Modeling recycling in LCA

Tomas Ekvall[1,2]

[1] Chalmers University of Technology
[2] Tomas Ekvall Research, Review & Assessment

KTH VETENSKAP OCH KONST

SWEDISH LIFE CYCLE CENTER

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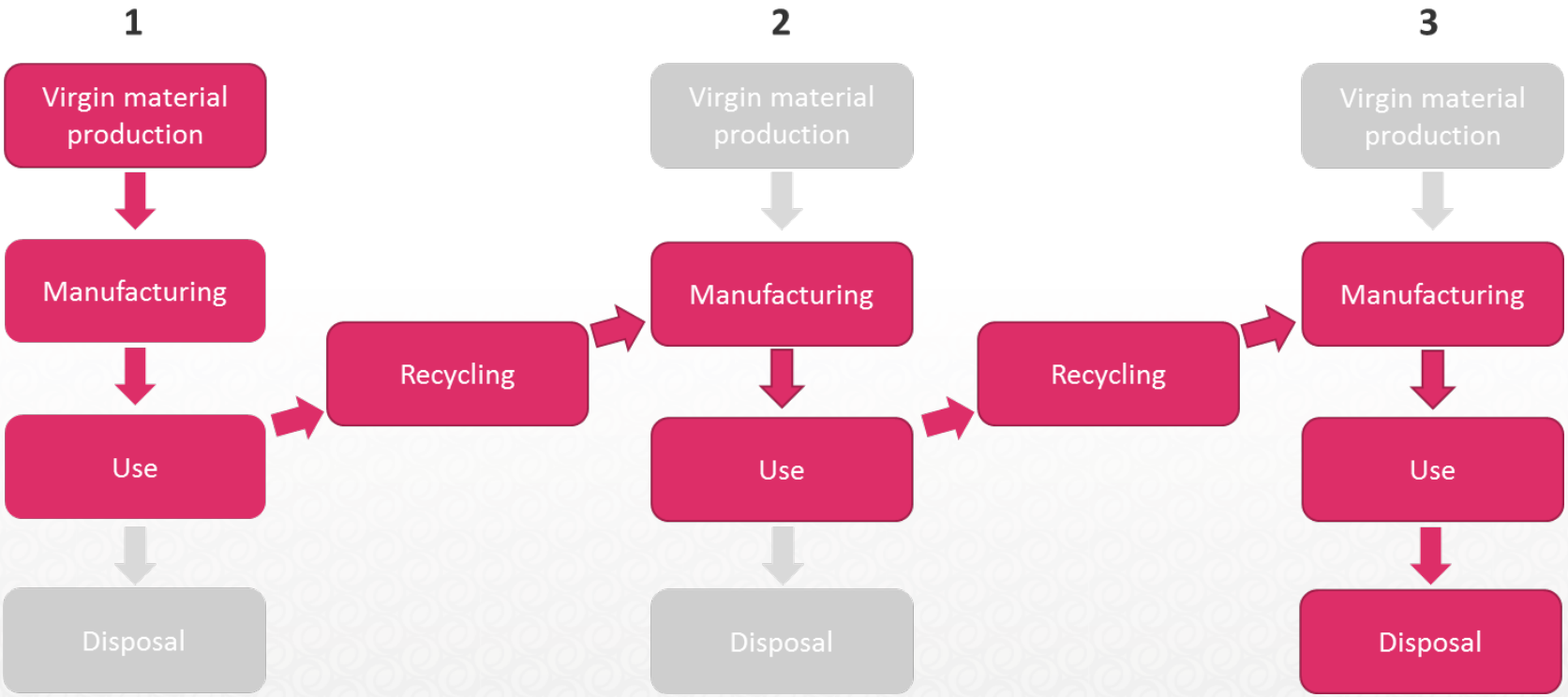
What are the benefits? Burdens? Methods?



Source: Ekvall et al. 2020

Funding:
Swedish Energy Administration
Re:Source Programme

Consortium

Coordination:
Swedish Life Cycle Center

Extended working group:

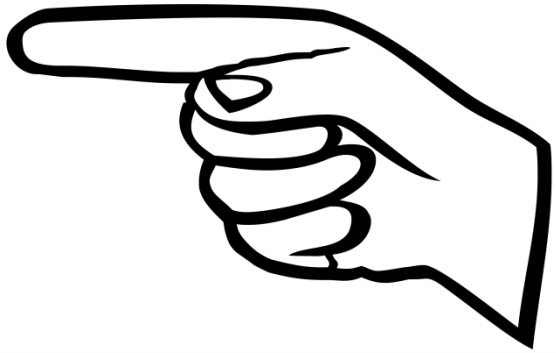
Research group:
Chalmers University of Technology
IVL Swedish Environmental Research Institute
Royal Institute of Technology

Case-study partners:
Essity
SSAB
Outokumpu
Volvo
Tetra Pak
RISE

Vattenfall
Volvo Cars
Nouryon
Stena Recycling

Jernkontoret
Swedish Environmental Protection Agency
Swedish Transport Administration

Achievements

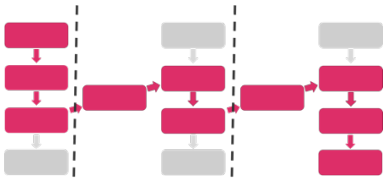
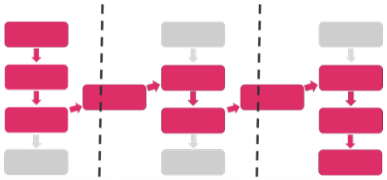
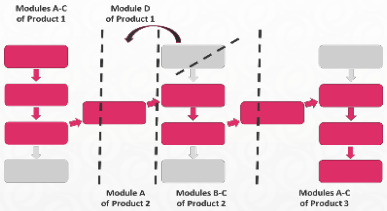


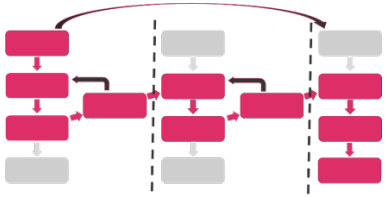
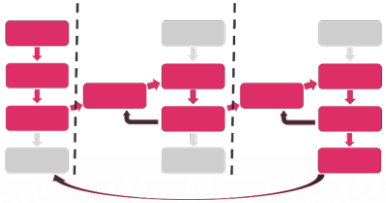
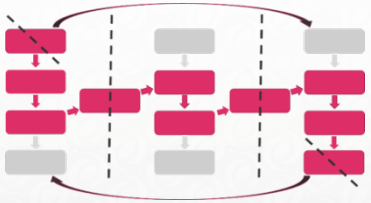
1. Compiled information on available methods
2. Developed criteria for good methods
3. Assessed the methods
4. Tested methods in case studies
5. Debated pros and cons

Standards	Guidelines	Scientific publications
ISO 14044 + TR 14049	PEF & OEF	Ekvall & Tillman (1997)
ISO 14067	International EPD	Ekvall (2000)
ISO 20915	Nordic Guidelines on LCA	Schrijvers et al. (2016)
ISO 21930	Dutch Handbook on LCA	Allacker et al. (2017)
EN 15804 + TR 16970	UBA guide on packaging LCA	
EN 16485	Greenhouse Gas Protocol	
PAS 2050	Worldsteel Association & ISSF	
	Ecoinvent	

=> 12 main approaches

Methods

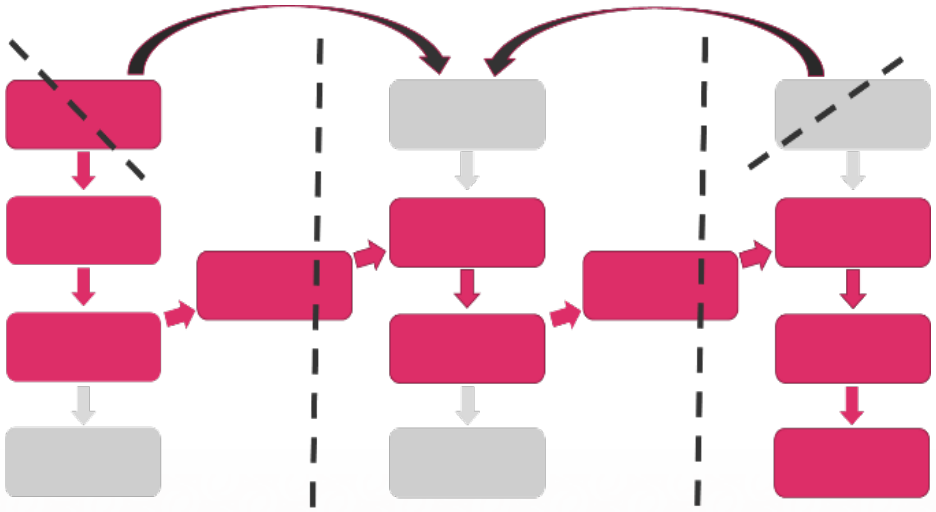
Simple cut-off	
Economic cut-off	
Cut-off plus credit	

Material losses	
Virgin material use	
50/50 methods	

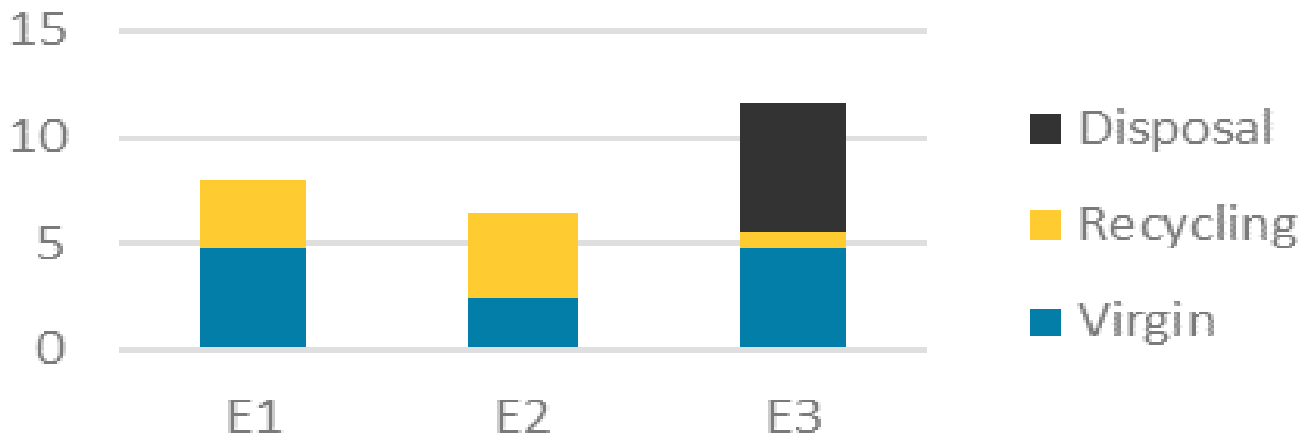
Plus:

- Quality-adjusted 50/50
- Circular Footprint Formula
- Price-based allocation
- Price-based substitution
- Price-elasticity approaches
- Allocation at the point of substitution (APOS)

Circular Footprint Formula



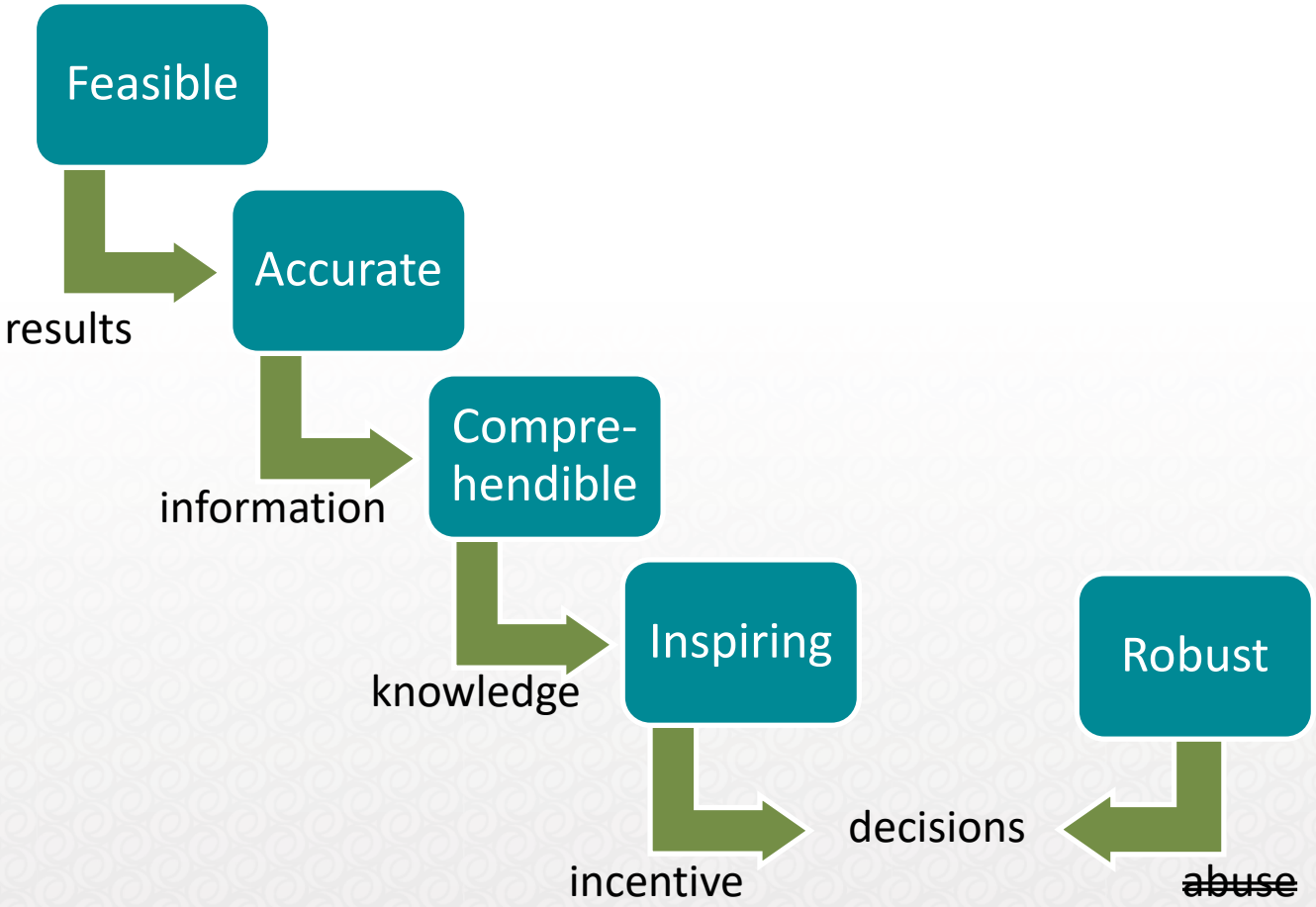
$$E = (1-R_1)\times E_V + R_1\times[AE_{Rin} + (1-A)E_V\times Q_{Sin}/Q_P$$
$$+$$
$$+ (1-A)R_2\times[(E_{Rout} - E^*_V\times(Q_{Sout}/Q_P)] +$$
$$+ (1-R_2)\times E_D$$



Criteria – starting point

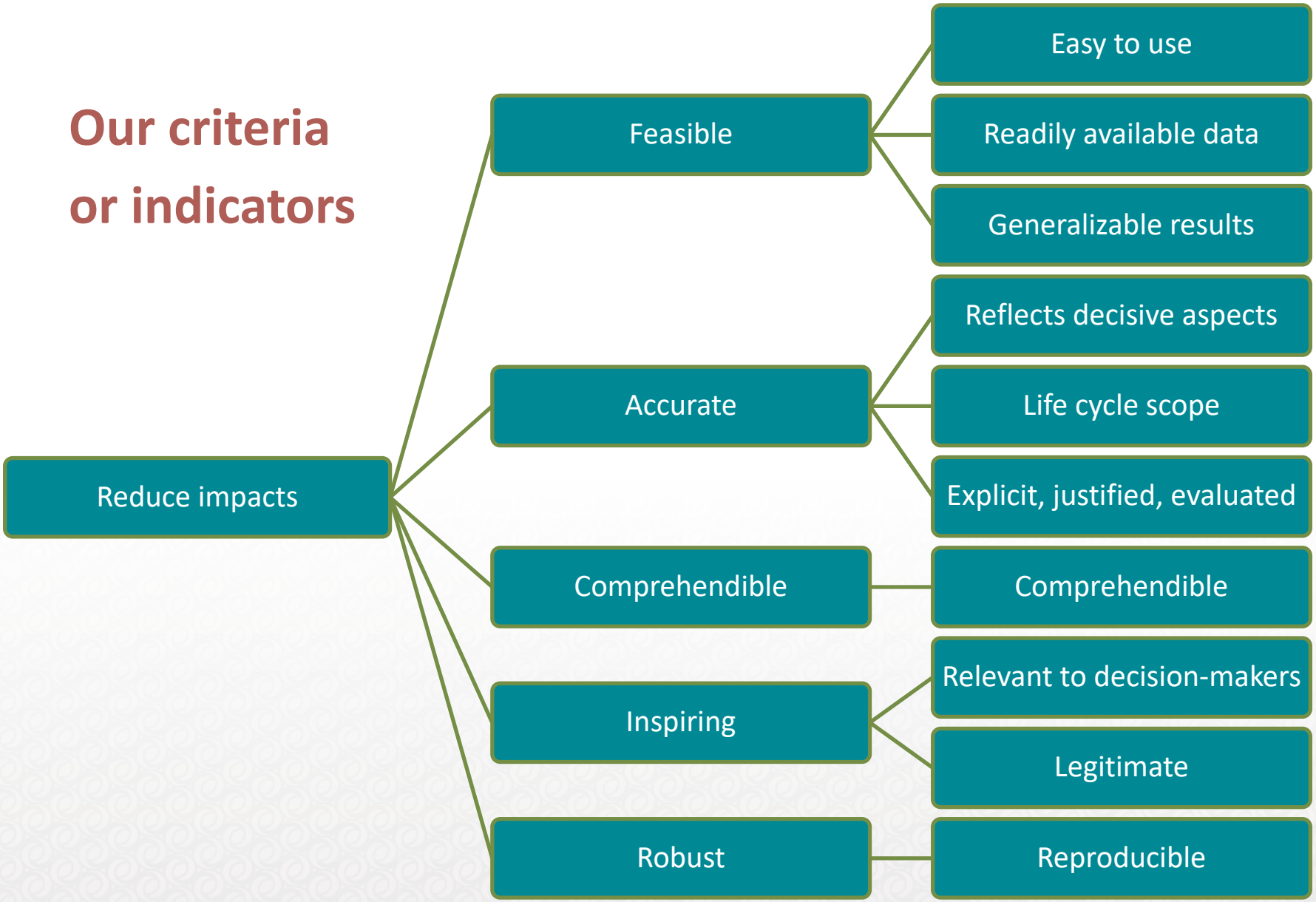
LCA should contribute to reducing environmental impacts

Previously derived criteria



Source: Ekvall et al. 2004

Our criteria or indicators

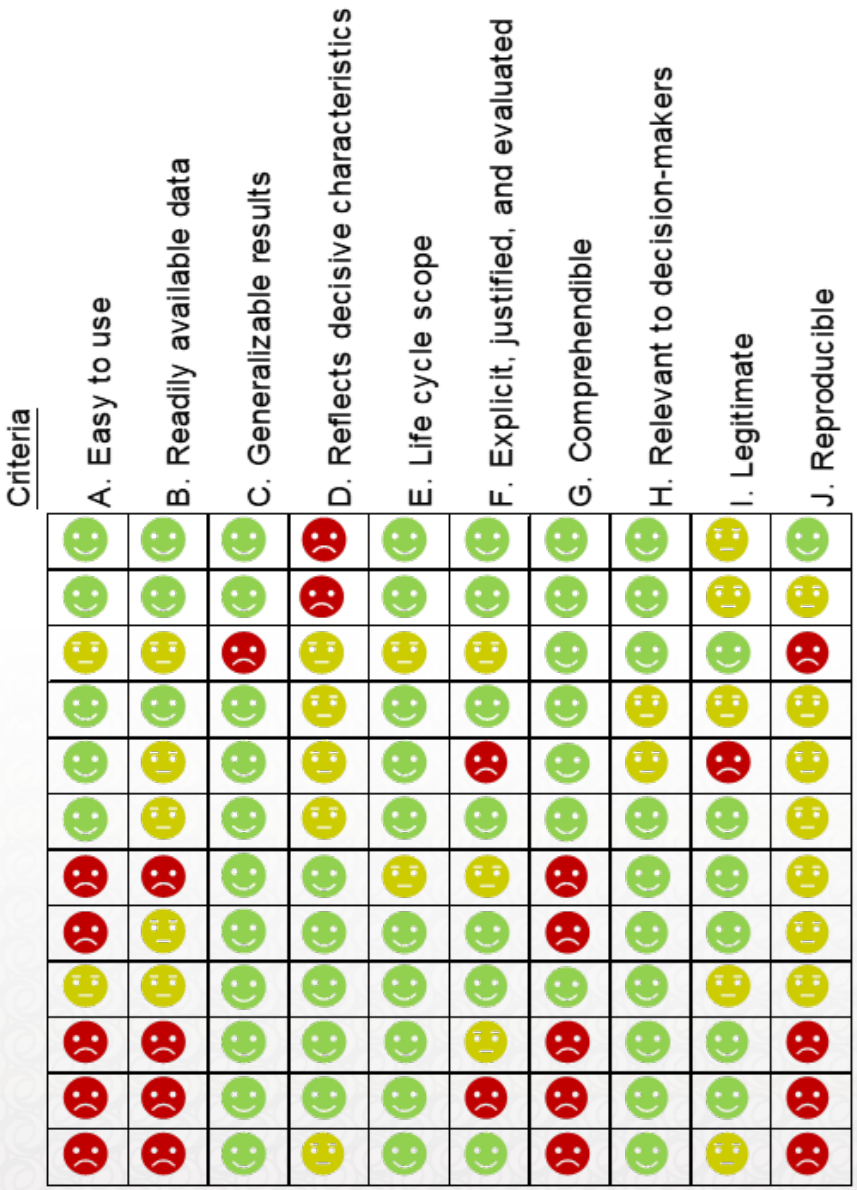


Source: Ekvall et al. 2020

Assessment results

Method

1. Simple cut-off
2. Cut-off with economic allocation
3. Cut-off plus credit
4. Allocation to material losses
5. Allocation to virgin material use
6. 50/50 methods
7. Quality-adjusted 50/50 methods
8. Circular Footprint Formula
9. Market price-based allocation
10. Market price-based substitution
11. Price-elasticity approaches
12. Allocation at the point of substitution



Source: Ekvall et al. 2020

Thanks for the attention!

Sources:

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Contact: terra@tomasekvall.se

What is the allocation problem?

Method	Virgin production	Manufacturing	Use	Recycling	Disposal
Simple cut-off				X	
Economic cut-off				X	
Cut-off plus credit	X			X	
Material losses	X			X	
Virgin material use	X			X	X
50/50 methods	X			X	X
Quality-adjusted 50/50	X			X	X
Circular Footprint Formula	X			X	
Price-based allocation	X			X	
Price-based substitution	X			X	X
Price-elasticity approaches	X			X	X
APOS	X	X	X	X	

Source: Ekvall et al. 2020

What is important for the LCA results?

Method	Recycled content	Recycling rate	Quality	Price	Market mechanisms
Simple cut-off	X	(X)			
Economic cut-off	X	(X)			
Cut-off plus credit	X	X			
Material losses		X			
Virgin material use	X				
50/50 methods	X	X			
Quality-adjusted 50/50	X	X	X		
Circular Footprint Formula	X	X	X		X
Price-based allocation	X	X		X	
Price-based substitution	X	X	X	X	
Price-elasticity approaches	X	X			X
APOS	X	X		X	

Source: Ekvall et al. 2020

Where do the methods fit?

Method	Attributional LCA	Consequential LCA
Simple cut-off	X	
Economic cut-off	X	
Cut-off plus credit	X (Modules A-C)	X (Module D)
Material losses	(X)	X
Virgin material use	(X)	X
50/50 methods	(X)	X
Quality-adjusted 50/50		X
Circular Footprint Formula		X
Price-based allocation	(X)	
Price-based substitution		X
Price-elasticity approaches	(X)	X
APOS	(X)	

Source: Ekvall et al. 2020

Where do the methods fit?

Application area	Tailor-made method(s)	Predefined method
Policy-making	Develop basis for policy-decision	Required by a policy instrument
External communication	General communication on product and its environmental performance	Environmental Product Declarations, etc.
Internal use	Develop basis for strategic decisions	Day-to-day decisions: simple method

Key requirements:

- Generate relevant knowledge
- Robust and reproducible
- Easy to use

Source: Ekvall et al. 2020

Where to next?

A. Modeling of recycling of production waste, e.g.:

- Applicability of methods and conclusions
- Accurate modeling of consequences

B. Modelling of energy recovery, e.g.:

- Methods for attributional and consequential LCA
- Factor B in Circular Footprint Formula

Interested? => terra@tomasekvall.se