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Environmental assessment & rating – have we lost the plot?

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Abstract

This paper asks whether after 20years of development, the new discipline of environmental impact assessment and rating has lost its way. The paper shows examples of problems in building environmental rating systems, and corrupted science in Life Cycle Assessment (LCA), Ecolabelling and Environmental Product Declarations (EPD). Comparisons are drawn with carbon accounting and the problems this will cause for government policies aimed at mitigating climate change internationally. The author speculates on possible causes and provides contrasting examples of initiatives that are trying to produce truly credible, scientifically robust outcomes but struggling to find acceptance. The author concludes with suggestions that might tip environmental impact practice back to legitimacy and relevance.

Peer-review under responsibility of the organizing committee iHBE 2016.

Keywords: Environmental Rating; Life Cycle Assessment; Ecolabel; Environmental Product Declarations

1. Are Building Environmental Rating Systems Failing?

After 15 years of phenomenal growth in the uptake of LEED in the US and internationally, growth has stalled Figure 1.

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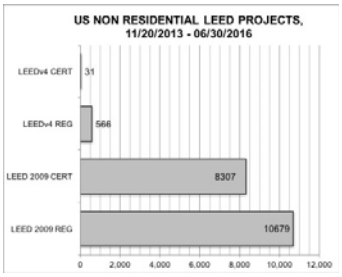


Fig. 1. LEED Projects in Decline.

Yudelson's book "Reinventing Green Building" [1] explores the likely reasons which include:

- A bloated agenda of issues that makes rating cumbersome, slow, expensive and bureaucratic.
- High cost making building rating exclusive to the BIG end of town.
- The expanded range of credits effectively marginalising the most critical issues like climate change.
- Hostile competition from both the traditional opponents of green building and from factions within the green building movement (including its own Chapters), impatient for progress on particular issues – e.g. health [2]
- The proliferation of competing rating systems confusing the market.

As US Green Building Council try to appease all stakeholders, they add more credits, compounding the problem.

Existing buildings are the largest sub-sector with the biggest footprint – only 1-2% of buildings are replaced every year (Europe) [3], so in any year at least 98% are existing buildings. Least progress is being made for existing buildings because:

- responsibility is shared between the owner and many tenants all with competing needs,
- performance varies continuously and needs to be tracked annually by the rating,
- but above all, the value proposition shared between owners and occupants is weak.

Few existing building rating tools have succeeded internationally without government support/mandate (e.g. Green Mark Singapore [4], Hong Kong BEEAM [5]).

- Technically many LEED rated buildings are falling short of expectations for energy and emissions performance. After 20 years of evolution, energy modelling is still not reliably predicting real building performance, costs and climate impacts. On average LEED rating is delivering 28% savings (better than the predicted 25% saving). But, the scatter in real vs modelled performance is alarming - some rated buildings don't even meet code requirements [6] Figure 2. LEED credibility is at stake.

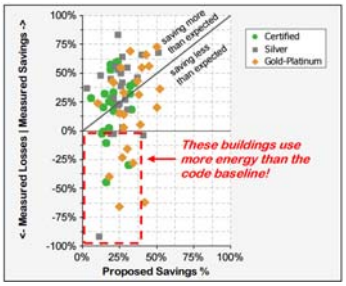


Fig. 2. LEED Measured Savings vs Modelled Savings

- Too many credits (including for energy) are based on relative rather than absolute performance resulting in perverse outcomes. It is easier to get energy credits in harsh climates (say Alaska) with a high absolute impact than in mild climates (say San Diego) with a low absolute impact. If LEED rewarded credits on an absolute basis then buildings in San Diego would automatically do well and could direct their innovation to other aspects, whilst in Alaska it would be vital to focus innovation in energy saving. Green Star also has relative energy credits, BREEAM has absolute credits.

- Overall energy use and greenhouse gas emissions from buildings are still going up in the US, with Green Building rating only making a small dent in the rate of growth (2%), and limited to large commercial buildings [7] Figure 3.

Fig. 3. US Energy Intensities

In Australia, according to ASBEC, housing regulation has made the biggest difference. Commercial buildings have reduced emissions by a similar 2% [8] to US. Even this 2% reduction may be optimistic though, other sources show a 5% increase in Commercial Building energy intensity [9]!!

The proliferation of credits, loss of focus, increasing costs and marginalisation to the BIG end of town are inherent problems for most rating systems internationally including Green Star in Australia.

2. Is Life Cycle Assessment (LCA) Failing?

LCA should be the most comprehensive, scientific and objective way of assessing environmental impact, but LCA seems to have lost its way. LCA has become divided into competing factions supporting either:

- traditional process LCA with a bounded scope physically and over, time measuring recent past performance OR
- consequential LCA unbounded physically or over time based on scenarios of likely future change

These two approaches should be complementary and not competing because they answer different questions – neither is appropriate for all uses. Most LCA studies gauge current performance (Ecolabels, EPDs) or inform decisions of modest scope over short to medium timescales. For these, bounded scope process LCA is most appropriate, because it is focussed on answering the questions of concern from current (recent past) data.

For government or major corporate policy or planning, where the implications of the decisions being informed cannot be easily bounded physically or over time or where the effect of the decisions will perturb the entire system with perverse or amplified feedback consequences, consequential LCA should be used, with the most plausible economic and technical scenarios embedded. The scenarios adopted will often determine the outcome though.

In addition, so-called “hybrid LCA” has emerged as a mix of traditional bounded scope LCA with unbounded scope LCA. This approach has been adopted as an expedient for filling data gaps, perhaps from economic

Input/Output data. Unsurprisingly, the unbounded scope data has an exaggerated prominence compared to the bounded scope data, making it impossible to draw robust conclusions from the hybrid LCA results. Hybrid LCA mixes five apples with two apple trees to make seven sources of fruit – it is not good science.

3. Are LCA, Environmental Product Declarations (EPDs) and Ecolabels?

After 20 plus years of debate, no significant progress has been made to build international consensus in a single, universally applicable robust LCA methodology to ensure consistent outcomes between practitioners, between competing products, between industry sectors, between nations. The weak ISO14040/4 international standard puts little constraint on every practitioner, sector, company adopting whatever version of methodology best suits their interests. ISO14040/4 now fails as a "standard" - "Something used as a measure, norm, or model in comparative evaluations" [10].

LCA studies, EPDs and Ecolabels abound showing every competing product/service to be best environmentally Figure 4. Sometimes the competing LCA's even come from the same practitioner/author (not these ones).

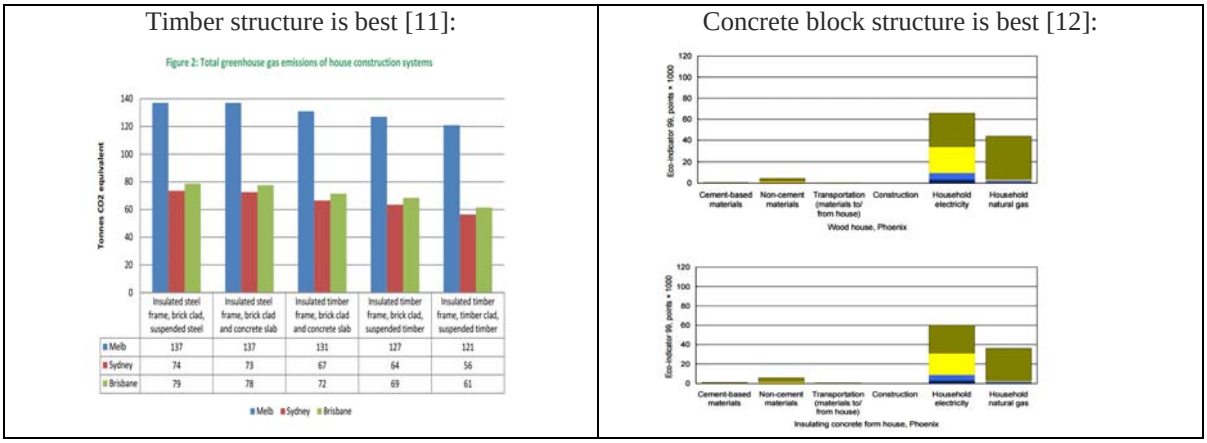


Fig. 4. Everyone's a winner with LCA

The main abuses in LCA methodology are:

- Misleading goal and scope definitions - physical or temporal scope
- Functional units that don't relate to function or create misleading comparisons with alternatives

Fig. 5. Misleading Functional Units and Scope

An Australian/International EPD for Kitset light fittings, uses a declared unit of 1 piece of light fitting / fixture / luminaire. The EPD [13] describes how because these are made of wood they are beneficial for sequestering carbon. As architectural features these fittings are attractive, but the function of a light fitting is surely to provide light. These light fittings substantially shade the light from the globe and since the largest life-cycle impact of the unit will really be its lifetime electricity consumption (the wood will be trivial), then impacts from the electricity use are likely to be very high compared to competing light fittings for the same illuminance. The scope and functional unit are misleading for not taking into account the full life and being expressed per unit of useful illuminance. This would have given a far less favourable impression of this light fitting compared to alternatives.

- Inconsistent rules for allocating single process impacts to multiple co-products for example:
    - Electricity, heat, flyash (used in cement) and bottom ash
    - Oil refinery co-products – LPG, naptha (plastics), transport fuels, lubricating oils, waxes, bitumen
    - Metals, slags (competing with flyash for use in cement), recycled metals
    - Transport services (e.g. planes carrying customers and cargo)
    - Wool (competing with plastics textiles), cuts of meat, bonemeal, leather

Traditionally mass was preferred as the allocating parameter, but obviously can't be used consistently with electricity/heat/flyash/bottom ash. Calorific allocation has been traditionally used for oil refining, but still doesn't work for electricity/heat/flyash/bottom ash. More recently, we have come to appreciate that processes exist to make money not mass or calorific value. It requires a philosophical shift to transition to economic allocation, but once adopted permits universally consistent application. LCA is riddled with inconsistent allocation units even up and down the supply chain of each product/service calling into question what any final LCA result really means. Economic allocation can be used with universal consistency.

- Abandoning the fundamental thermodynamic principles of LCA by compromising mass/elemental and thermodynamic balance.

Ecoinvent is the most prestigious and complete source of LCA data that most LCA practitioners rely on internationally. The latest revision – V3 of the Ecoinvent database, converts all multi-output processes into sets of apparently discrete single-output processes, using a proprietary algorithm to allocate the impacts between the co-products. This algorithm misinterprets ISO14040/4 by allocating not only the transformation processes, but also distorts the already known, mass balanced quantities of feedstocks transforming into quantities of co-products. The Ecoinvent guidelines [14] candidly admit this problem but erroneously attribute the cause to economic allocation:

"While mass inputs and outputs are balanced for each multi-product activity, the derived single product datasets are only balanced for the applied allocation property, and only if the partitioning is applied to all outputs"……
"The inability of system models with economic allocation to correctly reflect the elemental balances has led to the suggestion to add allocation corrections for the most environmentally important elements."

Economic allocation is not to blame – any allocation parameter would cause this problem if applied to feedstocks and co-product flows and not just to transformation processes. Moreover, the allocation parameter used is also inconsistent – economic allocation predominates but calorific allocation has been used for electricity generation and oil refining. Since these contribute to the inventories of all other processes, physical reality, mass/elemental/thermodynamic balance are distorted for the entire V3 database.

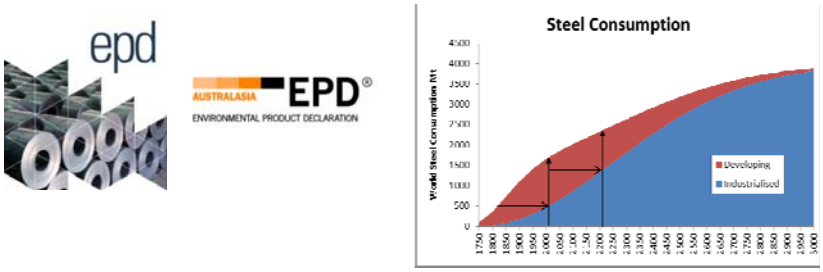
Although this problem is easily resolved by limiting allocation to transformation processes (as ISO14040/4 requires) the problem has remained for several years, compromising the integrity of all LCA's conducted using Ecoinvent V3 data. Disturbingly, this has been ignored and tacitly accepted by the LCA community!

- Intergenerational equity is also being compromised in LCA because of sustained pressure from commercial vested interests. The EN15804 standard has been adopted internationally to guide EPDs [15]

When accounting for future recycling benefits from primary production (Module D for impacts beyond the declared EPD scope), the CEN TC509 WG 3 have ruled that long-term (much higher) recycling rates should be used rather than current recycled contents. This breaches mass/elemental/ thermodynamic balance cycle-to-cycle and results in recyclable materials claiming large discounts from their current production NOW based on recycling that will not actually happen for many generations into the future – see Bluescope EPD example below.

Within the same module D, biomass products (Wood) should report the re-release of sequestered carbon. Claiming long term recycling benefit from the future to offset today's production and declaring today the reemission of sequestered carbon from biomass products that will not happen for generations into the future grotesquely distorts the apparent merits of these two materials for climate change mitigation. When IPCC climatologists are declaring a "Climate Emergency" [16] requiring urgent action to mitigate greenhouse gas emissions, we surely can't afford misleading claims actively promoted in European/International standards.

- Claiming large discounts from today's production impacts based on the promise of recycling benefits for future generations in EPDs.



World Steel Consumption and Development (Drawn by Author)

Fig. 6. Misleading EN15804 Module D Discounts

Bluescope Steel's International EPD [17] claims a Module D discount of 43% from its profile of current emissions and impacts on the basis that it's steel products will be recycled in future. The average period for steel to return for recycling is 100 years (i.e. 300 years for say 95% return). The demand for primary steel correlates with building infrastructure in developing countries. Extrapolating the historic rate of development for the proportion of the world still needing this infrastructure it will take 1000 years before the claimed recycling rates are reflected in the recycled content of new steel Figure 5. The way to preserve mass balance cycle to cycle is to use current post-consumer recycled contents (8.5%) rather than the eventual recycling rate (95-99% claimed for steel) and this would provide under 4% discount for future recycling (still taking 300years to realise). Meanwhile this EPD is informing decisions that will probably take a frightening toll on future generations from climate impacts long before the discount claimed NOW can ever be realised.

- Counting post-industrial waste recycling as though it were post-consumer recycled content.

Post-industrial waste is usually waste from fabrication of downstream products. This waste has provided no service to humanity, and should not be counted the same as genuine post-consumer recycled material. The perverse effect of treating post-industrial waste the same as post-consumer waste is that the more wasteful your fabrication processes, the larger the proportion of your impacts you can offset against recycled content and the smaller your apparent lifecycle impact profile. Being wasteful benefits rather than penalises your profile. To avoid this problem, post-industrial waste should be treated by system boundary expansion to wrap around the fabrication plant, the post-industrial waste then disappears from the inventory as an internal cancelling flow and the final product is just the fabricated product.

- The final cause for inconsistency in LCA arises from interpretation. Different practitioners use different sets of impact categories expressed in different ways before drawing conclusions and recommendations.

The first step in interpretation for a multi-attribute LCA entails classifying inventory items for their contribution to different impacts, then characterising them for their potency. This phase of LCA works quite consistently and will progressively improve for emerging impact categories. Many practitioners feel that they can interpret their results adequately at this stage (the minimum required for EPDs).

Normalisation is an optional step in LCA which serves firstly to benchmark all results back to a common basis – usually per-capita in each impact category and secondly to render all results dimensionless for comparison between categories. Some practitioners like to interpret their results at this stage, which takes no account of the relative importance of different categories to the public or to the client for the study. A comparison at this stage implies equal importance for all impact categories even though some may be just inconvenient whilst others may threaten extinction to large populations/ecology or even mankind itself.

The normalisation step must use the same normalising baseline but some environmental impacts are of global scope and should be normalised globally, others have more local scope (like water resources in a catchment) and should be normalised at their relevant scale. Impact assessment in LCA nearly always uses the national average citizen's impacts as its unifying parameter despite the fact that none of the impact categories genuinely have a national scale of impact (all are global or more local).

Changing the unifying principle to one of carrying capacity would allow all impacts to be normalised at scales appropriate to each impact. This would probably be more rational but presents practical challenges which have yet to be resolved and accepted into LCA practice. This provides a fertile topic for research.

The final optional stage in LCA is to weight the dimensionless results for relative importance. This has proved contentious in LCA and is even outlawed for "comparative assertions disclosed to the public" in ISO14040/4. This seems strange when studies making "comparative assertions disclosed to the public" are precisely the contentious ones where interpretation most needs to be freed from practitioner bias. Recently weighting is finding more acceptance because it practically reconciles a complex inventories back to easy comparisons.

Use of a standardised set of weighting factors provides a way to interpret results free from individual practitioner bias. Research conducted in UK (1997), US (2001), NZ (2007), Au (2010, 10 Cities, 8 major climate zones) [19] reveals that most of the preconceptions about weighting (i.e that only experts understand the issues well enough to weight appropriately) are incorrect. These weighting survey results provide a robust way of standardising the final step in reconciling and interpreting environmental impact results objectively and free from practitioner bias. These and earlier weightings have been used to weight credits within the BREEAM rating tools and the UK Green Guides to Specification and for NSDO standards development, but are otherwise ignored by LCA practice.

Using a well-designed survey method, there is a surprising degree of consistency in weighting results over time, between nations, regardless of demographics (age, sex, income), regardless of job title or seniority, with similar patterns of minor variation for particular stakeholder groups. The results are to a modest degree influenced by media in advance of the survey.

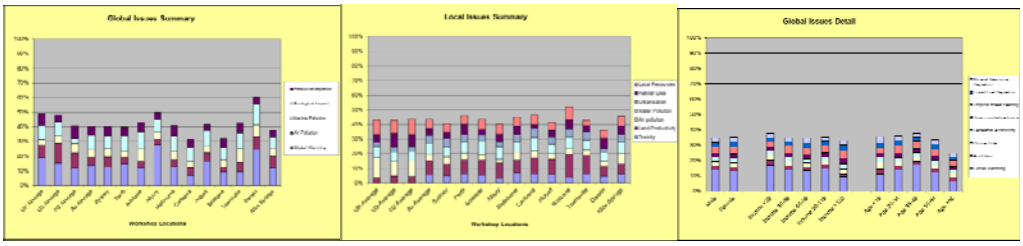


Fig. 7. Example Weighting Results [19]

Environmental and sustainability experts produce almost the same average weighting results as the general public, but with a wider spread of results. Arguably, the general public weight more consistently because they have no expertise bias to favour. Practitioners that don't use weighting presumably impose their biases in interpreting their environmental impact results.

4. LCA and carbon Accounting

LCA could be providing a robust technical basis for carbon accounting, but the lack of a single consistent methodology has prevented this. Different nations, sectors of industry and companies account carbon in different ways - problematic for Governments making commitments and designing policies to mitigate carbon emissions. These may put financial liabilities on carbon or incentives on measures that mitigate or sequester carbon. These policies may rely on carbon trading or taxes. What does a carbon offset/trade/price mean if the carbon offset is not measured compatibly with the carbon emitted? To-date there has been little acceptance of standardised carbon accounting measures and voluntary carbon prices have degenerated to the level of the cleverest cheating rather than ramped up as the seriousness and urgency for climate action has become evident.

The World Resources Institute and World Business Council for Sustainable Development have written the Greenhouse gas Protocol - A Corporate Accounting and Reporting Standard which offers voluntary guidance to corporations. [18]. This is a valiant effort, but still falls short of prescribing sufficient detail to ensure consistent accounting of carbon across all sectors, by all corporations/nations and between emitters and mitigators/ sequesterors. Perhaps a globally consistent methodology for carbon accounting should be mandated by UN to enable consistent policy drivers and carbon prices internationally?

5. Surely we can do better?

We can reverse the decline in the green building movement by focussing on a core set of critical issues and restoring scientifically credible metrics to measure and reward truly and significantly improved performance. Smart credits that promote maximum performance improvement at least cost to implement, document and assess for compliance can reduce costs and make the achievements of the BIG end of town accessible to the whole industry. Government support and patronage are also needed to drive rapid change. Focus on core critical issues can provide common purpose that all factions to promote a single vision of Green building. Bold, determined, charismatic leadership is needed from Green Building councils.

In LCA, we should fight harder for an internationally agreed consensus methodology that would work consistently in all economic sectors, up and down all supply chains. Strong technical leadership is required to hear and reconcile the interests of all vested interests, but prevent compromise of the fundamental scientific principles that underpin LCA.

In the UK BRE developed the UK Ecoprofiles Methodology with 23 vigorously competing industry sectors – completed in 1999 (as a majority report) after 10 years of contentious debate. This put in place supplementary requirements to ISO14040/4 that could ensure consistency [20]. The methodology has stood the test of time with only minor revisions in 2008. It is still used as the basis for the UK Green guides to specification that practically bring life cycle materials considerations into the UK BREEAM rating tool.

The Building Products Innovation Council (BPIC) Life Cycle Inventory project (BPLCI) is the Australian equivalent, taking 3 years of tough debate between the 10 main building product trade associations to reach consensus. Edge Environment used this methodology with seamless consistency in buildings, for infrastructure projects and even for Walmart in Chile for food and consumer product labelling. The agreed BPLCI methodology did not permit any of the misleading practices or bad science that are now endemic in LCA. The BPLCI methodology has been used to underpin the work of the National Standards Development Organisation (NSDO) to develop “Product Category Baseline Assessment” reports and truly robust freely available standards for ecolabels and EPDs [21]. The set currently covers Masonry Products and Roofing Systems with Windows soon to be published. Despite being founded on the Australian life Cycle Assessment Societies (ALCAS) own AusLCI methodology, ALCAS have actively opposed the use of the BPLCI methodology and NSDO standards, because they impose constraints that conflict with the weak requirements of International EPD that ALCAS are now commercially

vested in. BPIC have revised their consensus methodology guidelines to remove the crucial aspects of the methodology that enforce consistent outcomes to align with ALCAS advocacy.

NSDO's work remains based on the consensus agreed Version1 of the BPLCI. To-date, despite the rigour and robustness of NSDO work, these standards have been boycotted by EPD and ecolabelling conformance assessment bodies, perhaps because they shine such an unflattering light on the current stock of EPD's and ecolabels that the industry is vested in. Green Building Council of Australia (GBCA) could play a pivotal leadership role by requiring use of Version 1 of the BPLCI methodology for projects seeking LCA based credits within Green Star. They could also recognise NSDO based ecolabels and EPDs, to assure the credibility and consistency of Green Star's LCA based credits.

Over the past 20years, no significant progress has been made by official bodies to refine LCA methodology internationally (mainly Europe). Over 30 years, I have found that the most successful initiatives for change have started as unofficial grass-roots activities. I have tried to spark grass-roots engagement internationally through an "LCA Round Table" LinkedIn group [22] for folk dissatisfied with the state of LCA, who want to develop an unofficial, entirely voluntary grass-roots, internationally consistent, scientifically robust "Grail" methodology. Use of the "Grail" methodology with peer review to demonstrate compliance could establish a body of robust LCA's, ecolabels and EPDs that would stand in stark contrast to the current stock of compromised LCA. If this gained momentum as the "trusted" source of robust LCA then, in time, it would become adopted as the new international standard. Such a methodology might also provide a proper basis for internationally consistent carbon accounting.

6. Whole Building Integration

Design and facility management software tools and BIM can provide a fully integrated system for buildings. My own pet project, intermittently developed over 25years and now based on the BPLCI V1 methodology is branded ENVEST® and targets design inception [23] where the most critical decisions are made, usually in under an hour, on the basis of very limited information and locked-in never to be revisited. Usually these decisions are suboptimal with a long tail of consequences, often with perverse outcomes for the cost and performance of the building(s).

ENVEST® works with the limited information available at inception, requiring just location (postcode), building size (GFA), mix of uses and budget to start working. ENVEST® models a bland rectangular plan design that would fit these requirements (provided the budget is feasible) and then determines the initial and life cycle costs and environmental impacts of the design. The design team can choose to optimise based on any of 16 different environmental impact categories (including Climate Change and a composite weighted Ecopoint).

The initial design is locked-in as the reference and now the design team can experiment with different shapes, glazing areas, shading options, rooflights and atria, orientations, specifications (and hence material choices), structural systems, building services systems (including solar PV's and water heating). As the ENVEST® default parameters are replaced with design decisions, the ENVEST® reference design morphs into the actual design.

Every decision in ENVEST® is informed by a sweet spot diagram, (vector plot of the cost vs environmental effect) of the decision compared to the reference. ENVEST® potently reveals the often perverse consequences of design decisions as they are being made and before they are locked in. ENVEST® includes a low resolution, rapid estimating energy model. ENVEST® is highly dynamic, modelling and reconciling 16 layers of interaction between climate, uses, daylighting, building services, controls, element specifications (materials), structure, internal finishes, colour, life, cleaning and maintenance and their associated costs to reveal perverse outcomes.

ENVEST® can always significantly reduce both the initial and life cycle costs and environmental impacts for a building design simultaneously. Savings in cost and environmental impact are usually in the 10-20% range, but can be much greater. ENVEST® is being developed in 3 versions – for new commercial mixed use and multi-residential buildings, for existing commercial mixed use and multi-residential buildings and for houses. Web based, BIM

integrated versions are planned subject to funding and these provide a super-easy entry to BIM. The commercial/mixed use/ multi-residential web version is about 10% complete.

7. How has Environmental Impact Assessment gone astray? How can we repair the science and get back to legitimacy?

In a new field, the participants share a common goal of establishing their discipline. Critical questioning may be subdued out of a shared sense of loyalty to the cause. In the interest of establishing the discipline, vested interests that might go unchallenged initially, but then become entrenched in perpetuating bad practice that benefits their interests. In the long run though, this bad practice can become institutionalised and the practitioner community can become dulled to it and even complicit in justifying it. Those that do challenge can be perceived as negative, arrogant and disloyal and tend to be isolated. In Environmental Impact Assessment, when all of our clients win, we know that we have stopped genuinely differentiate products/services on a sound objective scientific basis and our practice has degenerated into Greenwash.

In 2016, although we have better tools than ever, we seem to have little stamina for addressing complexity. Many of the issues that we need to resolve are inherently complex, we can't afford to leave them unresolved.

We need to be more courageous, honest and ambitious for what we can achieve and keep control of our vested interests/stakeholders. With our top climate scientists declaring a "climate emergency" potentially even threatening mankind's extinction, there is nothing more important. We can't afford to compromise on good science any longer because nature will crush us for our delusions and duplicities.

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