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Netzwerk Footprinting - a holistic approach to assess environmental impacts

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Abstract

The ***Netzwerk Footprinting*** is a network of leading Austrian research and consultancy institutions founded to allow synergies within the research agenda of footprinting.

We define footprinting to be all methods that assign an objective value to environmental impacts and resources/ energy consumption of human production and consumption.

This includes dealing with existing metrics like Ecological Footprint, carbon footprint, water footprint, material footprints, combinations thereof and the forthcoming environmental footprint. We thrive to understand their interrelations and aim at improving the practical applications as well as the comparability of results.

In order to avoid shifting environmental pressures from one ecosystem to another, we promote
a) to look at all relevant environmental dimensions, especially including carrying capacities and biodiversity
b) to apply the biggest possible system boundaries (“outer stratosphere”)
c) to look into the wider effects of the products and services as well (consequential LCA)
d) to look at the hot spots of the environmental impacts applying the pareto-principle

A matrix approach is suggested to allow comparability along the life-cycle chain.

Ideas for visualizing the results in a comprehensible way are in development and will be presented later.

Keywords: Footprint, system boundaries, allocation rules, consequential LCA

Mission and Goal of Netzwerk Footprinting

The ***Netzwerk Footprinting*** was established in 2010 within the NGO **Plattform Footprint** by inviting leading Austrian research- and consultancy-institutions (see annex) to develop a common research agenda and to allow synergies for all kinds of footprining.

Netzwerk Footprinting aims to spread interest in, knowledge about, and applications of Footprinting into the broader business community.

We wish to see ecological accounting used by all individuals, public and private businesses, governments, and essentially all human institutions. Starting with Austria and the German speaking neighbors, we aim at influencing the debate on EU level and further. Ultimately we would like to see true Ecological Accounting to become a generally accepted economic procedure, with its metrics prominent and important like the Gross Domestic Product (GDP) today.

In this paper, we use the **term footprinting** for all kinds of methods that assign an objective (at least verifiable) value to environmental impacts and resources/ energy consumption for the production and use of products and services along their whole lifecycle.
This includes dealing with existing and forthcoming metrics, understanding their interrelations and improving the practical applications.

The methods recommended should allow all institutions and businesses to systematically account for and manage ecological assets, identify the risks associated with ecological deficits and measure tangible progress towards sustainability.

Netzwerk Footprinting aims to foster free and fair exchange of information. Clear rules are especially important in a field dominated by business sponsored research, undisclosed data and otherwise proprietary information.

Members of *Netzwerk Footprinting* thrive to provide business and decision-makers with relevant information to support the transformation of today's world into a more healthy and sustainable place.

The task

Human activities have depleted non renewable resources and polluted the environment for centuries. Lately, we act beyond the ability of ecosystem earth as a whole to cope with the impacts of these activities.

Equally worrying, today, humanity consumes more natural resources than the Earth can produce. Global calculations estimate that humanity's demand on nature is currently more than 50% greater than the planet's ability to meet this demand. [[i]0 This global "ecological deficit", also called ecological "overshoot" is depleting the natural capital on which both human life and biodiversity depend. Collapsing fisheries, loss of forest cover, depletion of fresh water systems and fertile soils, and most notably - accumulation of carbon dioxide in the atmosphere, are the already noticeable consequences of unchecked human consumption. If these trends continue, ecosystems will continue to collapse, leading to permanent reductions in the Earth's ability to provide sufficient resources for life in the future.

In spite of all efforts to reduce specific impacts, resource use continues to rise and especially rates of the use of biotic resources are expected to accelerate even further. To move out of the global overshoot situation, and to create a sustainable long term future for the planet, it is imperative that individuals and institutions around the world aim to live within the planet's natural resource limitations.

Addressing rising resource demands and associated impacts in the emerging economies and other developing countries, and seeking to reduce over-all consumption and associated impacts from wealthier countries will need a much better "management" of global resources.

Members of the network strongly believe that "**You can't manage what you can't measure".** This is true for ecological sustainability as well. Accordingly, managing sustainability in "Spaceship Earth" does require suitable metrics to measure the multiple dimensions of ecological sustainability.

However, when it comes to ecological impacts and even more, to humanity's demand on nature, there is no conclusive metric yet to allow measuring sustainability.

Why is information key for sustainability?

We acknowledge that for most places on earth and for most industrial sectors, almost any type of resource accounting will offer significant improvement to current practice.

However, our aim is to think well ahead and envision a society fit to deal with ecological limits, be it by taxing, tradable certificates or strict limits on access or usage.

Regardless of the political choices, informing customers and implementing regulative measures will require solid and comparable data about the impact of the process/product or service in question. Even a goal of "pure ecological enlightenment" of people would require metrics to understand and communicate the individual and collective impact of human actions.

Most likely, a mix of consumer awareness and local as well as global regulative measures will provide the necessary political and economic framework for reducing overshoot.

Knowing the true environmental "costs" is required for

- helping informed choices by customers
- allowing benchmarking between products/sectors,
- allowing to introduce purposeful regulatory policies
  (provide the base for taxes and levies)
- allowing introduction of allowances and global caps

Ultimate vision:
A resource-based economy with global per capita tradable resource allowances

We see the ability to allocate footprints to products and services as a necessary (though not sufficient) building block for **future-proof economic activities.**

The challenge: Measuring the total human impact on Ecosystem Earth

There have been a number of methods developed to help understand the human impact on nature, and to support ecologically sound decision making.
However, none of them can exclusively claim to describe a significant enough portion of ecological sustainability.

While the general rise of the idea of "reducing footprint" helps to raise awareness for impacts and resource use in general, it blurs the differences of the approaches and thus blurs some of the key messages of the different metrics.

We feel that there is too little emphasis with providers of environmental monitoring to educate users and target groups in understanding the principally different aspects of **ecological sustainability.**

We propose a four leaved clover to explain the complexity of environmental sustainability and the relating metrics:

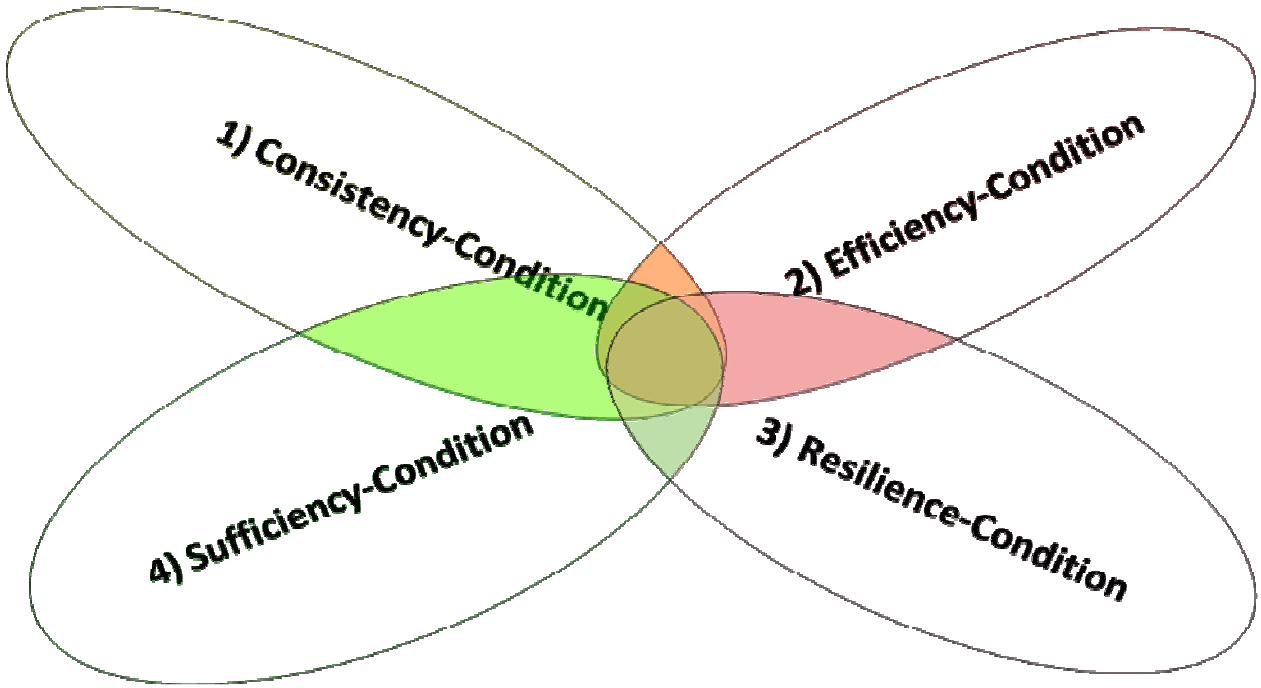

Figure 1: suggested "clover-leaf" for environmental sustainability, Pekny 2009

1) Consistency-Condition
All activities need to be in closed cycles, embedded in bigger natural cycles. Consistency is safeguarding carrying capacity regarding discharges.
Products and processes need to be non-toxic, climate-neutral, bio-degradable, bio-safe)

Addressed e.g. by CP (clean production), C2C (cradle to cradle) approaches and supported by REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) and the forthcoming environmental footprint.

2) Efficiency-Condition
Energy, material, acreage (and money) need to be utilized with least impact and maximum benefit. Realized e.g. by energy efficiency measures or reduction in MIPS (material input per unit of service)

3) Resilience-Condition
Ability of a system to cope with gross disturbance. In any phase, the system should stay functionally stabile. In many cases, maximizing efficiency will reduce resilience and vice-versa. (Biological-, cultural- and technical diversity are the key to increase resilience. (No metrics yet?)

4) Sufficiency-Condition
The imperative to get along with what is available in total. This condition is safeguarding carrying capacity regarding available resources and sinks.
Not only fossil fuels, noble earths and other non-renewables are limited. **Biocapacity is limited too!**
Addressed e.g. by Ecological Footprint, water footprint (at least time wise and regionally)

Ecologically future-proof societies will need to address all environmental aspects.
The most effective approach is not a maximum of one of the aspects but the optimum of all.

Existing approaches:

A set of accounting tools and metrics has been developed in the last few years. Some are already competing on the market and offered to customers, often enough without proper scientific basis or solid peer review.

Members of the Network have worked with a wide variety of metrics and methods, including GHG emissions analysis, "carbon accounting" and materials flow analysis, Ecological Footprint, carbon footprint, water footprint, the SERI set of indicators, EMAS and ISO approaches to LCAs and "Buwal-Points".[ii] **Fehler! Verweisquelle konnte nicht gefunden werden.**

The term Ecological Footprint originally was coined by Wackernagel and Rees[[iii]**Fehler! Verweisquelle konnte nicht gefunden werden.**] to measure the amount of biocapacity expressed as area necessary to provide the resources and sinks needed for a given region and a given lifestyle. At the same time, leaving a "footprint" has become a very strong metaphor understandable to everyone. Due to this striking metaphor, within a decade, "footprint" became almost synonymous for "environmental effects" in the general sense.
Examples of the wider use of the term "footprint" are the carbon footprint [[iv]], which in fact is a GHG rucksack, the water footprint[[v]] and sometimes even the term "material footprint" for the ecological backpack.[[vi]]
Additional, the latest development for a multidimensional environmental indicator–set developed by JRC / DG 11 [[vii]] **Fehler! Verweisquelle konnte nicht gefunden werden.**in the EU is called "Environmental Footprint", although it does not relate to area at all.

However, none of the approaches can satisfy our desire to really understand the human impact on ecosystem earth.

Our vision: A comprehensive Ecoindicator-System

- understandable for consumers
- reproducible and scientifically verifiable
- useful for regulatory politics (eco-taxes, contract & converge…)
- affordable for the business community

Ideally, all eco-information would condense to one figure, analogous to "price", in convertible currencies, and become as ubiquitous as "price" is for goods and services.

However, this is very unlikely to be achievable anytime soon. *See Potential for a basket of indicators to monitor environmental impacts from natural resource use, Report to the European Commission, DG Environment*.[viii]

So, for the time being, we seek a universally comparable set of indicators/metrics to provide the basis for sectoral improvement and cross sectoral comparison.

Only such comprehensive Eco-Indicator-Systems can form the base for a "Global Sustainability Indicator" system, which, of course, also will need to consider social criteria as well as global fairness and equitable convergence. "Economic sustainability" in the long run will be rather the result than a pre-requisite of a future-proof society!

Central questions with Footprintings for products and organizations

Our practical experience shows that regardless the methodology, almost any comprehensive LCA gives valuable information to the entity under investigation.

However, in order to benchmark products or organizations, the results need to be comparable. With today's "standards" we are far from this ideal.

Not even within the same metric (e.g. measuring CO_2) the results are easily comparable. Standards like PAS 2050[ix] the efforts by GRI [x] or Thema1[xi] and many more helped to some degree, but creating more confusion on the other hand. Unfortunately, the forthcoming ISO 14067 will bring no satisfactory solution to this either.
We understand that for the sake of practicability, standards are often achieved by excluding complex or contagious elements. Nevertheless, some of these non-elements might be highly important, (e.g. see the debate on including ILUC (indirect land use changes) in agro-fuels.

We understand that measuring and labeling "environmental impacts" of products, services and enterprises is a young „science", still featuring little transparency, limited scrutiny and hidden commercial agendas.

Our goals:

- Overcome the non-disclosure-dilemmas to allow scientific scrutiny
- Seek biggest possible system boundaries (include full process, ILUC (indirect land use change), human power, long term effects, even consequential effects)
- Wide and general PCRs to allow functional comparison ("travel" instead of "air-travel")

- An (EU-wide) open, independent, „wiki"-like compilation of all (physical) primary data of raw-materials, processes and basic services.
- Should be suitable for whatever aggregation and display formats are chosen.
    - (In principle, similar to GEMIS [xii]**Fehler! Verweisquelle konnte nicht gefunden werden.**, but multi-dimensional and invariant to display-metrics![xiii]

A set of sustainability parameters

We find footprinting to be of highest value when it provides information that can be used at many levels of decision making, from individual choice to industrial benchmarking and to national and global policy making.

Almost regardless of the metrics chosen to assess the physical „impact" of a product, a service or an organization, the choice of system-boundaries and allocation principles is key to a uniform, comprehensive approach and the comparability of the results.

Within the network footprinting, we propose a convergence process among the members that aims at making results comparable at least within the same metric. Special emphasize is given to a common understanding of system boundaries and allocation-principles

In order to relate results with different system boundaries to each other, we propose a matrix approach allowing defaults to substitute for missing data.

indicator / system boundaries	employee activities	capital goods	raw materials	manu facture	distribution / retail	consumer use	end-of-life	lasting consequential effects
ecological footprint								
carbon footprint								
water footprint								
material footprint								
environmental footprint								
further metrics …								

Table 1: example for a matrix of LCA-elements and metrics

Given the complexity of correctly calculating all these sectors, we propose to start with default values for all elements based on available literature, (should be under steady improvement).
Any incomplete investigation can be supplemented with default elements of the matrix to enlarge the system boundaries to the complete picture.
Certainly, a best guess is closer to reality than omitting an aspect in the first place, which would set the impact to zero.

Ultimately, such a matrix can also help to relate different metrics to each other.

Often, the calculations are based on a set of similar primary data. For example, carbon footprint and Ecological Footprint require CO_2-information that is identical, providing the same system boundaries.

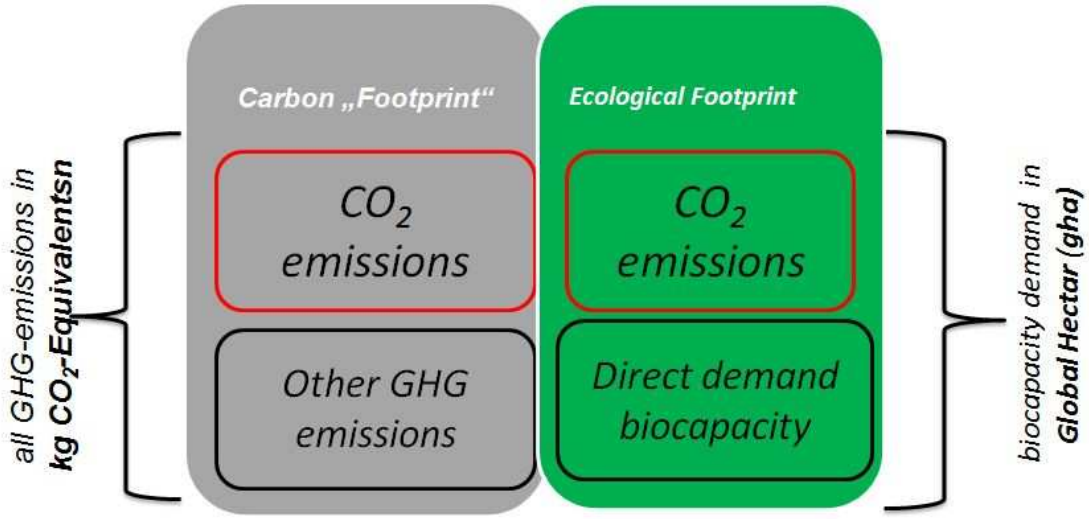

Figure 2: Simplified relations of EF und CF Burger et al., 2010 [xiv]

Main differences of current approaches to a holistic approach

ISO, GHG protocol, PAS 2050	**Archetype for holistic system boundaries**
Central question: How can specific parameters be minimized?	Central question: How can we reduce global overshoot and support a “one-planet living”
pragmatic system boundaries	vision-driven system boundaries
Industry/market oriented	Information/consumer-oriented
LCA-based	system-oriented, uses LCAs
bottom-up	bottom-up and top-down
policy derived “limits”	intrinsic global limits
Suitable for relative comparison of products or branches (benchmarking)	allows global and trans-sectoral comparison
applies simplifications for the sake of practicability	seeks holistic view and defines interim practical steps.
average national electricity mix	Specifies “green” electricity
ignores capital goods, housing and carpool	Includes capital goods (embodied footprint)
Human-resources excluded	Human resources included (labor and subsistence)

Table 2: differences of current and holistic approaches

Assessing the footprint of organizations

In a consumption-based approach, the footprint of an enterprise equals its total contribution to the consumption-footprint of those consuming products and services of this enterprise.

To complete the picture resulting from LCAs, we need to know the total impact of the producing/providing organization. (Including grey footprints, e.g. embedded energy, capital investment and the appropriation of infrastructure and public services.) This can be assessed bottom up (add overhead) or top down (hybrid I-O), but methods are still far from standard.

The total impact of an organization (including overheads etc.) needs to be completely allocated to its final products/services brought to market (including waste and un-sold products). There must be no unallocated footprint left!
The total of all product/service footprints (including all investments in capital goods) plus the footprint of subsistence-living should equal the total global footprint.

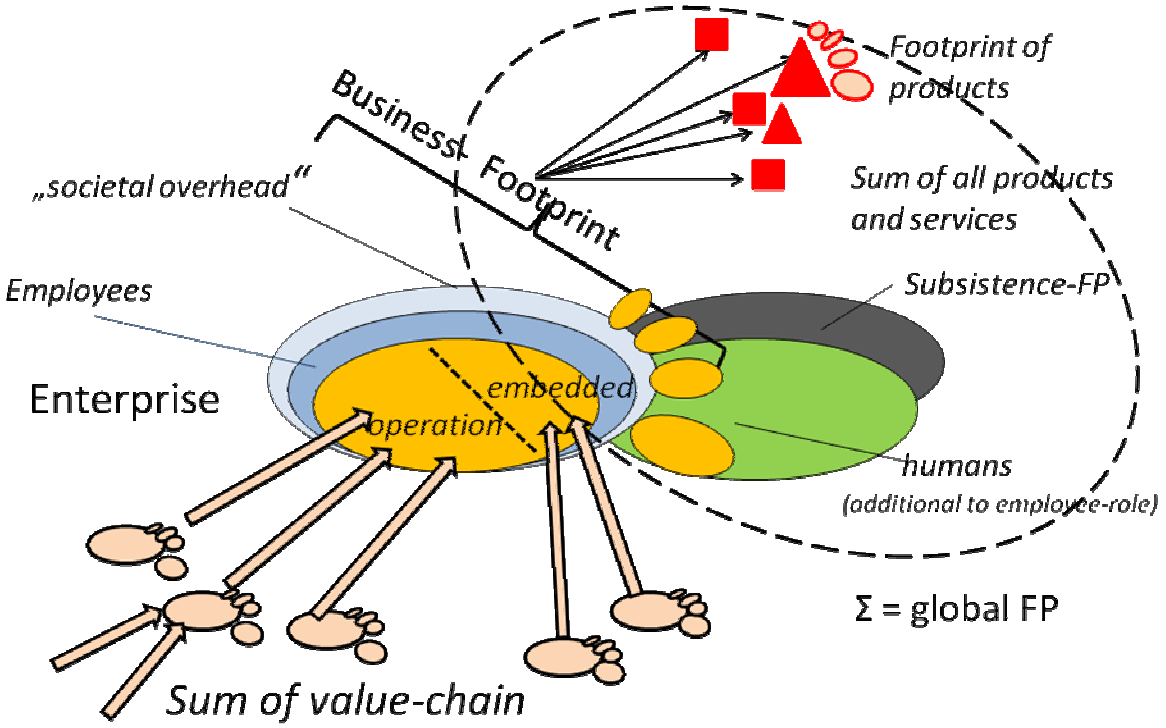

Figure 3: schematic flow of Footprints seen bottom-up and their aggregation to global totals [xv]

In calculating the total global footprint, business footprints and consumption footprints cannot be added!

Producing effects for sustainability instead of information overflow

While it is fair to strive to know as much as possible about the specific footprint of a product, a service or an organization, experience indicates that applying the **paretoprinciple** can significantly reduce the effort for the beginning. Indeed, depending on product type and sector, only a few aspects of the entire lifecycle determine the majority of impacts. These principle relations would be well displayed by the default values in the suggested matrix above.

Another central question is how to make the results **comprehendible and useful** for the users.

At the moment, a wide array of very different functional units and PCRs (product category rules) make comparison difficult and sometimes even useless.
Allocations of footprints may be per year, per lifetime, per kg, per MJ, per portion and many more. Data may refer to "at farm", "at shelf", "at consumption", "transport only" or indeed the total lifecycle, ideally even including the wider consequences of the consumption (e.g. rebound effects). Information may be absolute or relative within a given sector. Especially with relative ratings, narrow PCRs can produce fallacious information. (e.g. "best performing beef" might appear better than "poor potatoes", or the "best performing flight" better than a poor train-trip, both of which are grossly misguiding indications.)

Labeling the carbon footprint of an inflight-menu is gross deception! [xvi]

Within the Network Footprinting, we strive to convince clients to emphasize comparability and "global information value" over short term commercial interests.

We urge all certifying institutions to make sure that labels addressing consumers give indeed information fostering ecological benign choices rather than being mere marketing tools.

Beyond metrics

While promoting the compilation of exact data for products and services, we understand that there are no future-proof products per se.

Any judgment useful to foster sustainability needs to consider not only the product/service but the consequences of its use and its ultimate purpose.

(see e.g→ rebound effect! The fifth energy-saving flat-screen per household is certainly no better than a one-and-only tube-TV. Also, the first hydro-electric dam in a region might be a blessing, the 20th in the same region an ecological disaster.)

It requires a lot of global common sense with certifying institutions to indeed induce sustainability and not to surrender to the rebound effect.

We also understand, that even the most accurate measurements will not help us to address the central question for fully mature economies: When is enough enough?

Accordingly, many members of the ***Netzwerk Footprinting*** are engaged in developing alternative and complementary approaches to achieve the "good live for all", be it major economic changes or redefining the quality of life and the wealth of nations.

Annex: Members of the network (May 2012)

akaryon Niederl & Bußwald OG	www.akaryon.com
Denkstatt	www.denkstatt.at
FIBL Österreich	www.fibl.org
fleXible Informations-Systeme	www.flexinfo.ch
footprint-consult e.U.	www.footprint-consult.com
IFA Tulln, Institute for Environmental Biotechnology	www.ifa-tulln.ac.at

Institut für ökologische Wirtschaftsforschung	www.ioew.at
Österreichisches Ökologie Institut	www.ecology.at
Plenum gesellschaft für ganzheitliche entwicklung gmbh	www.plenum.at
SERI Sustainable Europe Research Institute	www.seri.at
Social Ecology Vienna, Alpen-Adria-Universität Klagenfurt	www.uni-klu.ac.at
STENUM Unternehmensberatung und	www.stenum.at
Forschungsgesellschaft für Umweltfragen	
Umweltbundesamt	www.umweltbundesamt.at

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[i] WWF International, Global Footprint Network, European Space Agency, Institute of Zoology: Living Planet Report 2012 - Biodiversity, biocapacity and better choices, ISBN 978-2-940443-37-6

[ii] for details see www.footprint.at/metrics.html

[iii] Rees, W. und Wackernagel, M. (1992): Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy. Stockholm: Second Meeting of the International Society for Ecological Economics.

[iv] Wiedmann, T. and Minx, J. (2008). A Definition of 'Carbon Footprint'. In: C. C. Pertsova, Ecological Economics Research Trends: Chapter 1, pp. 1-11, Nova Science Publishers, Hauppauge NY, USA.

[v] Hoekstra, A.Y., Chapagain, A.K., Aldaya, M.M. and Mekonnen, M.M. (2011) The water footprint assessment manual: setting the global standard, Earthscan London, London, UK ISBN 978 84971 279 8

[vi] see e.g. http://www.eea.europa.eu/data-and-maps/figures/carbon-material-and-water-footprint

[vii] European Commission, http://ec.europa.eu/environment/eussd/product_footprint.htm

[viii] Best, A., Giljum, S., Simmons, C., Blobel, D., Lewis, K., Hammer, M., Cavalieri, S., Lutter, S., Maguire, C. 2008. Potential of the Ecological Footprint for monitoring environmental impacts from natural resource use: Analysis of the potential of the Ecological Footprint and related assessment tools for use in the EU's Thematic Strategy on the Sustainable Use of Natural Resources. Report to the European Commission, DG Environment. Brussels.

[ix] PAS 2050: 2011, Specification for the assessment of the life cycle greenhouse gas emissions of goods and services, ISBN 978 0 580 71382 8

[x] Global Reporting Initiative, https://www.globalreporting.org/

[xi] Thema1: http://www.thema1.de/

[xii] GEMIS, www.gemis.de/

[xiii] see other paper to this conference "Open Footprint Puzzle Process" by Hellmut von Koerber

[xiv] Burger, E., Meixner, O. und Pöchtrager, S. (2010): Carbon Footprint bei Lebensmitteln Inhaltsanalytische Ermittlung relevanter Berechnungskriterien. Schriftenreihe des Institutes für Marketing & Innovation, Band 5, Wien: Institut für Marketing & Innovation.

[xv] Pekny et al. Siemens Eco-Fit presentation 2009

[xvi] See e.g. http://www.prthaiairways.com/thaiair_4p/front/news_detail.php?lg=en&dng=865