Driving 'Beyond LCA' Metrics for Net Positive Cities

David Baggs[1] Delwyn Jones[2], Mathilde Vleig[3] &Shloka Ashar[1]
[1] Global GreenTag, Morningside, Brisbane Australia
[2] The Evah Institute, Tamborine Mountain, QLD, Australia delwyn@evah.com.au
[3] Vlieg LCA, Yeronga, Brisbane, Australia

Background

LCA focuses on negative impacts of systems [1,2, 3]. It fails to adress most urgent climate change risks [4,5]. It can but does not yet quantify positive ecological system benefits essential for safe operating space within planetary boundaries [6].

Twenty five Non Government Organisations from 6 countries submitted a letter at the 2015 meeting of the ISO TC 207 on Environmental Management. It supported critical updates to ISO 14044 requirements for LCA and climate metrics used by 300,000 companies worldwide to make decisions about their products and operating systems [6]. It said: *"It is clear from the IPCC that we must act with significant emissions reductions in the next 5-10 years if we have any hope of avoiding irreversible climate change. Having a proper set of metrics installed to steer policy in the short amount of time we have to act is critical, as these metrics are essential guides for any type of informed decision making."*

Introduction

LCA issues to resolve include effectively ignoring the:

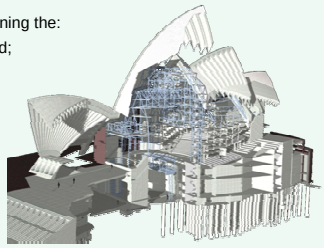
- 100-year horizon ignoring science, pace scale of oncoming climate tipping points;
- biomass emissions, especially from forest and paper industry sources;
- 60% of global radiative forcing caused by short-lived climate forcers;
- short-term climate benefits of reducing methane emissions by 80%; and
- mitigation opportunities in climate hot spots [5].

New life cycle benefit analysis (LCBA) can measure city operations that re-constitute ecological services and generate health benefits including oxygen generation and water cleansing.[7,8,9]. New metrics depicted in Figure 1 and listed in Table 1 allow measurement of progress towards true sustainability across the built environment from products to buildings to cities. The generation of scientifically robust, whole of life metrics, needs to done in a way that does not mean the whole industry must become instant experts in healthy chemicals and life cycle analysis.

Aim

The aim here is to demonstrate reasoning underpinning the:

- need for a change to the way LCA is conducted;
- use of LCBA beyond impact assessment
- proposed LCBA methods and metrics
- ways LBCA is used for products and projects



Scope and Methodology

Exemplars are vital to show how development:

- May factor in urgent climate change
- Can deliver net positive carbon outcomes
- May integrate planetary boundaries

CASE studies shown use novel LCBA metrics and tools to measure progress towards true sustainability across the whole built environment including products, buildings & infrastructure.

Results and Discussion

Result of various tools allow industry-wide, easy comparison of products. With adaption, LCA of developments can explore what is needed to constitute truly sustainable communities & cities.

For example LCBA results of renewable power New Zealand FCS pine 28mm 22kg/m2 MDF offers priority 1 33kgCO_{2e20}/m^2 climate brake. Figure 2 show a net-positive design whose world first full building life LCA results are depicted in Figure 3 and Table 2 [8,9] .

Figure 3 depicts a model of the Sydney Opera house which if rebuilt now in world's best practice Aragonite limestone precast concrete would yield a benefit of >17kt CO_{2eq} Aragonite brake = >0.01% of Australia's CO_{2eq}pa.

Tables 3, 4 & 5 shows LCBA results of

- 47%PCR stainless steel 1.87kg/m drain with 2.3kgCO_{2e20}/m brake on climate change
- 89% PCR 0.8kg/m^2 Polyester insulation saved 49% GGE, 99% water use in manufacture.
- 2400gsm ceramic floor tile with 40MJ/m^2 feedstock reuse cogenerated 78MJ heat plus 6.2 MJ/m^2 biofuel as well as priority one -52kgCO_{2e20}/m^2 braking of climate change potential.
- Recovered fish net 1000gsm upholstery 50%PCR SDN6 saved 43% water, 39% fossil fuel
- Impacts & benefits 4kg/m^2 Carpet SDN6 Face fibre 6% PCR versus virgin product

These exemplars show how development can contribute to delivery of ecological services and healthy environments

Conclusions

The need for 'beyond LCA' metrics is demonstrated in practical CASE studies including of

- LCA comparing impacts and benefits for Type 1 and Type 3 ecolabels
- Positive outcomes of projects to achieve Green Building Council Ratings
- Fitout product LCBA for Environmental Product Declarations
- Building scale LCBA for net carbon positive outcomes

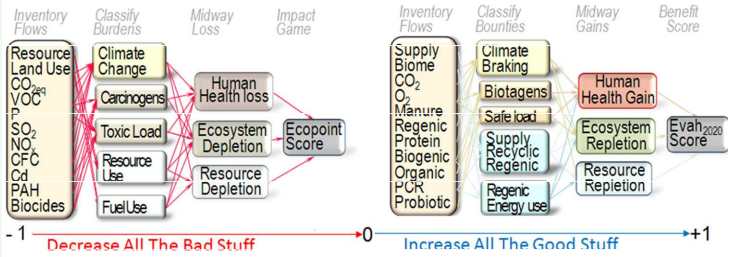


Figure 1 Negative Impact To Positive Benefits

Table 1 Benefit Assessment Metrics

Benefit Layer	Positive Outcomes	Unit
Health	Hale Human Health Years	HALY m^2/yr
Indoor Oxygen	Oxygen generation with carcinogen sequestration	IAQ m^2/yr
Outdoor Oxygen	Make O_2 avoid pollutants to replenish species health	Ox m^2/yr @ C1750
Low Allergen Air	Sequestration of dust, inorganics and allergens	Air m^2/yr
Climate Braking	Carbon sequestration for safer climate with less damage	CO_2e $_{20\ year}$ m^2/yr
Safe Water	Avoid toxics in effluent Toxin mg, rain Ml pp	Potable Ml pp/yr
Access	Secure food, water & rest Food kJ,H_2O Ml & Area m^2 pp	Access kJ Ml m^2 pp/yr
Household	Local supply shelter, food, water GFA, vkm work, MJ pp pa	Shelter MJ m^{2}pp/yr
Ecosystem	Positive Ecosystem Replenished Formation	PERF*m^2/yr
Secure Space	Captured pollutants to protect corridors and habitat	Space m^2/yr @ C1750
Bio-Stock	Balance toxins and replenish terrestrial aquatic biodiversity	Stock m^2/yr @ C1750
Built Bounty	Building GFA converted to natural carrying capacity	Built m^2/yr @ C1750
Urban Bounty	Urban land area converted to full natural carrying capacity	Urban m^2/yr @ C1750
Secure Climate	Community soil & biomass sequester CO_{2e} & generate O_2	Clime @ C1750 m^2/yr
Stock Habitat	Land native fauna, flora range biomass $O_{2\ carrying\ capacity}$	Habitat @ C1750 m^2/yr
Stock Aquatic	Restock marine catchment fauna & flora range biomass O_2	Marine @ C1750 m^2/yr
Secure Safety	Equity, recreation & aid crime rate+ Ha + Medical km pp pa	Safety/capita/m^2/yr
Supply	Energy & Resource Viability	SERV*MJ/yr %
Viable Supply	Replenish concentrated & locally accessible resources	Supply MJ/yr
Viable Water	Replenish concentrated & locally accessible reservoirs	Water MJ/yr
Viable Fuel	Enhanced catchment or supply of renewable fuels	Fuel MJ/yr
Viable Reserve	Enhanced regeneration of scare material reserve stock	Reserve MJ/yr
Viable Mineral	Enhanced regeneration of finite material reserves & stocks	Mineral MJ/yr
Viable Food	Reliance on local Organic food Ha, tkm & MJ % pp pa	Food MJ/yr
Viable First Aid	Accessible Aid & Medicine Paramedic Ha, vkm% pp pa	Nurse MJ/yr

Figures 2 & 3 Building LCIA & LCBA Results

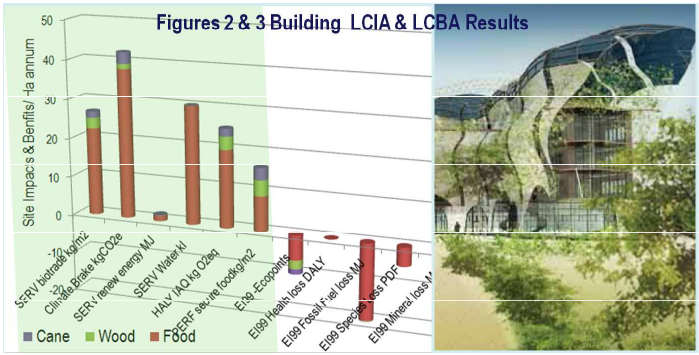


Table 2 Building Design LCBA Positive & LCIA Negative Results

Method	Metric	Unit	Gross
Evah 2020 LCBA Benefits	Biomass Energy	SERV $_{trade}$ kg/m^2	26.7
	Climate Brake	HALY $_{clime}$ kg CO_{2eq20}	42.2
	Energy Renewable	SERV $_{energy}$ MJ $_{surplus}$	1.5
	Water Catchment	SERV $_{Water}$ kl $rain_{eq}$	30.1
	Healthy Oxygen	HALY $_{IAQ}$ kg O_{2eq}	25.2
	Retained Food Stocks	PERF $_{secure}$ *m^2	16
EI99 LCIA	Point score	Ecopoints Burden	-9.9
EI99 Impact	Human Health Loss	Death Adjusted Years	-0.05
EI99 Mid Point Damage	Ecotoxins	Disappeared Fraction	-76.3
	Fossil Fuel Depletion	MJ surplus required	-19.9
	Acid/Eutrophy	Disappeared Fraction	-4.7
	Mineral Depletion	MJ surplus required	-0.1

Table 3 Building Design LCIA+LCBA Net Positive Results

Method	Metric	Unit		Brake Climate CO_{2eq} sequestered	
Units	SERV $_{biomass}$	SERVE $_{feed}$	SERV $_{reuse}$	HALY $_{clime}$	PERF $_{ecos}$
Drainage	2.2MJ/m	7MJ/m		2.35kg/m	2.19 kg/m
Insulation	0.2MJ/m^2	56MJ/m^2	90MJ/kg	30kg/m^2	27kg/m^2
Ceramic Tile	6.2MJ/m^2	40 MJ/m^2	78MJ/m^2	14kg/m^2	10kg/m^2

Table 4 50% PCR SDN Upholstery LCIA+LCBA Net Positive Results

20 year	Renewable Feedstock	Recover Resources	Brake Climate
Units	SERV $_{biomass}$	SERVE $_{feedstock}$	HALY $_{clime}$
	0.41MJ/kg	≤70MJ/m^2	4kgCO_{2e}/kg

Table 5 6% PCR Carpet LCIA Negative + LCBA Positive Results

Metric	ReCiPe $_{mid}$	BAU	6%PCR	Evah $_{2020}$	Benefit	Unit
Climate change	Radiative Forcing	-17.6	-11.98	HALY $_{clime}$	5.6	kg CO_{2eq20}
		-15.5	-10.63	PERF $_{ecos}$	5.0	kg CO_{2eq100}
Resource Depletion	Metal	-0.50	-0.26	SERV $_{resource}$	0.2	kg Fe_{eq}
	Fossil	-2.7	-1.83	SERV $_{biofuel}$	0.9	kg oil_{eq}

References & Bibliography

1. Bare, J. C. (2012) Tool for the Reduction and Assessment of Chemical and Other Environmental Impacts V2.1 Manual EPA/600/R-12/554
2. Goedkoop M et al (2000) Eco-indicator 99 Manual for Designers, https://www.pre-sustainability.com May 2016
3. Goedkoop M et al.(2008) RECIPE 2008 Method, Dutch Ministry of Housing, Spatial Planning & Environment
4. Stocker et al (eds.) Climate Change 2013: The Physical Science Basis, CH8, IPCC AR5, Cambridge U, UK
5. http://environmentalpaper.org/wp-content/uploads/2015/09/To-the-ISO-TC-207-Secretariat-11-September-2015-1.pdf
6. Rockström, J., W. et al (2009) Planetary boundaries: exploring the safe operating space for humanity. *Ecology & Society* 14(2):32
7. Birkeland, J. (2008) Positive Development: From Vicious Circles to Virtuous Cycles etc, Earthscan 408 p.
8. Cole R J. 2015. Net-zero & net-positive design. Building Research & Information, 43:1, 1-6
9. Renger B. C., Birkeland J. L., Midmore D.J. (2015) Net-positive building carbon sequestration, Building Research & Information 43:1, 11-24

GLOBAL GREEN TAG INTERNATIONAL
green product certification trust brands

The Evah Institute

VliegLCA