2 would sit better within an overall life cycle approach, and should be aligned with relevant EN 15978 indicators, which report on similar aspects but in slightly different ways.
- The public consultation and discussions with SG3 indicated that both '*disassembly and recycling'* (indicator proposal 2.3) and 'design for adaptability' (identified as an option in Working Paper 2) would have value, but it was highlighted that mature and/or formally standardised methods do not currently exist for application across the EU. Some stakeholders highlighted the methods of EN 15343-3/EN 16309, DGNB and BREEAM Netherlands.
- Service life reporting was considered useful by some stakeholders, but others saw it difficult in practice to estimate. The latter point could be addressed by referring to guidance provided in ISO 15686-8 standard and service life estimation is also addressed in EN 15978 (*because it is essential to describe the buildings life cycle).*
- '*Disassembly and recycling'* could be a useful complement to Module D of EN 15978 but it should not be a defining factor that permits reporting on Module D benefits.
- Some SG3 members still consider it essential to have a simpler indicator that encourages/engages with structural engineers *e.g. a mass based indicator, or potentially the two abiotic depletion potential (ADP) LCA indicators*, as long as it is always reported alongside GWP. The potential to encourage the use of ADP was also suggested by some respondents to the public consultation. This would complement the

[2] QUALICHeCK (2016) *Source book for improved compliance of Energy Performance Certificates (EPCs) of buildings*, http://qualicheck-platform.eu/2016/03/source-book-for-improved-compliance-of-epcs-of-buildings-draft/

idea of input (inventory flow) data supporting calculation of impact categories.

***Table 3. Revised MO2 proposals for discussion***

| | | |
|---|---|---|
| **Proposed indicators** | **Environmental indicators** | ○ Abiotic Resource Depletion Potential for elements (kg Sb equivalent/$m^2$)<br>○ Abiotic Resource Depletion Potential of fossil fuels (MJ/$m^2$) |
| | **Inventory flow indicators** | ○ Service life bill of materials: Associated with construction and use stage of the building (kg/$m^2$)<br>○ Waste and output flows arising from demolition (pre-construction), construction (A5) and end-of-life (C1) stages, with reporting in kg/100 $m^2$ development (excluding backfilling) on (this was indicator proposal 2.4):<br>– Landfill: hazardous and non-hazardous waste<br>– Components for re-use<br>– Materials for recycling |
| **Building scenario tools** | | ○ Design and service life: To inform the definition of the overall service life and the design life for major building elements (*e.g. the structure*) (this was indicator proposal 2.2)<br>○ Design for adaptability: To inform scenarios for life cycle stage B5<br>○ Design for deconstruction, recyclability and re-use: To inform scenarios for life cycle stage C1 and reporting on Module D (this was indicator proposals 2.2) |
| Technical improvements and clarifications | | ○ A mass flow derived from the bill of materials is deemed to still be important, but shall only be reported on alongside GWP, so as to encourage structural engineers to identify/understand any potential trade-offs.<br>○ Demolition of buildings that pre-date a new construction shall be reported under a separate heading, given its potential importance to re-use and recycling.<br>○ The semi-quantitative indicator proposal 2.3 Disassembly and recyclability will be developed as a supporting tool to develop building life cycle scenarios. Users will be recommended to use this tool to complement reporting on C1 and Module D declarations.<br>○ The concept of *'design for adaptability'* will be introduced as a building life cycle scenario tool alongside a scenario for *'design for deconstruction, recyclability and re-use'.*<br>○ The construction and demolition waste indicator 2.4 is to be aligned more closely with the waste categories and output flows specified in EN 15978. |

***Key points for discussion:***

1. Does the proposed combination of impact categories, output flows and life cycle scenarios improve the proposal?
2. Could material mass or *'ADP elements'* plus *'ADP fossil fuels'* be reported alongside GWP in order to engage with structural engineers?
3. Which aspects of the DGNB Germany, DGNB International and BREEAM Netherlands methodologies are suitable for 1) the design for deconstruction and recyclability scenario tool and 2) the design for adaptability scenario tool? Are any aspects missing?
4. *Common question:* how should indicator use and implementation be supported?

**Macro-objective 3: Efficient use of water resources**

***Summary findings from the public consultation and discussions with SG1 and SG3:***

- The headline indicator was supported, with normalisation based on predicted building occupation and adjustments applied to calculated household water use in order to reflect national or regional variations across the EU.
- The main challenge for the headline indicator will be the calculation methodology, which needs to be suitable for both offices and homes.
- Regionalisation could be linked to LCA methodologies and/or EEA and Eurostat datasets that are currently in the process of being updated.
- Some stakeholders requested that the use of rain water and grey water should be reported on.
- A number of stakeholders requested embodied water along the life cycle to be included.

***Table 4. Revised MO3 proposals for discussion***

| | | |
|---|---|---|
| **Proposed indicators** | **Environmental indicators** | ○ *Not directly applicable* |
| | **Final performance indicators** | ○ Net use of fresh water ($m^3$)<br>- Operational fresh water use (life cycle stage B7) (*this was indicator proposal 3.1*) |
| Technical improvements and clarifications | | ○ In order to align with the EN 15978 parameter, it is necessary to split the reporting into final water use and embodied fresh water use.<br>○ Reporting on potable water use is to focus on operational water use associated with life cycle stage B7.<br>○ The reference data for adjustment of calculated household consumption will need to be agreed. This shall reflect variations at national or regional level |

***Key points for discussion:***

1. Which aspects of the current calculation methods of Portugal, Spain, Germany and UK should be used? *Background information can be found on pages 143 – 147 of Working Paper 2* [3]
2. How should residential and office building occupation be determined?
3. What should be the reference data and method for adjusting calculated household water use to national or regional averages?
4. To what extent should rain and grey water be accounted for or reported on, or is it sufficient that drinking water is reported on?
5. *Common question:* how should indicator use and implementation be supported?

**Macro-objective 4: Healthy and comfortable spaces**

***Initial focus of attention:* Indoor air quality**

**Summary findings from the public consultation and discussions with SG1 and SG3:**

- The public consultation and discussions with and SG1/3 have highlighted the need to emphasise that indoor air quality represents only one aspect of 'health and comfortable spaces' for which indicators may be developed.
- Good quality indoor air and health-based ventilation should somehow be reflected in the parameters measured – which could include $O_2$, ventilation and relative humidity
- The proposal included a combination of hazard-based (*i.e. source control of building products*) and risk-based (*in-situ measurement of exposure*) approaches. It was considered difficult to directly relate the two, as modelling is not well advanced in this area.
- In-situ measurement (pre-occupancy) appears to be the main preference, in order to ensure that a building minimises risk and creates value for investors/owners based on real performance.
- Source control was still considered important, and is relevant as a focus for attention by design teams. Guidance should be provided on typical internal fit out products that are exposed to air and have the potential for emissions.
- Health-based ventilation should still somehow be considered alongside source emissions, but it should not be used to avoid a focus on *source control*.
- Radon should be considered (where relevant as concentrations are related to geology). Semi Volatile Organic Compounds (SVOC) and carbon monoxide were also requested.
- R-value was supported by many stakeholders even though it appears complex to verify and it is not clear if it is feasible to specify for in-situ testing.
- Mould evaluation was broadly supported, although it was pointed out that the causes can be complex and often may relate to occupant behaviours. More work is needed to bring together examples of property assessment/rating methods, accepting that a standard method is not available. The reference inspection method for Finland, where there has been a national focus on moisture and mould in buildings, is currently being reviewed.

[3] Working paper 2 can be downloaded from the study home page: http://susproc.jrc.ec.europa.eu/Efficient_Buildings/documents.html

- The role of humidity was highlighted, and it was proposed that relatively humidity should be reported on according to EN 15251.

***Table 5. Revised MO4 proposals for discussion***

| | | |
|---|---|---|
| **Proposed indicators** | **Environmental Indicators** | ○ *Potential to characterise using Photochemical Ozone Creation (POCP,kg ethane eq.) and Human Toxicity (for example, CTUh or DB eq.)* |
| | **Final performance indicators** | ○ Indoor air (IDA) class performance according to EN 15251 (*shortly to be superceded by prEN 16798*)<br>– Scope: ventilation, $CO_2$ and relative humidity<br>○ Target list of pollutants (according to source) (*this was indicator proposal 4.1*):<br>- Building product source: TVOC, formaldehyde, Carcinogenic VOCs, R-Value for VOCs<br>- External source: Benzene, particulates (PM 2,5/10,0), radon (where relevant)<br>- Biological source: Mould growth |
| Technical improvements and clarifications | | ○ The focus of attention for the reporting will be in situ monitoring based on a sample of rooms or offices.<br>- For indoor air class performance: post-occupancy;<br>- For building product and external sources: post-completion/pre-occupancy;<br>- For mould: pre-renovation and post-occupancy.<br>○ The ventilation rate, together with associated control of levels of $CO_2$ and relative humidity, are to be addressed by reporting on the relevant indoor air (IDA) classes.<br>○ The pollutant list shall be linked to Annex A6 – WHO health-based criteria for indoor air – of prEN 16798.<br>○ Guidance shall be provided on interior fit out materials that have the potential for emissions as well as test standards for both products and in-situ building testing.<br>○ Guidance shall be provided on the scoping of building location and external air quality, with reference to EN 13779 outdoor air (ODA) classes. |

***Key points for discussion:***

1. Given the support for a focus on in-situ measurement, should the pollutant scope be restricted to only those that can be practically/cost effectively assessed at both design and post-occupancy stage?
2. *For example,* how realistic is the inclusion of R-value?
3. Which components of the EN 15251 indoor air quality should be reported on? *Options could be: health-based ventilation, $CO_2$ concentrations, relative humidity*

4. Would (as recommended by experts) the inspection of mould both before/after a renovation provide a suitable basis for reporting?
5. *Common question:* how should indicator use and implementation be supported?

**Macro-objective 5: Resilience to climate change**

***Initial focus of attention:* Protection of occupier health and thermal comfort**

***Summary findings from the public consultation and discussions with SG1 and SG3:***

- The public consultation and discussions with SG1/3 have highlighted the need to emphasise that overheating and thermal comfort represent only one aspect of *'resilience to climate change'* for which indicators may be developed.
- The retention of MO5 was supported, but potentially it should be expanded to also address cooler climatic conditions in addition to overheating.
- The need for future meteorological datasets for 2030 and 2050 was not the subject of significant comment, but availability was highlighted by some stakeholders as a potential issue and the use of historic weather data for worst case years (e.g. heat waves causing excess deaths) was proposed instead.
- Indicator 5.1a *'Additional cooling energy required'* was supported but the need for dynamic simulations is considered by some stakeholders as a potential barrier. Many member states use simplified daily or monthly steady state estimates.
- 5.2b received a neutral or negative response in the consultation, but the concept of taking account of green infrastructure in building energy modelling could be supported but requires further investigation.
- The durability of external building materials exposed to changing climatic conditions was also recommended as a focus for attention by some stakeholders.

***Table 6. Revised MO5 proposals for discussion***

| **Proposed indicators** | **Final performance indicators** | ○ % of heating and cooling degree days or hours per year above/below the temperature ranges determined according to the adaptive approach in EN 15251 for:<br>- Mechanically cooled buildings<br>- Free-running buildings<br>And for the following scenarios:<br>- Present climate<br>- 2030s medium scenario<br>- 2050s medium scenario<br>(*this was indicator proposal 5.1a)* |
|---|---|---|
| **Building scenario tools** | | ○ Future climate change: This would inform scenarios relating to heating and cooling demand (life cycle stage B6) and, if added to the scope, the resilience of the external building fabric (which would have links to life cycle stages B2-5 and indicator 6.1). |

| | |
|---|---|
| Technical improvements and clarifications | ○ The duration and intensity of overheating or cooling could additionally be reported on, but would tend to rely on hourly probabilistic data.<br>○ The use of historic worst case weather data requires further investigation, as evidence reviewed for Working Paper 2 suggested that it may not provide consistent basis for risk assessment.<br>○ The resilience of external building elements to changes in the climate can be addressed through a building life cycle scenario. This could make the link between performance and cost, providing information on relevant standards. |

***Key points for discussion:***

1. Could simplified steady-state overheating assessments used for EPBD compliance be promoted alongside dynamic assessments? *If so, how should the diversity of methodologies be handled?*
2. Could meteorological data for past summer heat waves be used as a substitute for future climate change projections?
3. To what extent can the cooling effect of green infrastructure/vegetation be taken into account in the building thermal simulation?
4. Should the durability of external building materials also be considered? If so, what reference standards exist?
5. *Common question:* how should indicator use and implementation be supported?

**Macro-objective 6: Life cycle cost and value**

***Summary findings from the public consultation and discussions with SG1 and SG3:***

- Indicator 6.1a/b on long term utility and maintenance costs was supported but from discussions in SG3 it was noted that in practice the financial parameters used will vary depending on the client/property owner's investment outlook and intended service life. It was therefore suggested that a cost plan and associated cash flow be modelled without discount rates. If discount rates are to be used, some set rates could be defined. It shall furthermore be described how VAT and inflation are handled.
- Strong regional differences in costs (e.g. energy, water) might make such an indicator less useful, so this would need to be taken into account.
- Moreover, feedback from the consultation was to bring together 6.1a and 6.1b in order to provide an overall picture of costs. There were no specific comments comment on the proposal that ISO 15686-5 should be the reference standard, although EN 15643-4/EN 16627 were referred to by some stakeholders.
- The long time frames outlined in the proposals were not considered by some stakeholders on the client side to be realistic. This suggests that the time frames supported by the consultation respondents – offices 20-30 years, apartment blocks 30-50 years, individual houses 30 years - should be orientative not prescriptive.
- The potential to narrow the scope of building elements that shall be reported on was supported in the consultation, and would reflect the

current practices to support adoption. These building elements could be defined based on known problems with data availability, or conversely those that clients focus on to optimise value (e.g. HVAC, facades).

- Indicator 6.2 on '*value and risk factors'* was considered to be important by property valuation experts, but received a high neutral response in the consultation, suggesting that the idea requires further discussion and potentially also development/testing
- It was also considered that the originally proposed list of valuation factors should be expanded because they do not cover all relevant sustainability aspects that may impact on a property's value and risk profile. It was suggested to consider the aspects listed in a number of reference documents developed for use by valuers – for example, guidance developed by RICS.
- The absence of data/reporting on an indicator was highlighted as creating risk. This is because it would reflect an absence of information about a potential risk that could impact on the valuation.
- Occupant satisfaction was highlighted as a key area which could drive increased value (see discussion point 1, in relation to post-occupancy surveys).
- The presentation of verified information was considered to be of potential value.

***Table 7. Revised MO6 proposals for discussion***

| **Proposed indicators** | **Final performance indicators** | ○ Overall life cycle costs reported by life cycle stage, with separate reporting on (*this was indicator proposals 6.1a and 6.1b*):<br>- Long term utility costs: € per year and normalised per m²<br>- Acquisition and maintenance costs : € per year and normalised per m² |
|---|---|---|
| **Building scenario tools** | | ○ Future climate change: This would inform scenarios relating to heating and cooling demand (life cycle stage B6) and, if added to the scope, the resilience of the external building fabric (which would have links to life cycle stages B2-5 and indicator 6.1). |
| Technical improvements and clarifications | | ○ The two separate reporting items are intended to be of direct value to occupiers, owners and asset managers.<br>○ It could be desirable to pin some costs to national averages in order to support comparability (as is done by DGNB).<br>○ Orientative service life spans for offices, apartment blocks and individual homes could still be provided in order to indicate what can be considered to be best practice. The reference methodology shall be ISO 15686-8.<br>○ The absence of data/reporting should be penalised/lead to a higher risk rating for indicators, reflecting the absence of information about a potential risk. |

***Key points for discussion:***

1. How shall different potential service lives and types of investment be reflected in the calculation of 6.1a/b?
2. How best could attention be focussed on 'hot spot' building elements? *Would minimum reporting requirements be appropriate?*
3. How would such a reliability rating for each indicator improve the valuation process?
4. Is it sufficient to start with the reliability of the framework indicators or should other risk factors be added? *If so, which?*
5. With reference to the earlier discussion on data quality/reliability, what information should such the reliability rating take into account and provide?
6. Are there working examples of such a reliability rating? If so, how do they work?
7. *Common question:* how should indicator use and implementation be supported?