Roland Geyer – CV

Bren School of Environmental Science and Management
University of California, Santa Barbara, CA, USA
Since 2011 Associate Professor
2003-2011 Assistant Professor

University of Surrey, Guildford, UK
2004 PhD in Engineering
2000-2003 Research Fellow in Environmental Strategy

INSEAD, Fontainebleau, France
1998-2000 Research Associate in Environmental Management

American Management Systems, Munich, Germany
1997-1998 Consultant in Financial Risk Management

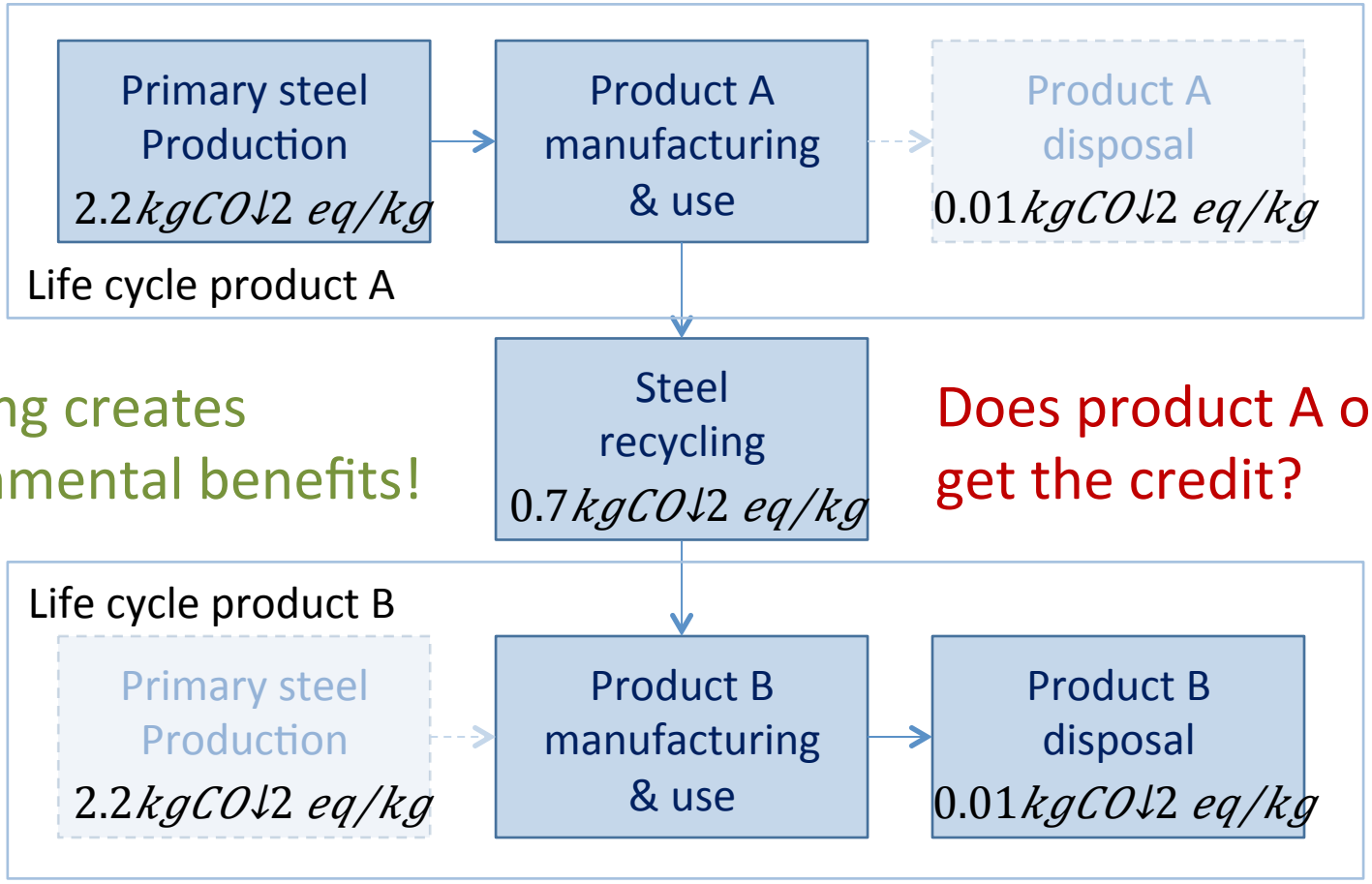
Technical University, Berlin, Germany
1997 German Diplom in Physics (MSc equivalent)
1992-1996 Course Tutor in Mathematics
1992 German Vordiplom in Physics (BSc eqivalent)

Roland Geyer – LCA Projects

Why does Recycling create an Allocation Issue in LCA?

Total: 4.4 $kgCO_2$ eq/kg

Why does Recycling create an Allocation Issue in LCA?



Recycling creates environmental benefits!

Does product A or B get the credit?

Total: 2.9 $kgCO_2$ eq/kg (34% reduction)

What ISO 14044 says about Allocation

- The rank-ordered list of allocation procedures is:
  1. Sub-divide the co-producing unit process

     (i.e. the allocation issue isn't real).
  2. *Expand the product system*

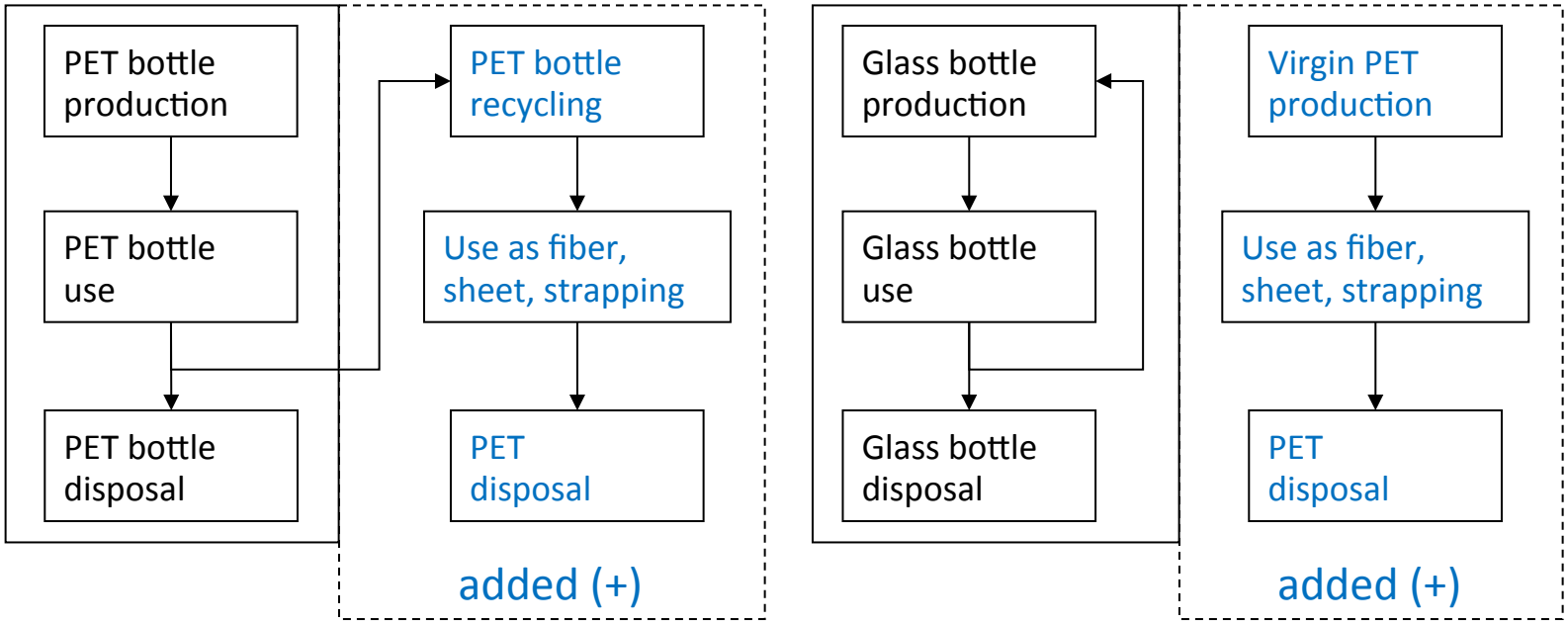
     (can be done in an attributional or consequential way).
  3. Allocate the in- and outputs according to the underlying physical relationship

     (this is a widely misunderstood, but mostly inapplicable procedure).
  4. Allocate the in- and outputs according to other relationships

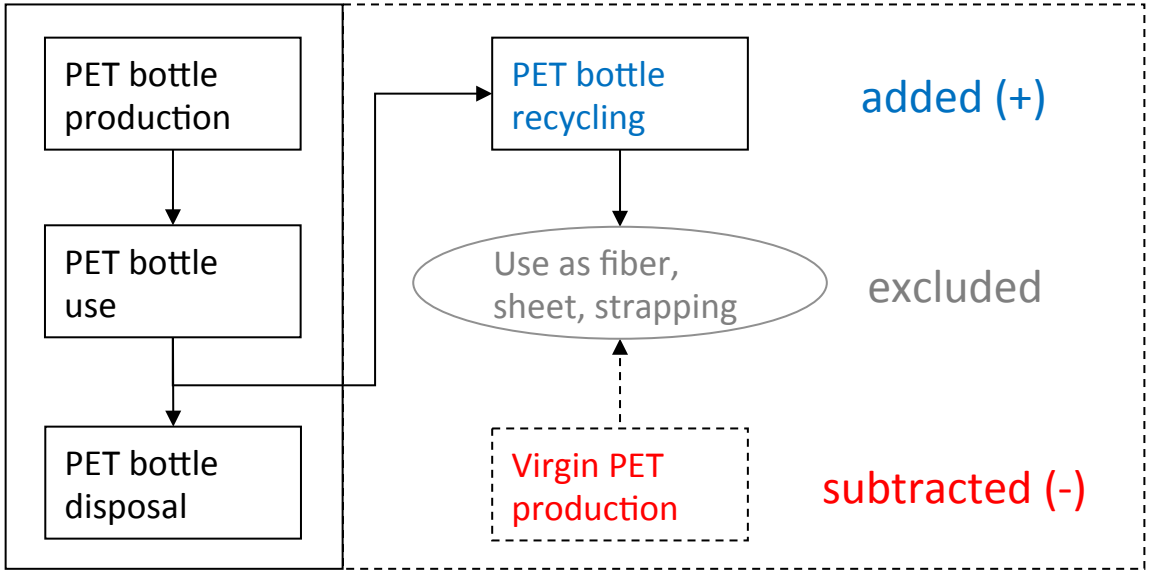
     (e.g. economic value, mass, or energy content).
- Whenever several alternative allocation procedures seem applicable,

  a *sensitivity analysis* with regard to allocation shall be conducted.

Attributional system expansion:

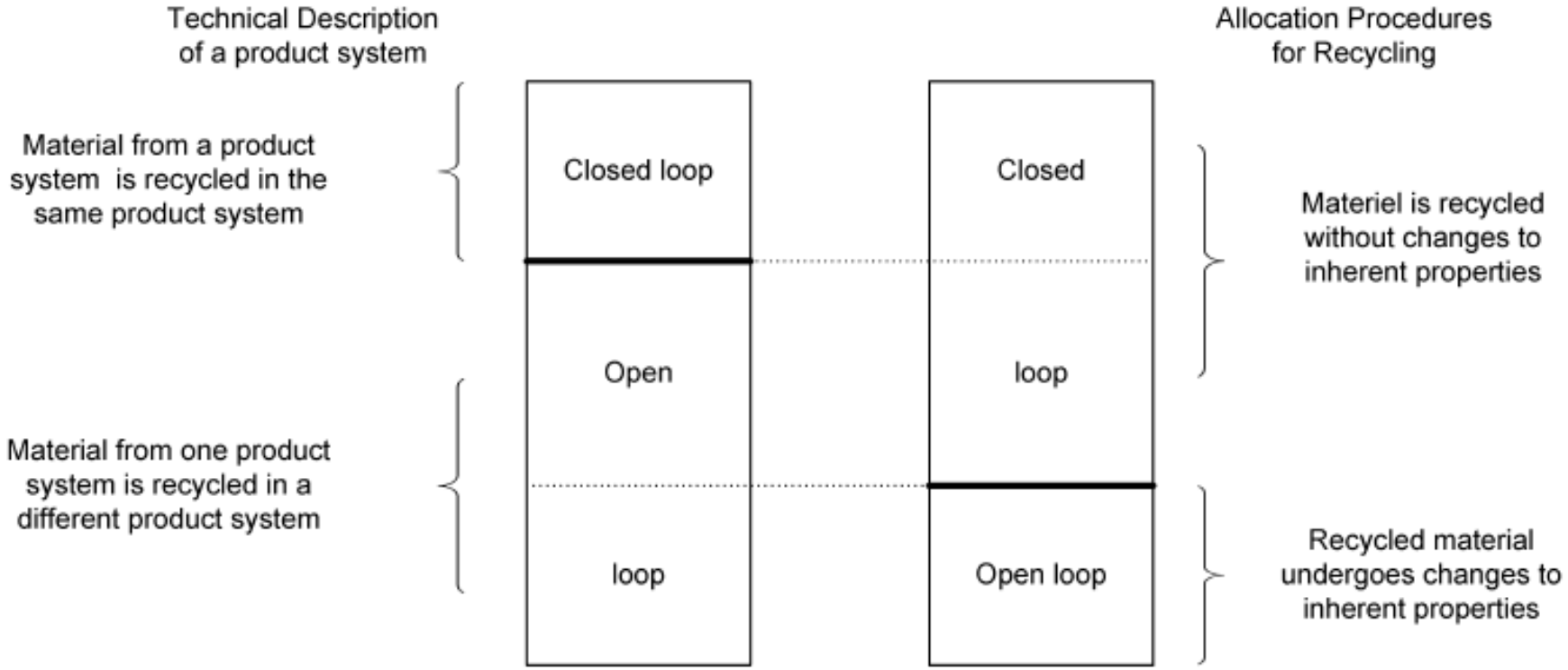


Consequential system expansion:



<u>Assumption:</u>
PET bottle recycling avoided virgin PET production.

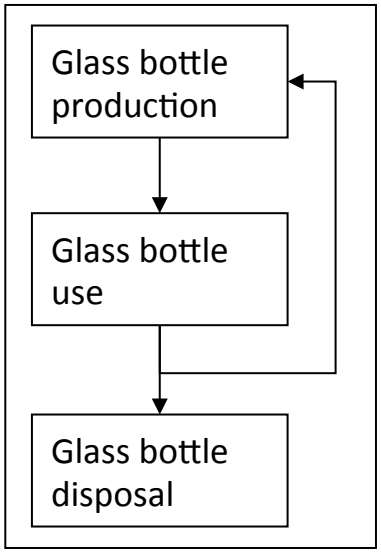
ISO 14044's Recycling Terminology



- Closed-loop recycling: Material from a product system is recycled in the same product system.
  Problem: What exactly is meant by *same*?
- Recycling may change the inherent properties of the material (and lead to "down-cycling").
  Problem: No guidance on *identifying and measuring* inherent properties.
- Recycling without changing the inherent properties of the material displaces the use of virgin (primary) materials.
  Problem: This is just an unsubstantiated claim.

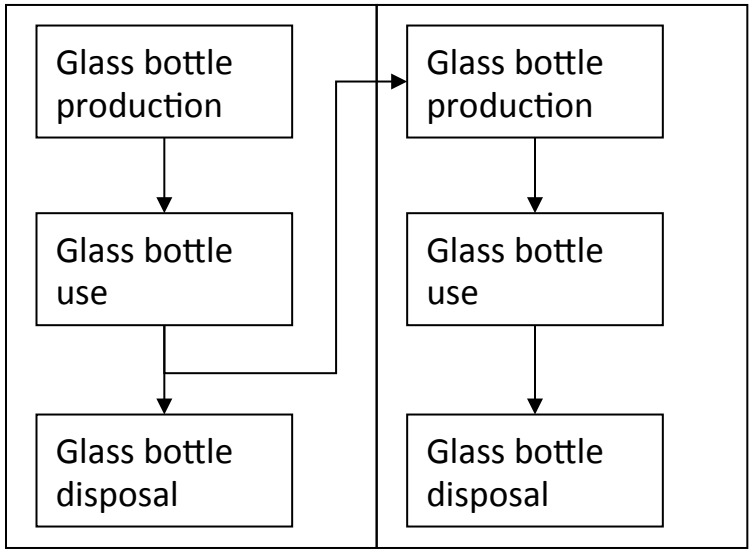
Source: ISO 14044:2006, Figure 2, page 17

What, exactly, is Closed-Loop Recycling?



Truly used within the studied system.

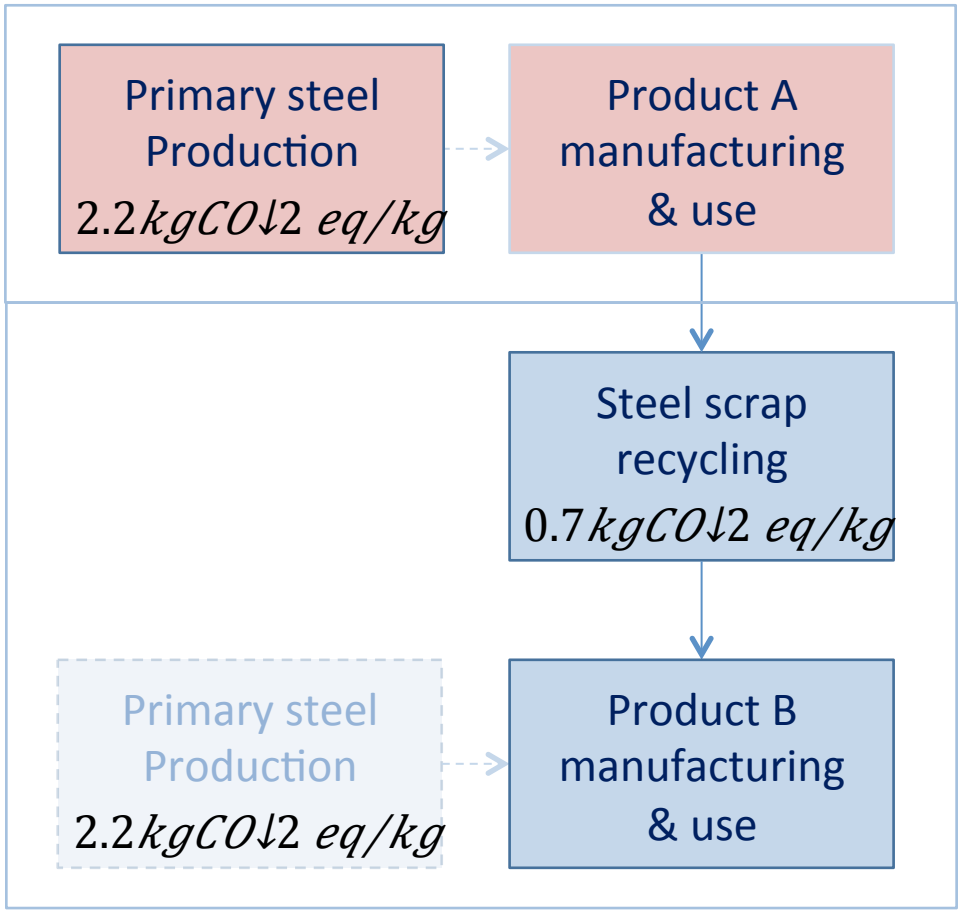
…is not the same as…



Used in a 'similar' product system.
Problem: How similar is similar enough?

- True closed-loop recycling does not create an allocation problem
- However, the vast majority of recycling is open-loop.
- ISO 14044's focus on *closed-loop recycling* and the *inherent properties of the recycled materials* is (IMHO) misleading.
- The focus should be on what production activities recycling displaces.

Recycled Content Method



Product A: 2.2 $kgCO_2$ eq/kg

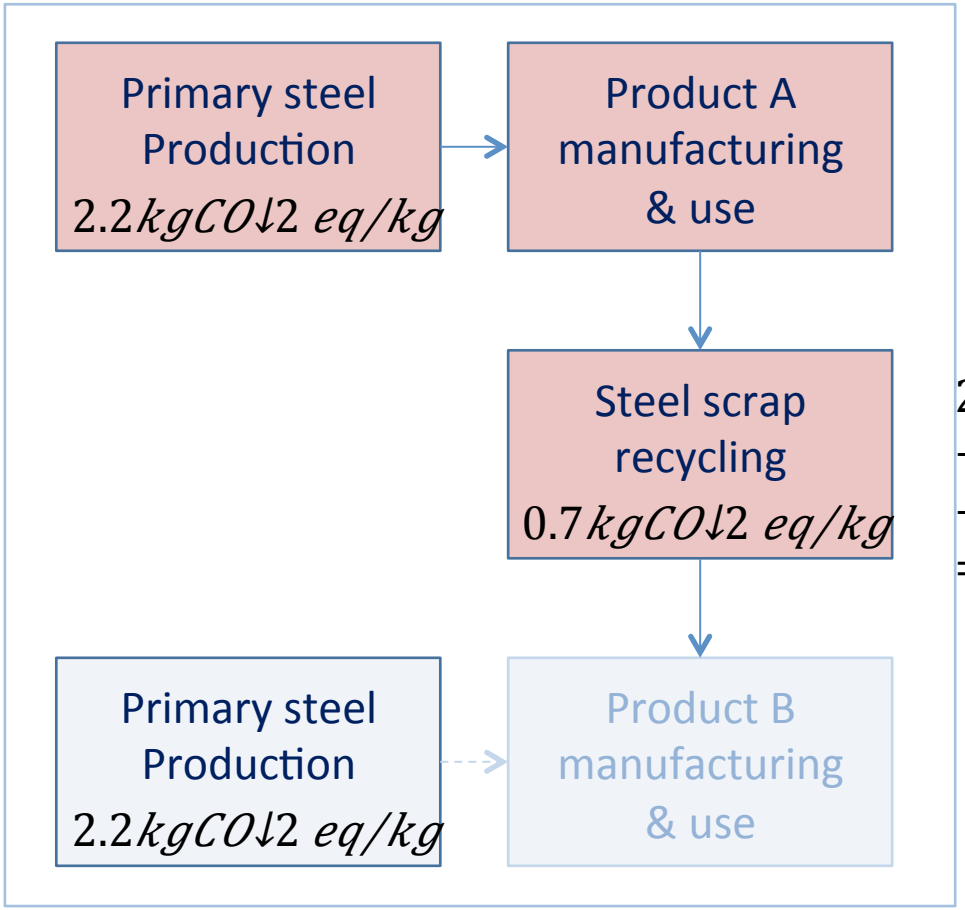
Product B: 0.7 $kgCO_2$ eq/kg

Total: 2.9 $kgCO_2$ eq/kg

- Scrap enters the product system without burden.
- Downstream recycling is excluded.
- The scrap user gets the recycling benefit.

Note: For simplicity, disposal is excluded.

Avoided Burden Method

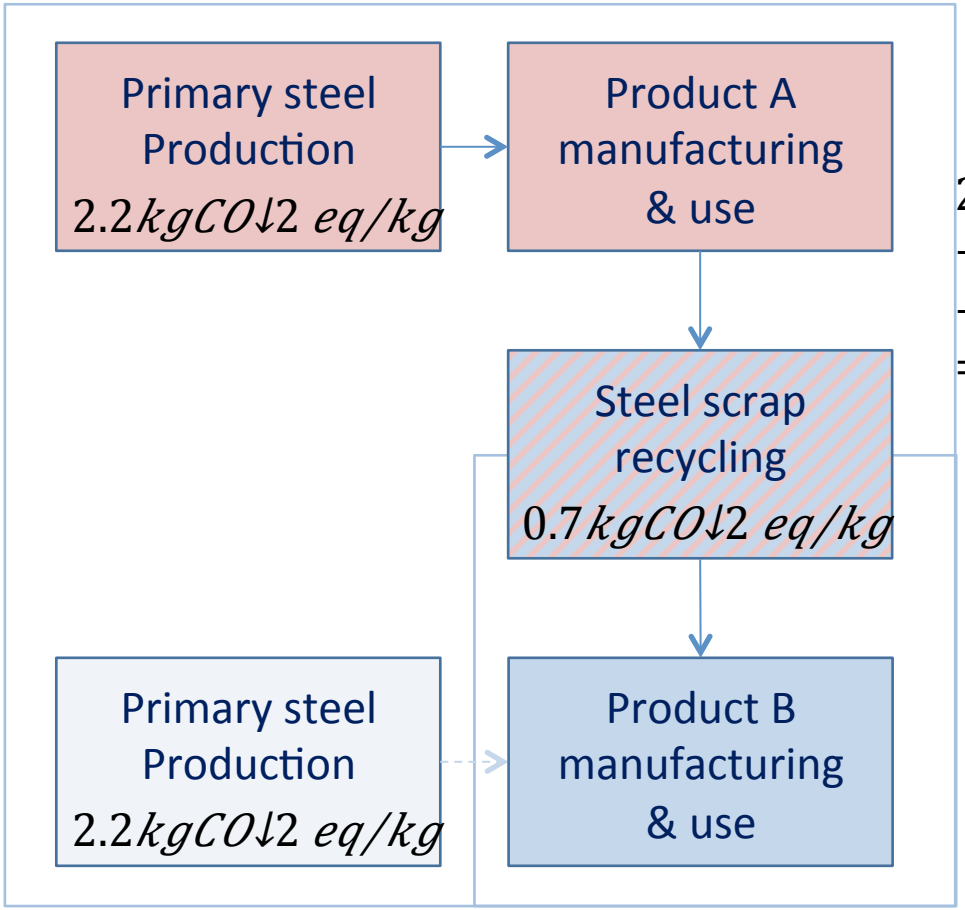


Product A (in $kgCO_2\ eq/kg$)

2.2	Primary material production
+0.7	Material recycling
−2.2	Avoided primary material production
=0.7	Total

- Downstream recycling is included.
- The avoided burdens of displaced production processes are included.
- The scrap generator gets the recycling benefit.

Using Recycled Content for Scrap Inputs and Avoided Burden for scrap outputs Double-Counts the Benefits of Recycling



Product A (avoided burden):

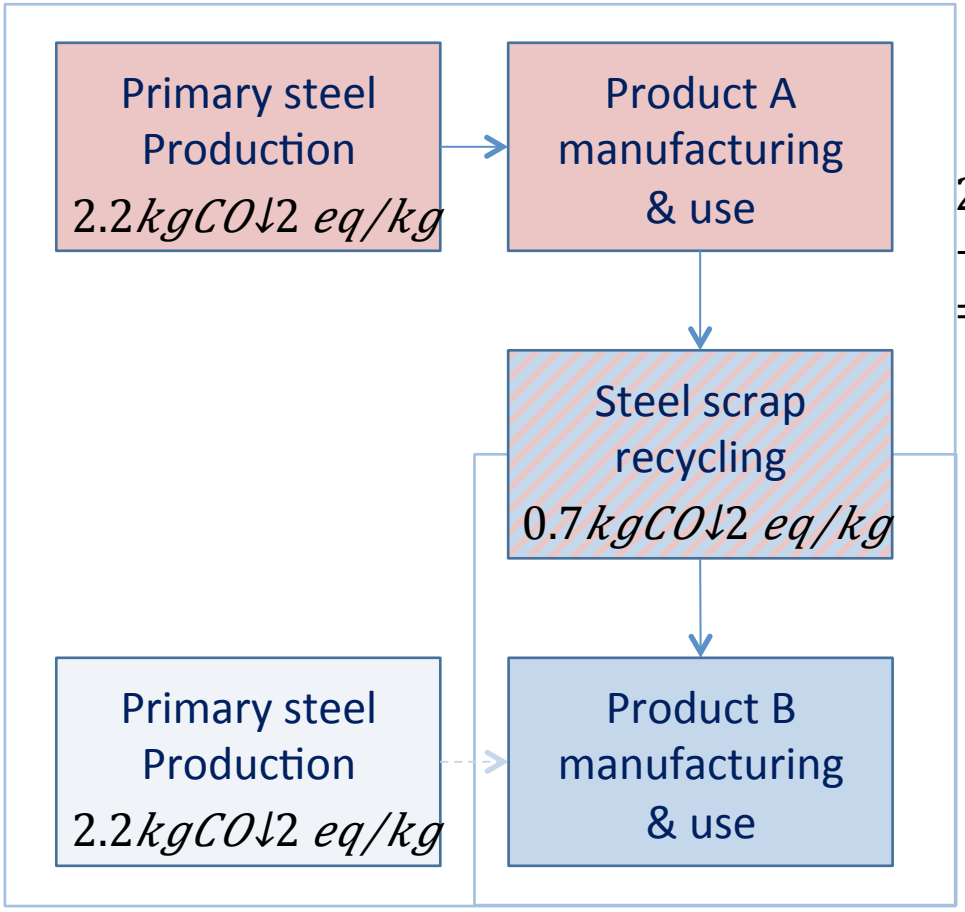
2.2 Primary material production
+0.7 Material recycling
−2.2 Avoided primary material production
=0.7 $kgCO_2\ eq/kg$

Product B (recycled content):

$0.7\ kgCO_2\ eq/kg$

Total in $kgCO_2\ eq/kg$: $(0.7+0.7) = 1.4 \neq (2.2+0.7) = 2.9$

Solution for the Avoided Burden Approach: A Scrap Debit



Product A (in $kgCO_2\ eq/kg$)

2.2	Primary material production
−1.5	Recycling credit (+0.7-2.2=1.5)
=0.7	Total

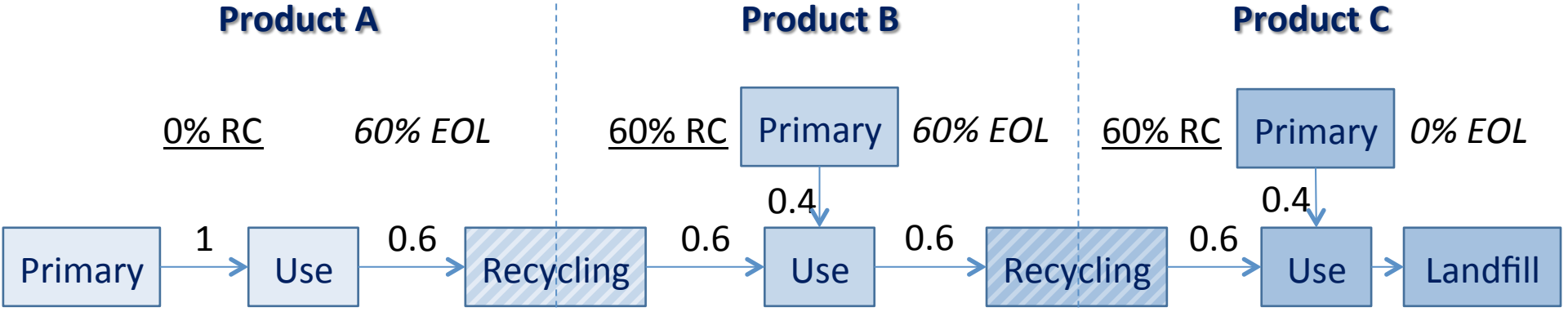
Product A (in $kgCO_2\ eq/kg$)

0.7	Primary material production
+1.5	Scrap debit (-0.7+2.2=-1.5)
=2.2	Total

Total: $2.9\ kgCO_2\ eq/kg$

- Scrap enters the product system with an environmental burden.
- The scrap user gets the recycling benefit.
- Recycled content “doesn’t matter”.

There are a few other methods – none are unanimously considered ideal



GHG emissions in $kgCO_2eq$:

	Product A	Product B	Product C
Recycled Content	1·2.2 = **2.2**	0.4·2.2+0.6·0.7 = **1.3**	0.4·2.2+0.6·0.7 = **1.3**
Avoided Burden	+2.2 -0.6·(2.2-0.7) = **1.3**	+0.6·(2.2-0.7) +0.4·2.2+0.6·0.7 -0.6·(2.2-0.7) = **1.3**	+0.6·(2.2-0.7) +0.4·2.2+0.6·0.7 = **2.2**
50/50	+2.2 -0.3·(2.2-0.7) = **1.75**	+0.3·(2.2-0.7) +0.4·2.2+0.6·0.7 -0.3·(2.2-0.7) = **1.3**	+0.3·(2.2-0.7) +0.4·2.2+0.6·0.7 = **1.75**
Multicycle (n=2, r=0.6)	(1.8·2.2+1.2·0.7)/3 = **1.6**	(1.8·2.2+1.2·0.7)/3 = **1.6**	(1.8·2.2+1.2·0.7)/3 = **1.6**

There are many names, but only a handful of different methods

Recycled content method
Cut-off method
100/0 method

Avoided burden method
Closed loop approximation method
0/100 method
End-of-life approach
System expansion
Substitution method

Market-based approach

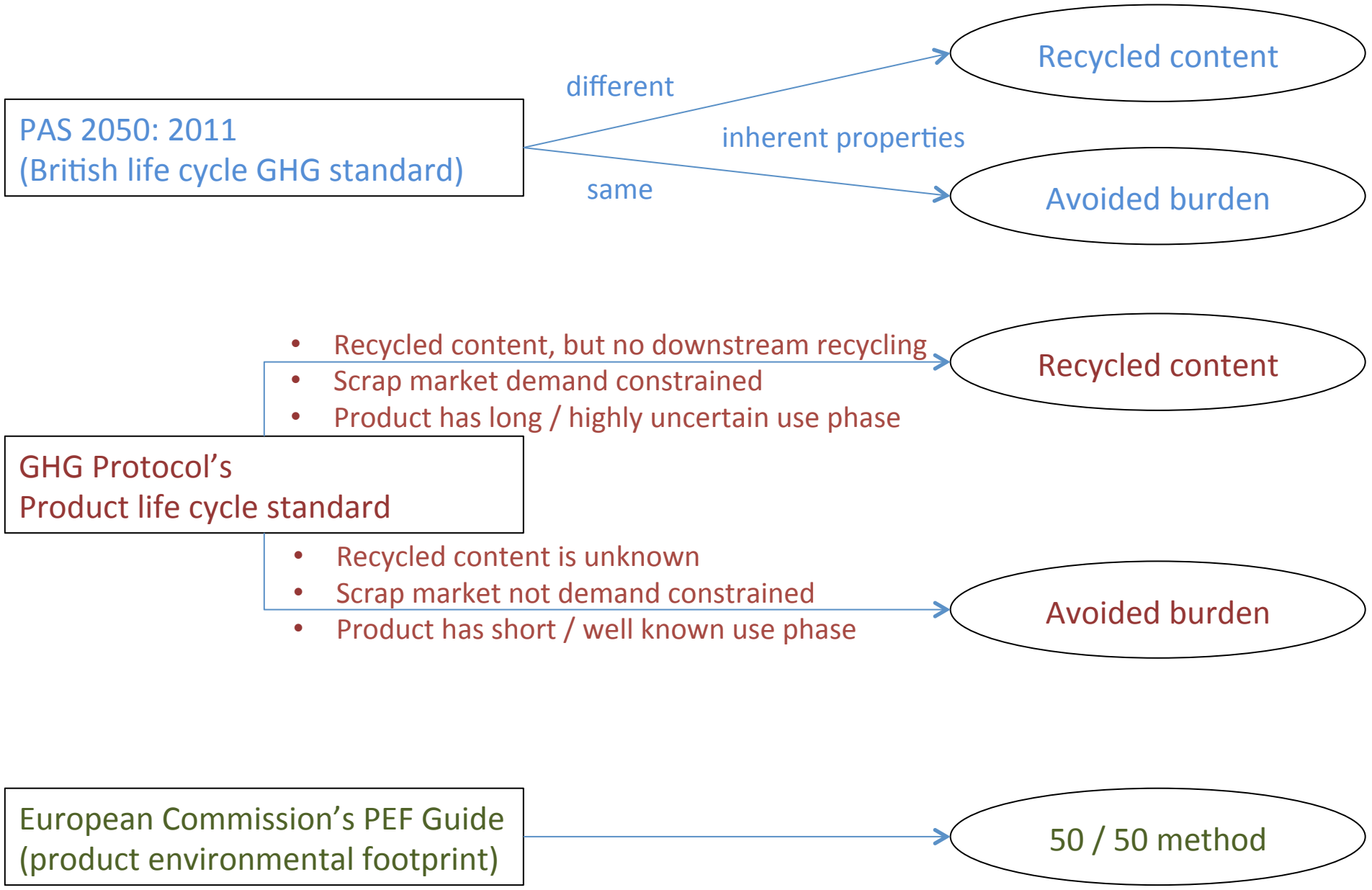
50/50 method

Value-corrected substitution (VCS)
Integrated approach

Multi-step recycling method
Multi-recycling approach

Flawed

LCA / foot printing standards and the methods they propose / prescribe



Complicating Things 1: Attributional versus Consequential LCA

Attributional LCA (ALCA):

- Studies product systems in a given state.
- Most LCA / foot printing standards are based on ALCA.
- Separating the studied product system from the rest generates allocation issues.
- However, allocation procedures are frequently justified by *consequential arguments*.

Consequential LCA (CLCA):

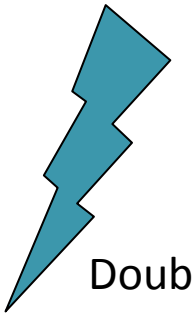
- Studies the consequences of a change in the product system.
- Is regarded as more relevant for environmental decision making.
- By definition avoids allocation through consequential system expansion.
- However, how to expand the system is frequently justified by *accounting arguments*.

Complicating Things 2: Lack of Coordination between Product Category Rules (PCRs)

Environmental product declarations (EPDs) require LCAs, which are conducted according to specific product category rules (PCRs). Many PCRs have recently been developed or are in development. There is a lack of coordination between these developments.

Imagine the following example:

Construction component PCR requires ***avoided burden*** method



Building PCR requires ***recycled content*** method

Double counting