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Abstract. Interpreting contradictory results of multiple midpoint environmental indicators is challenging task. Hence, partial or full aggregation into building single scores has gained ground for the clear message they convey. This paper helps to improve understanding of the possibilities and limitations of such practice. Partial aggregated scores of five buildings were explored, limited to the environmental indicators shared by the methods examined and inventoried for the case studies. In general, the buildings' single score ranking was maintained regardless of the aggregation approach, but rank reversal is possible if e.g., ecotoxicity impact indicators are considered. Such indicators are directly influenced by the mass of metals used in a building. Furthermore, uncertainties on their results, in LCI data and in impact and damage assessment are high, and experience with them is still limited. No single best aggregation stands out per se. All of them can play their part if officially supported to ensure that coherent weights/factors are built upon solid, up-to-date data and fair intergenerational and income equity valuation procedures. In such cases, LCA practitioners are encouraged to use single scores in addition to environmental profiles or selected indicators. Overall aggregation procedures shall be transparently described, and zero pure time preference rate and equity weighting applied and explicitly declared. Sensitivity/uncertainty analysis shall be performed to assess results robustness, potential ranking reversal risks, and the effect of different discount rates. When partial aggregation is alternatively pursued, it shall be based on endpoint categories.

Keywords: buildings LCA, weighting, distance to target, panel, monetisation

1. Introduction

Within the framework of an environmental performance assessment, Life Cycle Assessment (LCA) results are available for several impact categories. Often, drawing the correct conclusions based on a broad variety of environmental impact and/or aspect-related indicators can be challenging. Sometimes, assessment methods choose to select a single LCA indicator perceived as the most important to focus on. Indeed, optimization towards one variable is much more straightforward than doing the same for more than a dozen indicators, and this partly explains the popularity of single-issue approaches like carbon footprint. However, some assessment methods support their users in interpreting disparate LCA results by applying aggregation methodologies. Special cases combine aggregated indicators with a few other essential indicators.

Aggregating indicator results into single indexes involves the optional LCIA steps of normalization and weighting [1]. In general and simple terms, each indicator result is normalised, i.e. divided by normalisation factors connected to reference information which expresses the total impact of a certain region in a reference year. Then, the normalised values can be multiplied by a weighting factor assigned to each indicator. Once they are all expressed on the same basis, they can be added up into a single value.

The purpose of weighting is to ensure that the focus is on aspects considered or perceived most relevant. However, while normalisation can be science-based, this is often not the case for weighting schemes, which inherently involve value choices that depend on policy, value systems, and cultural and other preferences [2]. Additional controversy arises when the partial results are usually no longer visible at the first look, and whether insufficiently robust indicators should be included in external communications or in a weighted result until their robustness is improved [2].

Several concepts are applied to weighting across impact categories in LCIA (Figure 1), but distance-to-target (DTT), ‘monetisation’ and the social and expert panel-based methods are most often used [3], also within the building sector. Some methods opt for equal weights to aggregate environmental indicators (see e.g., [4]). Each approach has advantages and drawbacks.

In distance to target (DTT) methods like the ecological scarcity, critical flows are derived from statistics and policy targets. Weights stem from how far society’s activities are from achieving the desired targets. The underlying assumption is that a correlation exists between the seriousness of an effect and the distance between the current and target levels. So, if for achieving a sustainable society impact A must be reduced by a factor of 2, and impact B must be reduced by a factor of 6, then impact B is regarded as three times as serious. An outstanding example in this group is the Swiss eco-factors method (UBP) [5, 6], which has been generally applied in Switzerland’s policymaking for years and in several applications, including in the building sector.

Another way to derive weighting factors in LCA of buildings is through the ‘monetary valuation’ or ‘monetisation’ of impacts [7]. Monetisation is most often based on ‘prevention’ (aka. ‘control or abatement’) or ‘damage’ cost methods. Prevention cost methods value an impact based on marginal cost to securing the relevant policy target for an impact. Doing so requires policy objectives clearly expressed quantitatively (e.g., emission concentration in the air), and cost-effectiveness analyses of all potential prevention measures to enable ranking in monetary terms per prevention (control or abatement) unit, like €/kg emission. The costs of the least cost-efficient measure to meet a given target indicates the value that society is willing to pay or impose on citizens or firms to control that environmental problem [8]. In the construction context, this kind of approach has been used e.g., in the Dutch Determination Method [9].

As quantitative policy objectives are not always available, and at times defined more on political than on scientific grounds [10], damage cost methods are sometimes preferred, like in the Belgian ‘Environmental Material Performance of Building Elements’ (MMG) method [14, 15]. Damage cost methods calculate how emissions or use of resources damage human health and the economy, in terms of additional costs, loss of ecosystem services, reduced income or loss of well-being for current or future generations. Individual environmental indicators are hence aggregated by multiplying their respective characterization values (e.g., X kg $CO_{2\text{-eq}}$) by a monetisation factor (e.g., Y €/kg $CO_{2\text{-eq}}$) that indicates the extent of the damage to the environment and/or humans. Such extent is expressed as the financial amount corresponding to the external environmental cost. Ecosystem damage valuation is based on two elements: first the damages on nature (say, biodiversity losses) are quantified, then, a value for the loss of biodiversity is needed, which is usually determined by how much of their income people are willing to give up for one additional unit of environmental quality or their 'willingness-to-pay' (WTP) for damage avoidance. Similarly, two elements are needed for human health damage valuation: first the damages on human health are quantified in terms of, e.g., disability-adjusted life years (DALY). Second, a value of life needs to be determined to monetise the damages, expressed in $/DALY for a certain region.

Finally, in a panel weighting exercise, a number of experts express their perceived severity of a given impact relatively to others in the local/regional/national/global context. In LCIA, a panel approach has been used, for instance, in damage-oriented (endpoint) methods like eco-indicator 99 [17] and ReCiPe [18], which combine a series of individual midpoint indicators into three standardized endpoints - human health, ecosystems quality, and resource scarcity - based on scientific factors. As such, value judgment is applied close to the end of the cause-effect chain. In the context of building LCA, the panel-based approach has been used in the UK (BRE EN Ecopoints [19]) to convey single-scores of normalised values of indicators mostly based on EN15804+A1.

This paper provides an overview of approaches used to aggregate LCA-based indicator values into single-scores for buildings to highlight recommendations for communication and overall calculation rules.

2. Weighting approaches used in building single scores

2.1. Swiss Eco-factors (UBP) (distance-to-target method)

The Swiss Eco-factors (UBP) according to the ecological scarcity method were first published in 1990 [5]. The method was last updated in 2021. Based on Swiss environmental policy, it allows for a complete picture of the environmental impacts of the use of energy and material resources, land and freshwater use, of emissions in the air, water bodies and soil, of the deposits of residues from waste treatment, of traffic noise and of marine fish (wild catch), expressed in eco-points. It meets the requirements of a true and fair view in terms of environmental information [6].

The ecological scarcity method uses the information on the current annual emissions of pollutants and extraction of resources (current flow, see equation below) in or of a country (here Switzerland) and the maximum allowed annual emissions and extractions (critical flow, see Equation (1)) according to environmental legislation in that country.

For every environmental pressure, the eco-factor expresses the distance to target and is defined as follows:

$$\text{Eco-factor} = \underbrace{\mathrm{K}}_{\substack{\text{Characterization}\\ \text{(if applicable)}}} \cdot \underbrace{\frac{1 \cdot \mathrm{UBP}}{\mathrm{F_n}}}_{\text{Normalisation}} \cdot \underbrace{\left(\frac{\mathrm{F}}{\mathrm{F_k}}\right)^2}_{\text{Weighting}} \cdot \underbrace{\mathrm{c}}_{\text{constant}} \qquad \text{Equation (1)}$$

Where: ***K*** is the characterization factor of a pollutant or a resource
Flow is the load of a pollutant, quantity of a resource consumed or level of a characterized environmental pressure:
Fn is the normalization flow: Current annual flow, with Switzerland as the system boundary
F is the current flow: Current annual flow in the reference area
$\boldsymbol{F_k}$ is the critical flow: Critical annual flow in the reference area
c is a constant (10^{12}/a)
UBP is ecopoint, the unit of the assessed result

Environmental pressures may be individual substances emitted to air, water or soil, radioactive and non-radioactive wastes deposited underground, individual resources extracted, or characterised flows to and from the environment. Characterization factors are determined for pollutants and resources that can be allocated to a specific environmental impact (e.g., global warming potential to quantify the greenhouse gas emissions). Here, the effect of a certain pollutant (e.g., the global warming potential of methane) is placed in relation to the impact of a reference substance (carbon dioxide). All other emissions of pollutants and resource extractions are normalised and weighted directly, i.e., without characterisation.

2.2. The Determination Method – NL (monetisation, prevention costs approach)

The 'Determination Method of environmental performance of buildings and civil engineering works' [10], hereafter 'Determination Method', focuses on the environmental performance of an entire building (or infrastructure work) - the unit to which the performance relates (i.e., the functional equivalent) - instead of on that of individual products. The design and the intended service life define the building products and installations used and the number of replacements over the service life [21].

The method is structured after the EN 15804:2012 + A1 standard [22], developed for environmental product declarations (EPDs). Weighting factors convert the calculated indicator values into 'shadow prices' [23], which supposedly represent the estimated costs that actions to prevent or solve the impact in question would have, i.e., the highest permissible cost level for the government (prevention cost) per unit of emission control.

Each characterized effect score is multiplied by the weighting factor for the corresponding unit, without prior normalization. Once all emission values are collectively expressed in monetary terms, they can be added up into the Environmental Building Performance (EBP), a single score expressed in €/m^{2}GFA*year of lifespan. These weighting factors indicate the (relative) severity of the environmental effects in the country [21]. Only the factor for abiotic depletion (€ 0.16) differs from the original RWS report by TNO-MEP [23], which set it to zero.

Until January 1st, 2021, the building environmental profile comprised eleven environmental impact categories (or 'set 1') in accordance with EN 15804+A1. In July 2020, the Determination Method was updated and included a new set of indicators - 'set 2' [21] to align with EN15804+A2 [24], but the corresponding weighting factors were not found in the searched literature at the time of writing.

2.3. Belgian MMG method (monetisation, damage costs approach)

MMG includes 14 environmental indicators, divided in two subsets. The seven mandatory environmental impact categories for EPDs expressed in EN 15804+A1 standard [22]: Climate change, ozone depletion, acidification for soil and water, eutrophication, photochemical ozone creation, depletion of abiotic resources (elements and fossil fuels) are called 'CEN indicators'. Other seven indicators (named 'CEN+') are aligned with recommendations by the ILCD Handbook [25] and the Product Environmental Footprint (PEF) Guide [16].

As the Belgian authorities specifically commissioned an aggregated building score approach and the European standards do not recommend a particular aggregation procedure, the MMG developers opted for an environmental external cost-based weighting method [15]. Three optional aggregated environmental scores, expressed in monetary value (EURO) are used: for CEN indicators, for CEN+ indicators, and for an overall single score, which is the sum of both.

For most impact categories, information on damage costs is available, though at different amount and quality. Categories such as terrestrial and marine ecotoxicity are not yet translated to environmental costs, while others like land use impact on biodiversity, ecotoxicity require proxies such as the costs of typical measures, amount of environmental taxes, or restoration costs (e.g., ecosystems and biodiversity) or configure multi-source and multi-effect problems (e.g., acidification, ozone formation, particulate matter) that complicate prevention cost assessment for single effects, whose targets often reflect short term compromises instead of long term policy objectives, and are seldom used as indicators for social costs [8].

For most impact indicators, MMG's central estimate is based on damage cost approach and a 3% p.a. discount rate is applied, whilst the low and high estimates account for uncertainty and information from other sources and methods, including that based on prevention costs. External environmental costs may vary regionally. As most processes related to the life cycle of building products are related to Western Europe, only those values are considered for the publicly available version of the method. The monetary values for Flanders/ Belgium and the 'rest of the world' are determined for sensitivity analyses sake.

Worldbank's purchasing power parity (PPP[5]) is used to adjust monetary values for differences in GDP/capita between Western Europe and the 'rest of the world' (RoW= 40% of Western Europe values) in cases like acidification of land and water sources, eutrophication, human toxicity and particulate matter impacts [8].

2.4. *UK BRE EN Ecopoints (panel approach)*

In 2015, UK BRE assembled an expert group weighting exercise to create a set of weightings for an aggregated metric (BRE EN Ecopoints) to be reported in addition to the parameters required by EN 15804 standard. The panel assessed the relative importance of eleven EN 15804+A1 environmental indicators, preselected as representative of the overall environmental impact of the construction products analysed, whilst ensuring that it reflects the relative importance of the underlying issues within the Western European context [19]. Human and ecotoxicity impacts are excluded, and waste and freshwater use - relevant environmental pressures for construction activities - are counted in.

The characterised data for the eleven environmental indicators are referenced to the impact of one European citizen per year, using appropriate normalisation factors. The normalised impact values are then multiplied by the weighting factors for each indicator and their summation gives the single score.

The highest BRE EN Ecopoints score indicate the highest environmental impacts. The derived weightings can be used in communicating the environmental performance of construction products in BRE decision making tools and building level assessment tools [19].

In parallel, a stakeholder panel went through the same survey and procedure used for the expert panel. A multi-criteria decision-making method was used to generate the weights and subsequent prioritisation of the issues in terms of their impact. The chosen option was the analytic hierarchy process (AHP), which uses fuzzy logic to make sense of value judgements, through pairwise comparisons. A detailed description of the weighting exercise consistency, reliability, sensitivity analyses for both the expert and stakeholder panels is provided by [19].

3. **Method**

Four approaches used to aggregate LCA-based indicator values into single-scores for buildings are examined: distance-to-target Swiss Eco-factors (UBP) 2021 (CH); monetisation methods MMG (BE) and Dutch Determination Method (NL); and panel-based weighting method BRE EN Ecopoints (UK). Calculations were illustratively applied to five selected building cases to shed light on key points to consider when aggregating building scores. Assuming a simplified evaluation at building level as the sum of material impact of their building elements, calculations were applied to five cases - concrete and masonry school building, a steel-framed laboratory, a concrete-framed and masonry residential high-rise, an office passive building, and a wood-framed building - assumed as built in the same country.

These cases had been previously assessed in accordance with the EN15804+A1 standard and using CML-IA baseline and CED methods. Hence, only the corresponding indicators values were available for use, which limited our application. Inventories, LCA assumptions and methodological decisions are not herein detailed, given the focus on aggregation through different perspectives.

4. **Results**

Environmental impact categories considered, indicators within them and weighting/monetisation factors used in the different methods vary. Some categories – ODP, AP, EP, POCP – are most often used, but only GWP is present in all selected methods. Hence, Table 1 displays all impact factors (1 unit of impact) relatively to the impact of the emission of 1 kg CO_{2eq}.

The Swiss Eco-factors (UBP) 2021 weighs ODP much heavier than any other approach: one ODP reference unit is about 25,000 times as serious as one GWP reference unit, which is about 25 to 42 times

[5] PPPs enable to compare the output of economies and the welfare of their inhabitants in 'real' terms, as they control price level differences across nations. The PPP concept is used by multilateral institutions like the UN, Worldbank and IMF, policymakers and private sector agents, among others.

higher than that assigned by monetisation approaches used in the building sector. It notably details assessment of impacts on human health. BRE EN Ecopoints, the panel-based method examined, weighs climate change much heavier than any other impact. Regardless of the approach chosen, panel-based weighting sets incorporate values and subjectivity. Users should be aware and encouraged to routinely carry out sensitivity analyses to test the effects of changes in the weighting set on the environmental impact scores.

Though contrasting factors across methods based on different grounds is not meaningful, comparisons within the same aggregation approach reveals variations to some extent expected, as both criticality perception translated into policy goals and mitigation valuation can vary regionally. For example, MMG applies a factor to abiotic depletion potential excluding fossil energy carriers between 10 times higher than its neighbour Dutch DM, which in turn weighs acidification heavier by about the same factor. In this regard, the SBK value attributes all the prevention costs of reducing SO_2 emissions to 'acidification', whereas these costs should be shared with health impacts from secondary particles.

Other divergences of the kind are noticeable. The Dutch DM breaks down ecotoxicity into terrestrial, marine and freshwater, while MMG considers only the latter, while distinctively attempts to address built environment specifics like land use occupation and transformation.

Table 1. Relative single score impact factor of the emission of 1 unit of an impact compared to the impact of the emission of 1 kg $CO_{2\text{-eq}}$ in the methods examined.

Environmental impact	Original reference unit	UBP21 CH [1]	MMG BE [2]	DM NL [3]	BRE EN Ept UK [4]
Global warming potential [1] [2] [3] [4]	kg CO_2-eq.	1	1	1	1
Ozone depletion potential [1] [2] [3] [4]	kg R11-eq (CFC-11-eq)	25,000	982	600	0.56
Acidification potential [1] [2] [3] [4]	kg SO_2-eq.	8.3	8.60	80	0.35
Human toxicity potential [3]	1.4-DCB-eq			1.8	
Human toxicity: non-cancer effects [2]	CTUh		2,881,620		
Human toxicity: cancer effects [2]	CTUh		13,302,180		
Carcinogenic potential of PAH, dioxin, furan and benzene emissions to air [1]	CTUh	$2.6 * 10^8$			
Carcinogenic potential of radioactive emissions to air [1]	GBq C-14-eq.	110			
Carcinogenic potential of radioactive emissions to surface waters [1]	GBq U-235-eq.	29			
Carcinogenic potential of radioactive emissions to seas [1]	GBq C-14-eq.	150,000			
Oestrogenic potential of endocrine disruptors [1]	kg E2-eq.	$8.7*10^6$			
Bioconcentration factor of persistent organic pollutants [1]	kg 2,4,6-tribromphenol-eq.	59,000			
Impact potential of plant protection products [1]	kg glyphosate-eq.	285			
2000-watt society primary energy resources [1]	MJ oil-eq.	0.0083			
Depletion of abiotic resources: fossil fuels [2] [4, in GJ]	MJ, net calorific value		0.02		0.17
Depletion of abiotic resources: fossil fuels [3]	kg Sb-eq			3.2	
Abiotic depletion potential (excluding fossil energy carriers) [1] [2] [3]	kg Sb-eq	0.15	31.2	3.2	
Mineral resource extraction [4]	tonnes				0.27
Non-hazardous waste disposed [4]	m^3				0.09
Hazardous waste disposed [4]	m^3				0.21
Radioactive waste disposed (higher level) [4]	m^3 high level waste				0.29
Radiotoxicity of radioactive waste [1]	cm^3 HAA-eq.	54			
Eutrophication [2] [3] [4]	kg $(PO_4)_3$ - eq		400	180	0.34
Photochemical ozone creation [2] [3] [4]	kg (C_2H_4)-eq		9.6	40	0.24
Particulate matter [2]	kg PM2.5-eq		680		
Ionizing radiation: human health effects [2]	kg U235-eq		0.02		
Terrestrial ecotoxicity [3]	1.4-DCB-eq			1.2	
Marine aquatic ecotoxicity [3]	1.4-DCB-eq			0	
Freshwater aquatic ecotoxicity [3]	1.4-DCB-eq			0.6	
Ecotoxicity: freshwater [2]	CTUe		0		
Net use of fresh water [4]	m^3				0.63
Water resource depletion [2]	m^3 water-eq		13.4		
Biodiversity damage potential through land use [1]	m^2.a settlement area-eq.	0.63			
Land use occupation: soil organic matter [2]	kg C deficit		0		

Land use occupation: biodiversity flows. loss of ecosystems service [2]		
from urban	m^2yr	6
agricultural		6
forestry		0.12
Land use transformation: soil organic matter [2]	kg C deficit	0
Land use transformation: biodiversity flows [2]	m^2	
from urban land		n/a
from agricultural land		n/a
from forest		n/a
from tropical rainforest		540

Aggregated scores were calculated for the four individual midpoint impact categories for which all methods selected provide a quantitative assessment (GWP, ODP, AP, ADPresources); for the seven CEN midpoint categories (MMG and Determination Method) (Table 2). In general, the performance ranking was maintained, regardless of the aggregation approach used. However, rank reversals are possible, particularly when ecotoxicity categories are considered. Such indicators are directly influenced by the mass of metals used in a building. Furthermore, uncertainties on their results, in LCI data and in impact and damage assessment are high, and experience with them is still limited, as disclaimed in EN 15804+A2. One possibility is to aggregate results with and without those categories for now, as recommended by [2] for PEF aggregated scores.

Table 2. Environmental single scores of five building cases, considering four categories common to all methods (or seven categories, for MMG, Determination Method and BRE EN Ecopoints). The higher the score, the worse (in red) is the performance.

Weighting approach	DTT	Monetisation				Expert Panel	
Methods and categories weighted	Swiss Ecopoints 2021	MMG (Western Europe)		Dutch Determination Method		BRE EN Ecopoints	
	4 common	4 common	7 common	4 common	7 common	4 common	7 common
Weighted score (per m^2GFA*year)	UBP	€				Ecopoints	
School building, concrete-frame, masonry	51,533.15	2.57	4.93	3.63	4.77	1,178.17	3,381.32
Laboratory building, steel-framed, metal cladding	42,061.40	2.10	4.66	2.94	4.16	962.44	2,742.79
Residential high-rise building, concrete-framed, masonry	18,046.26	0.90	1.74	1.25	1.66	414.92	1,144.87
Office passive building	14,010.69	0.70	0.99	0.89	1.04	326.49	974.58
Residential building, wood-framed	8,962.94	0.45	0.66	0.60	0.72	206.69	662.94

4 common categories: GWP, ODP, AP, ADP resources | 7 common categories: GWP, ODP, AP, EP, POCP, ADP resources, ADP ffuels.

The adherence of the Determination Method to the available pre-assessed indicators allowed its aggregated score to be fully calculated. When the additional ecotoxicity categories were computed, the school concrete building and the steel-framed laboratory reversed ranks. This is not an inconsistency of the method itself or of the monetisation approach, as the methods general structures herein examined are not fully comparable, but rather an expression of how the buildings' materiality (considerably more steel in the lab building) is described by the ecotoxicity indicators added, which also bear high uncertainties, as previously mentioned.

5. A final word on discounting

Costs and future benefits differ in their distribution over time and must be brought to a common point in time to become comparable. A centrepiece to do so is discounting, which uses discount rates to put a present value on costs and benefits that will occur at a later date. Discounting (using positive discount rates) always gives a lower numerical value to damages in the future than to those happening in the present. When using a low discount rate, more importance is given to future generations' wellbeing in cost–benefit analyses, which supports the view to act now to protect future generations. Contrastingly, the use of a high discount rate implies that people put less weight on the future and therefore that less investment is needed now to guard against future costs. Its choice greatly influences valuation outcomes when impacts and mitigation measures spread over very long time periods, as for climate change. GHGs long lifespan in the atmosphere will extend over generations, thus the damages expected of their emissions today are valued centuries into the future.

In an inter-generational framework, the 'pure time preference rate' characterizes the ethical attitude towards future generations. The second key ethical parameter is the 'purchase power parity', which indicates if a life-year lost by any world citizen causes the same economic damage regardless of where he/she lives. There is a strong case for factoring in the ethical issues of (intergenerational and income) equity- and age-weighting via the social discount rate. The Intergovernmental Panel on Climate Change (IPCC) Second Assessment Report (AR2) notes recommended, as early as 1996, a discount rate of 2-4%, by considering fair to account for a pure time preference rate equal to zero, and a growth rate of GDP per capita of 1-2% per year for developed countries and a higher rate for developing countries that anticipate larger growth rates [11]. IPCC's AR5 [12] reinforced the case for a zero or near-zero pure rate of time preference to, holding consumption constant, give all generations equal weight in calculating social welfare. Finally, IPCC's AR3 Chapter 7 highlighted the substantial ethical controversies involved in valuing human health impacts and recommended that valuation techniques to determine monetary values of statistical values of life shall reflect people in a fair and meaningful way and use uniform average global per-capita income weights to treat all human beings as equal.

From the monetisation approaches currently used in the building sector, only MMG explicitly declares adoption of a social discount rate of 3% p.a., on average in line with declining rates over time used by several governments, and of purchasing power parity (PPP) do account for GDP/capita variations. The Dutch DM uses a shorter list of individual LCIA indicators, whose monetary values mainly refer to a study on shadow prices commissioned by the Dutch Ministry of Infrastructure and Environment to TNO in 2006. Shadow prices have been updated since then, until a thorough conceptual update commissioned by the same Ministry resulted in the 'Environmental prices Handbook 2017' [13]. From its 2020 supporting documentation, the Determination Method has not adopted the updated environmental prices concept so far. It only provides the shadow price-based weighting set used, without explicitly declaring key monetisation decisions it relies upon. The discount rate is herein inferred to be a 3% p.a. rate, as advised by the Discount Rate Working Group [30], but no reference to purchase power parity/equity weighting was found.

6. **Final remarks**

The weighing of environmental impact scores into one or a few scores is often requested by the target audience. Using a single-score indicator to express the environmental performance makes it easier to compare the environmental performance of different buildings with each other, and to communicate it.

It also provides a comprehensive picture, which allows to identify the important environmental impacts and the most relevant building elements or construction materials. That is why some countries like Switzerland have a long-term tradition in applying single score methods in LCA which are endorsed and authorised by the Swiss Federal Administration.

There is no best method for aggregating impact results, though, and each one has strengths and limitations. Expressing policy targets in quantitative terms is not always straightforward and factors for relevant categories indicators still lack. Value choice-based damage estimations often embeds personal attitude and perspectives of the decision-maker. And monetisation costs are established within a virtual market, whose results can involve considerable uncertainty. Moreover, not all countries and regions have equally developed science, targets and data.

LCA practitioners carrying out studies in regions or countries with data and methods that allow weighting are encouraged to report an aggregated index in addition to the detailed environmental profile, for communication's sake. Target audiences not familiar with the implications of weighting should be made aware of the controversy and objections to do so, of the uncertainties embedded, and of the fact that, despite the acknowledged limitations, attempts to evolve are in course to help to fulfil their practical relevance. That said, as general recommendations:

- Give preference to weighting schemes endorsed by authoritative bodies like national environmental agencies or ministries. Among others, this is expected to ensure that the sets of prices/costs/weights are updated every few years to reflect the latest policies.
- Where appropriate, use conversion factors that comply with scientific or engineering principles first. These normative principles apply to any level of aggregation (see also ISO 21931-1).
- Use a method that explicitly declares all conversion/weighting factors and assumptions made. Aggregation procedures shall be transparently described in easily accessible documents.
- Always provide partially disaggregated information, the life cycle inventory result or, even better, the unit process data shall in addition to the aggregated score.
- If impact category indicators embed high uncertainty (e.g., ecotoxicity), present the aggregated result with and without those individual indicators.
- If monetisation methods are used, choose one that applies zero discount rate and world average equity weighting, in line with IPCC's recommendations.

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