Lowell Center for Sustainable Production
UNIVERSITY OF MASSACHUSETTS LOWELL

Alternatives Assessment 108 Webinar:

The Role of Lifecycle Considerations in Chemicals Alternatives Assessment

NOVEMBER 20, 2012

FACILITATED BY: JOEL TICKNER, SCD

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** If you would like to ask a question or comment during this webinar please type your question in the Q&A box located in the control panel.*

Goals

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- Continuing education and dialog
- *"To advance the practice of alternatives assessment for informed substitution across federal, state, and local agencies through networking, sharing of experiences, development of common approaches, tools, datasets and frameworks, and creation of a community of practice."*

Purpose of this call

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- Alternatives assessments primarily focused on chemical hazards in production processes or products.

- But: Chemical substitutions may result in changes in both process and upstream and downstream chemical hazards or trade-offs in terms greater energy or material use.

- Lifecycle assessment has been used as a tool to evaluate and compare product lifecycle hazards, but has been criticized for its limited treatment of chemical hazards and overemphasis on energy and material consumption.

- Goal: To explore how and when lifecycle considerations should be considered in the context of a chemicals alternatives assessment and tools and approaches for evaluating lifecycle impacts.

Speakers

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- Stig Olsen, Technical University of Denmark
- Frans Christensen, COWI Consultants, Denmark
- Bob Boughton, California Department of Toxic Substances Control

Discussion Questions

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- What is the difference between lifecycle thinking and lifecycle assessment?
- How can lifecycle thinking help to avoid unintended consequences of chemical substitutions?
- How can lifecycle considerations be included in alternatives assessments without unnecessarily bogging down the assessment in analytic details and debates?
- What tools and approaches are most promising for incorporating lifecycle considerations in alternatives assessments.

Webinar Discussion Instructions

- Due to the number of participants on the Webinar, all lines will be muted.

- If you wish to ask a question, please type your question in the Q&A box located in the drop down control panel at the top of the screen.

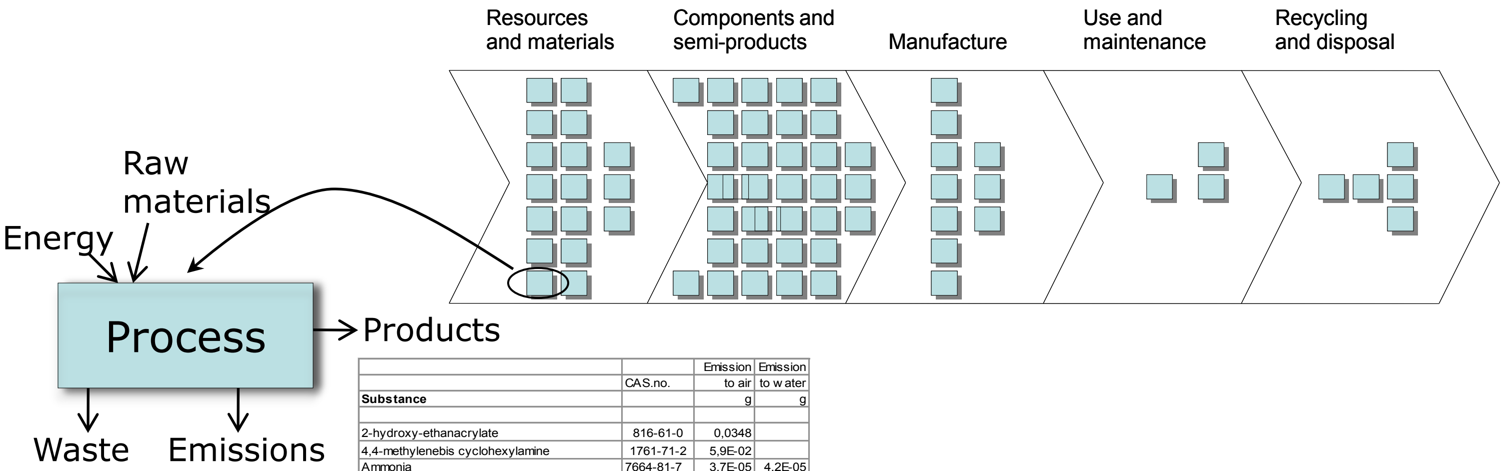
- All questions will be answered at the end of the presentations.

Life Cycle Assessment and Risk Assessment

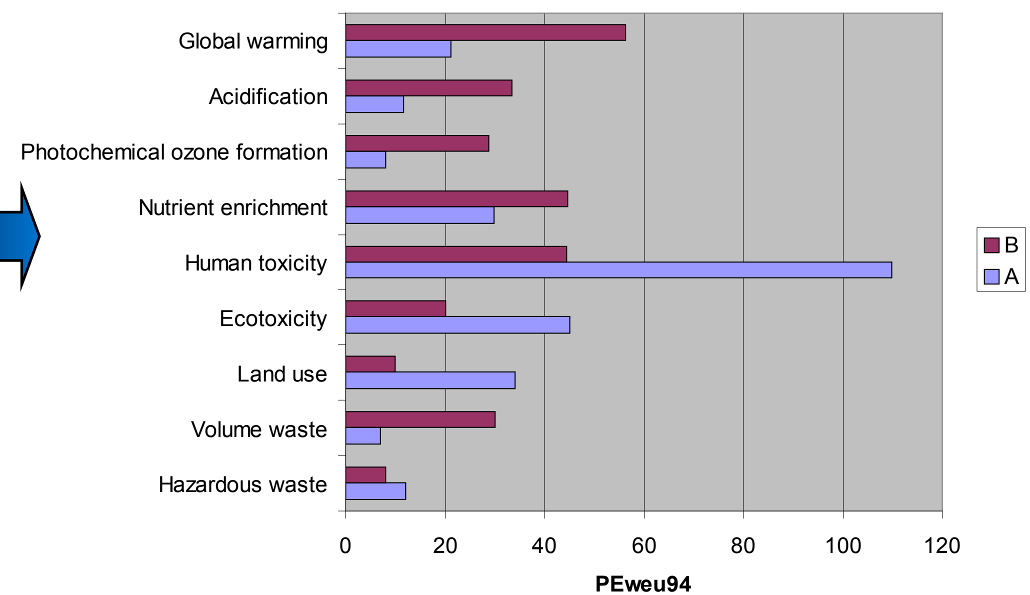
What's the difference?

Stig Irving Olsen
Section for Quantitative Sustainability Assessment

DTU Management Engineering
Department of Management Engineering



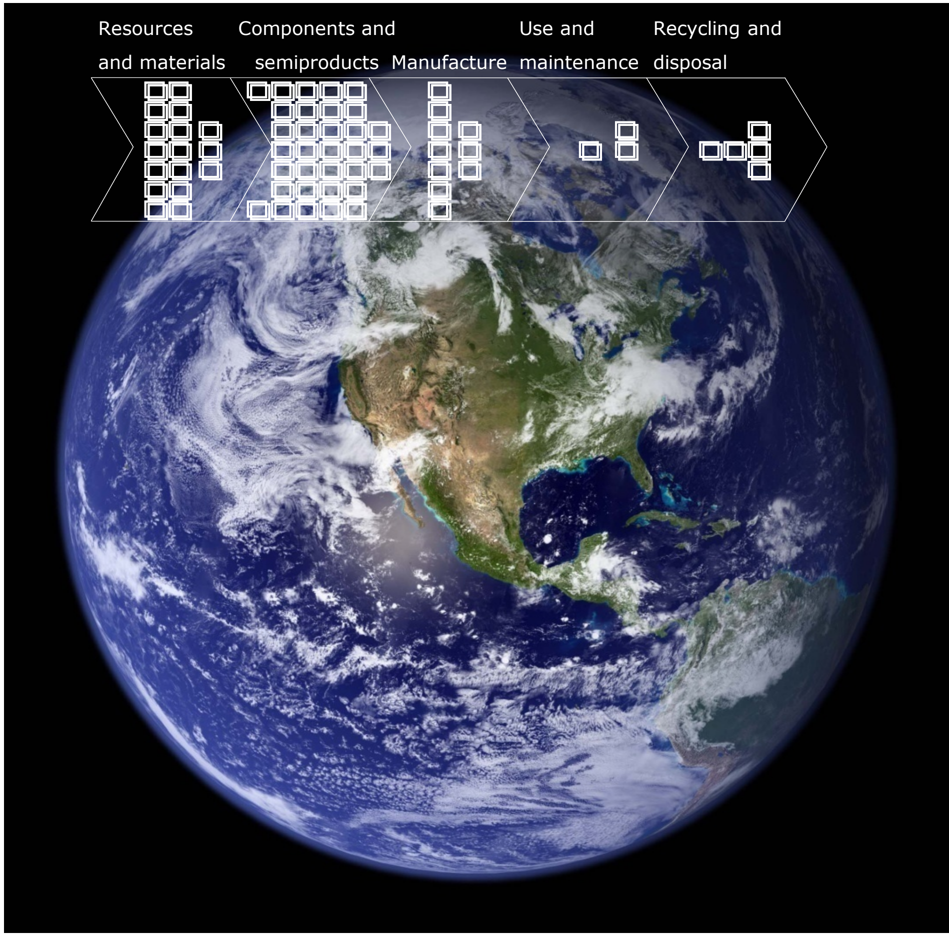
Substance	CAS.no.	Emission to air g	Emission to water g
2-hydroxy-ethanacrylate	816-61-0	0,0348	
4,4-methylenebis cyclohexylamine	1761-71-2	5,9E-02	
Ammonia	7664-81-7	3,7E-05	4,2E-05
Arsenic (As)	7440-38-2	2,0E-06	
Benzene	71-43-2 (cur	5,0E-02	
Lead (Pb)	7439-92-1	8,5E-06	
Butoxyethanol	111-76-2	6,6E-01	
Carbondioxide	124-38-9	2,6E+02	
Carbonmonoxide (CO)	630-08-0	1,9E-01	
Cadmium (Cd)	7440-46-9	2,2E-07	
Chlorine (Cl2)	7782-50-5	4,6E-04	
Chromium (Cr VI)	7440-47-3	5,3E-06	
Dicyclohexane methane	86-73-6	5,1E-02	
Nitrous oxide(N2O)	10024-97-2	1,7E-02	
2,4-Dinitrotoluene	121-14-2	9,5E-02	
HMDI	5124-30-1	7,5E-02	
Hydro carbons (electricity, stationary combusti	-	1,7E+00	
Hydrogen ions (H+)	-		1,0E-03
i-butanol	78-83-1	3,5E-02	
i-propanol	67-63-0	9,2E-01	
copper (Cu)	7740-50-8	1,8E-05	
Mercury(Hg)	7439-97-6	2,7E-06	
Methane	74-82-8	5,0E-03	
Methyl i-butyl ketone	108-10-1	5,7E-02	
Monoethyl amine	75-04-7		7,9E-06
Nickel (Ni)	7440-02-0	1,1E-05	
Nitrogen oxide (NOx)	10102-44-0	1,1E+00	
NMVOC, diesel engine (exhaust)	-	3,9E-02	
NMVOC, pow er plants (stationary combustion)	-	3,9E-03	
Ozone (O3)	10028-15-6	1,8E-03	
PAH	ikke specifik	2,4E-08	
Phenol	108-95-2		1,3E-05
Phosgene	75-44-5	1,4E-01	
Polyeter polyol	ikke specifik	1,6E-01	
1,2-propylenoxide	75-56-9	8,2E-02	
Nitric acid	7782-77-6 (c	8,5E-02	
Hydrochloric acid	7647-01-0 (c	1,9E-02	
Selenium (Se)	7782-49-2	2,6E-05	
Sulphur dioxide(SO2)	7446-09-5	1,3E+00	
Toluene	108-88-3	4,8E-02	
Toluene-2,4-diamine	95-80-7	7,9E-02	
Toluene diisocyanat (TDI)	26471-62-5	1,6E-01	
Total-N	-		2,6E-05
Triethylamine	121-44-8	1,6E-01	
Unspecified aldehydes	-	7,5E-04	
Uspecified organic compounds	-	1,5E-03	
Vanadium	7440-62-2	1,8E-04	
VOC, diesel engine (exhaust)	-	6,4E-05	
VOC, stationary combustion (coal fired)	-	4,0E-05	
VOC, stationary combustion (natural gas fired)	-	2,2E-03	
VOC, stationary combustion (oil fired)	-	1,4E-04	
Xylene	1330-20-7	1,4E-01	
Zinc (Zn)	7440-66-6	8,9E-05	



Framework, principles and requirements are standardized in ISO 14040 and 14044

Conditions for the impact assessment

- The life cycle is *global*
- The product system is *extended in time*
- Focus of the assessment is a functional unit
- The impact assessment predicts potential impacts and not real effects



Characterisation
- how much does the emission contribute to impacts?

- Characterisation factors represent the contribution from the substance based on **modelling of the environmental mechanism**
- for all substances which contribute to this impact
- characterisation through multiplication of emission and relevant characterisation factor(s)

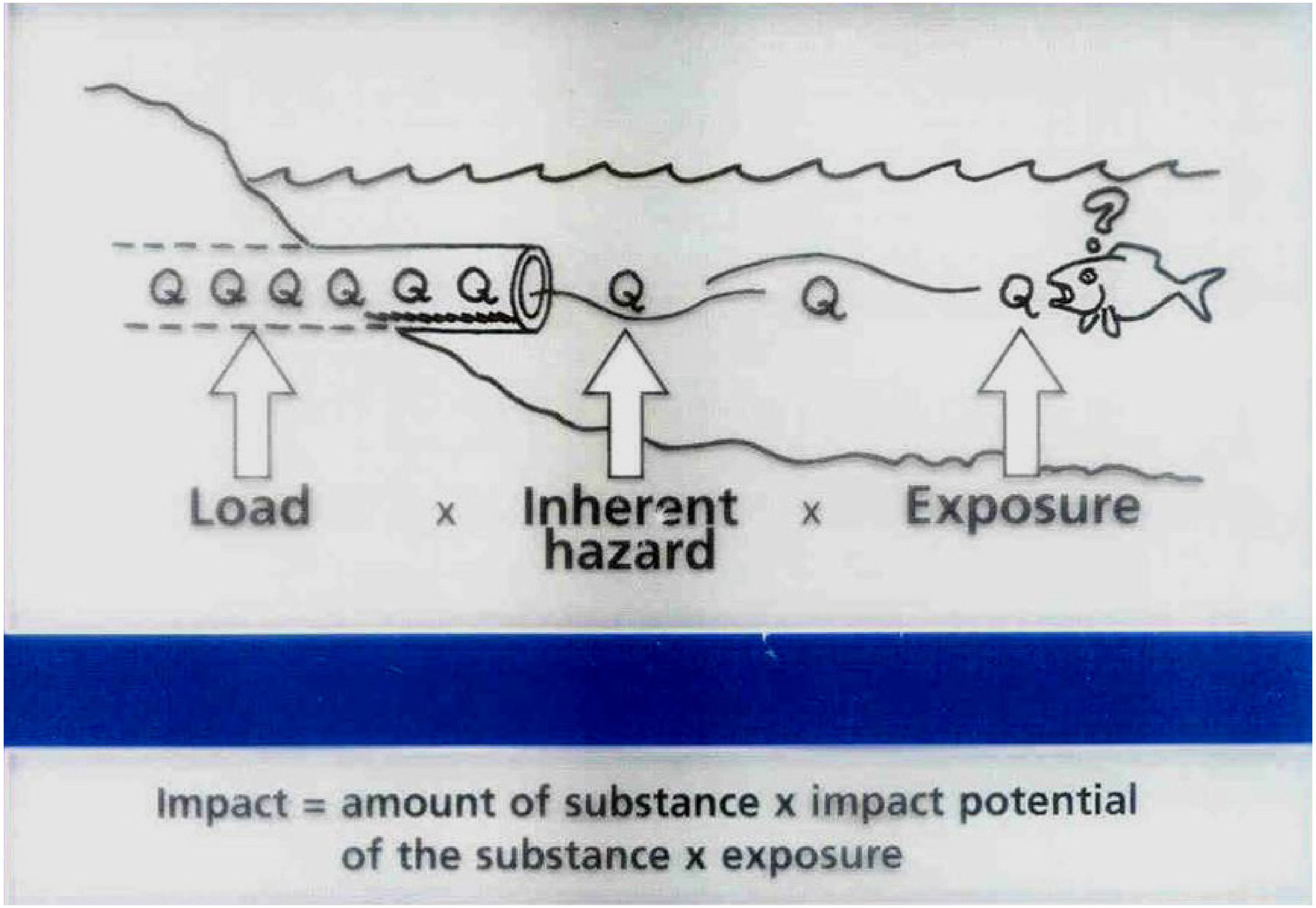
$$IP(j)_i = Q_i * CF(j)_i$$

$$IP(j) = \Sigma_i (Q_i * CF(j)_i)$$

j is Impact category

i is single compound

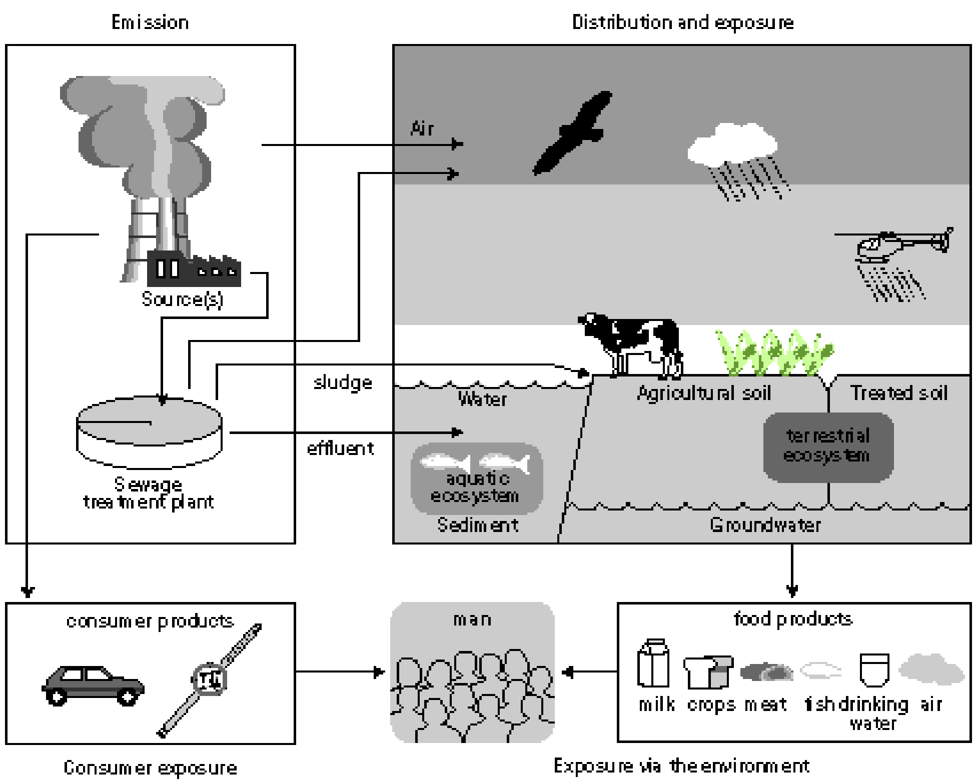
Characterisation of chemical impacts

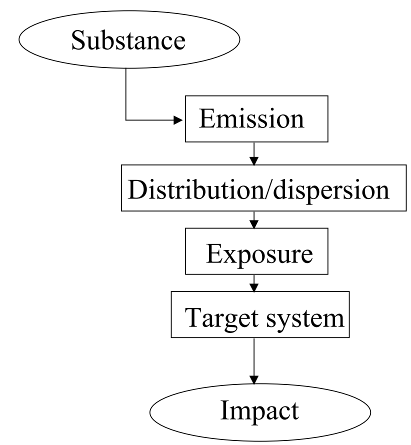


Toxic impacts: Modelling the fate

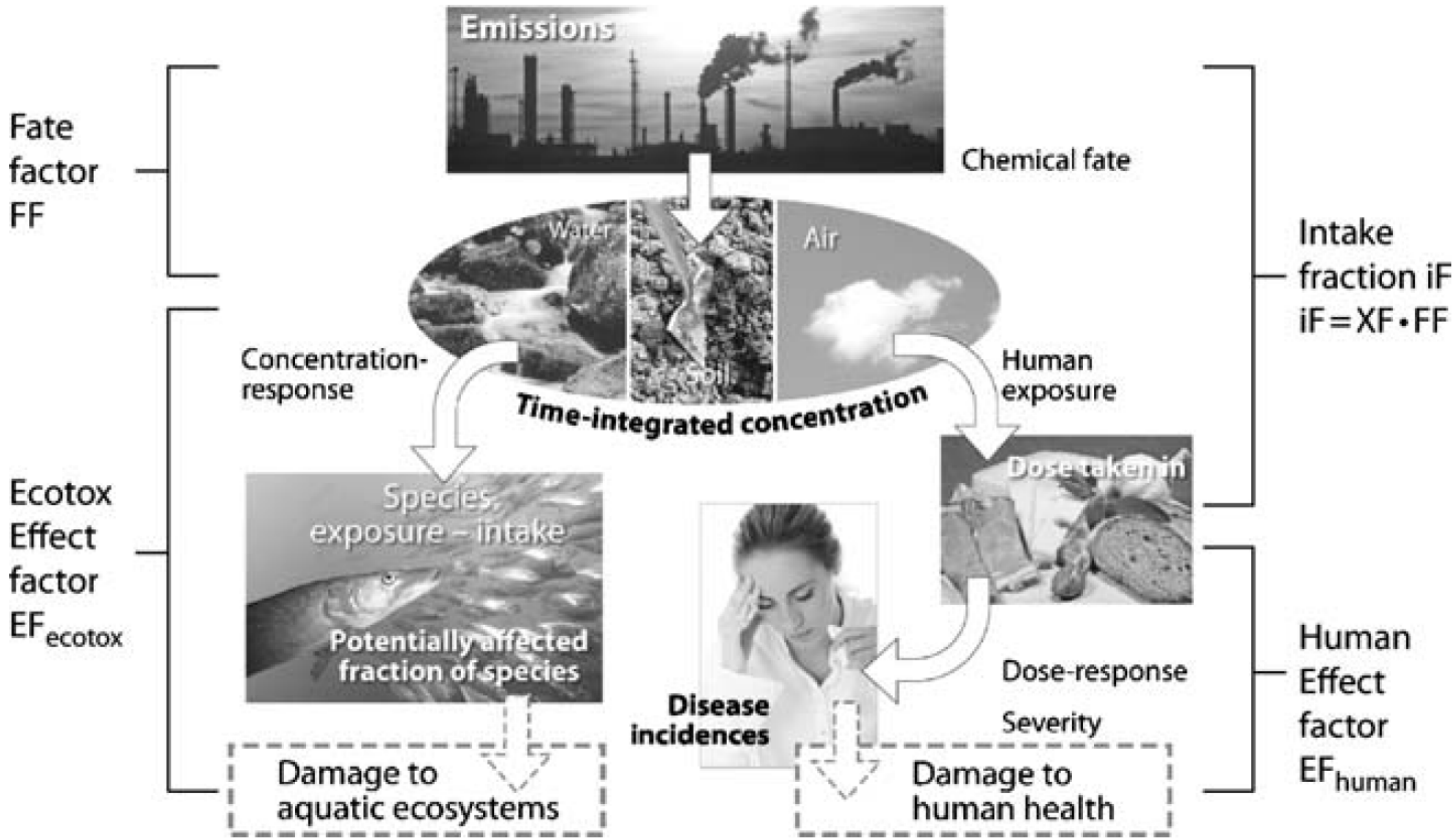
Integrated approaches

Typically adaptation of existing predictive models for *chemical risk assessment* e.g. EUSES





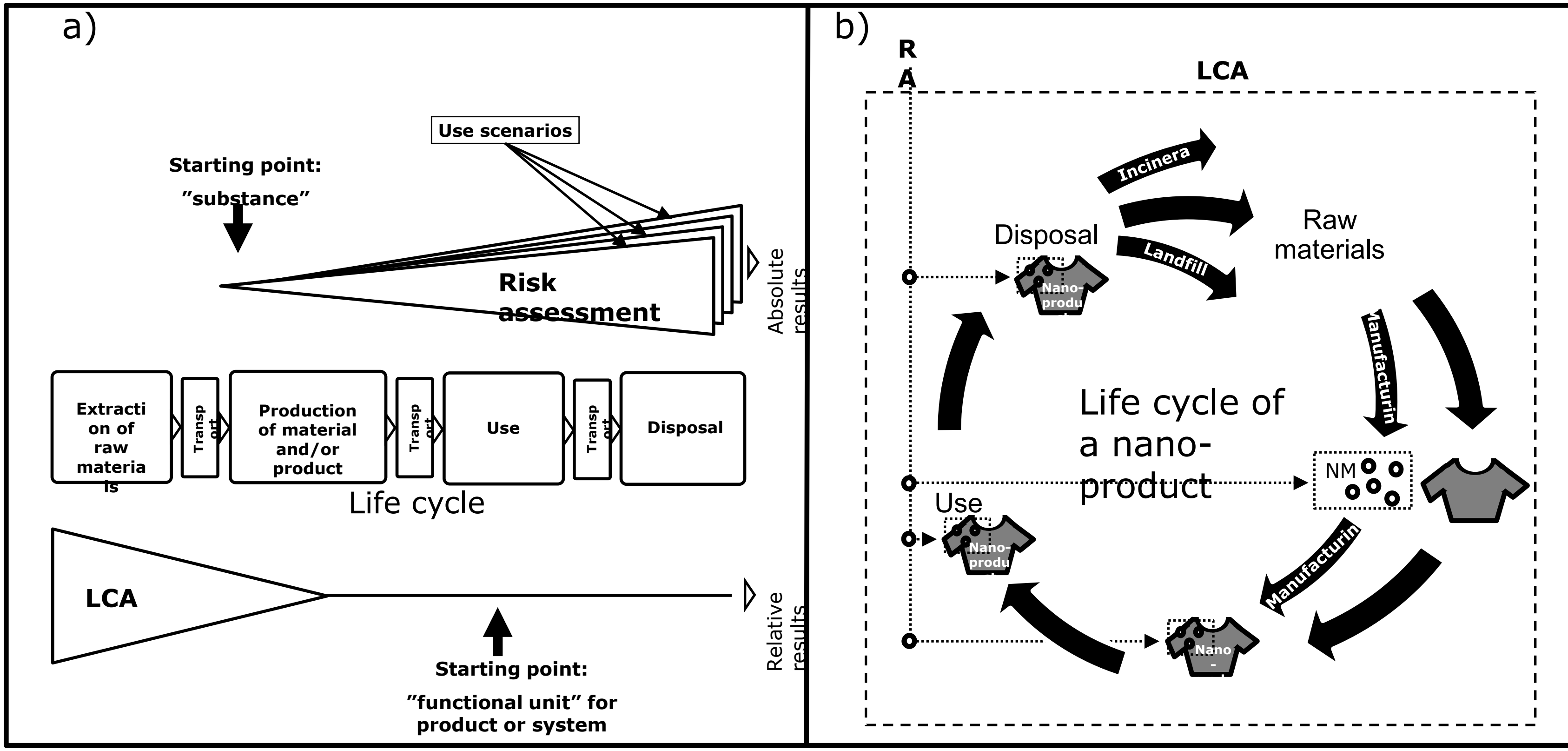
Framework



Ecotoxicity: CF=FF·EF Human toxicity: CF=iF·EF

Ralph K. Rosenbaum et al., Int J Life Cycle Assess (2008) 13:532–546

Life Cycle Assessment and Risk Assessment



Grieger et al. 2012

Conclusions

- LCA assesses potential impacts
- LCA is a comparative assessment
- LCA is ”holistic”
  - Considers the product life cycle
  - Considers ”all” environmental impacts

  → Good to prevent problemshifting

- Risk assessment assesses absolute impacts (Risk? yes/no)
- Risk assessment considers a substance in all its uses (substance life cycle)
- Risk assessment (only) addresses (eco-)toxic impacts

- LC Impacts Assessment principles/framework can be used for comparative risk assessment

Life cycle considerations in EU chemicals policy

Frans Møller Christensen, Pollution Prevention, Sustainability and Risk Management

EU chemicals policy – REACH (REGULATION 1907/2006)

Key elements:

- Registration by industry of manufactured/imported chemical substances > 1 tonne/year (staggered dead-lines over 11 years)
- Evaluation of some registered substances (Agency and Member States)
- Authorisation only for use of Substances of Very High Concern (SVHCs): CMR, PBT and similar concern substances
- Restrictions: "Safety net" (Community wide action)
- Chemicals Agency to efficiently manage the system

COWI

REACH – Risk/safety assessment and socio-economic analysis

- A socio-economic analysis is like LCA a comparative methodology; addressing social and economic impacts in addition to environmental impacts
- Authorisation (SVHC: CMR, PBT, similar concern substances):
  - SVHC substances gradually included in procedure (REACH annex XIV)
  - Industry to:
    - cease use by "sunset date", or
    - apply for an authorisation within an "application date"
      - Risk/safety assessment, substitution considerations, socio-economic analysis
- Restrictions ("community wide" risk)
  - Proposals for restrictions prepared by the authorities
    - Risk/safety assessment, substitution considerations, socio-economic analysis

Guidance – Authorisations and restrictions

http://echa.europa.eu/guidance-documents/guidance-on-reach

- Guidance on the preparation of an application for authorisation
- ***Guidance on the preparation of socio-economic analysis as part of an application for authorisation***

- Guidance for the preparation of an Annex XV dossier for restrictions
- ***Guidance on Socio-Economic Analysis – Restrictions***

=> Life cycle thinking/considerations build into the guidance documents on socio-economic analysis

COWI

Thank you for your attention!

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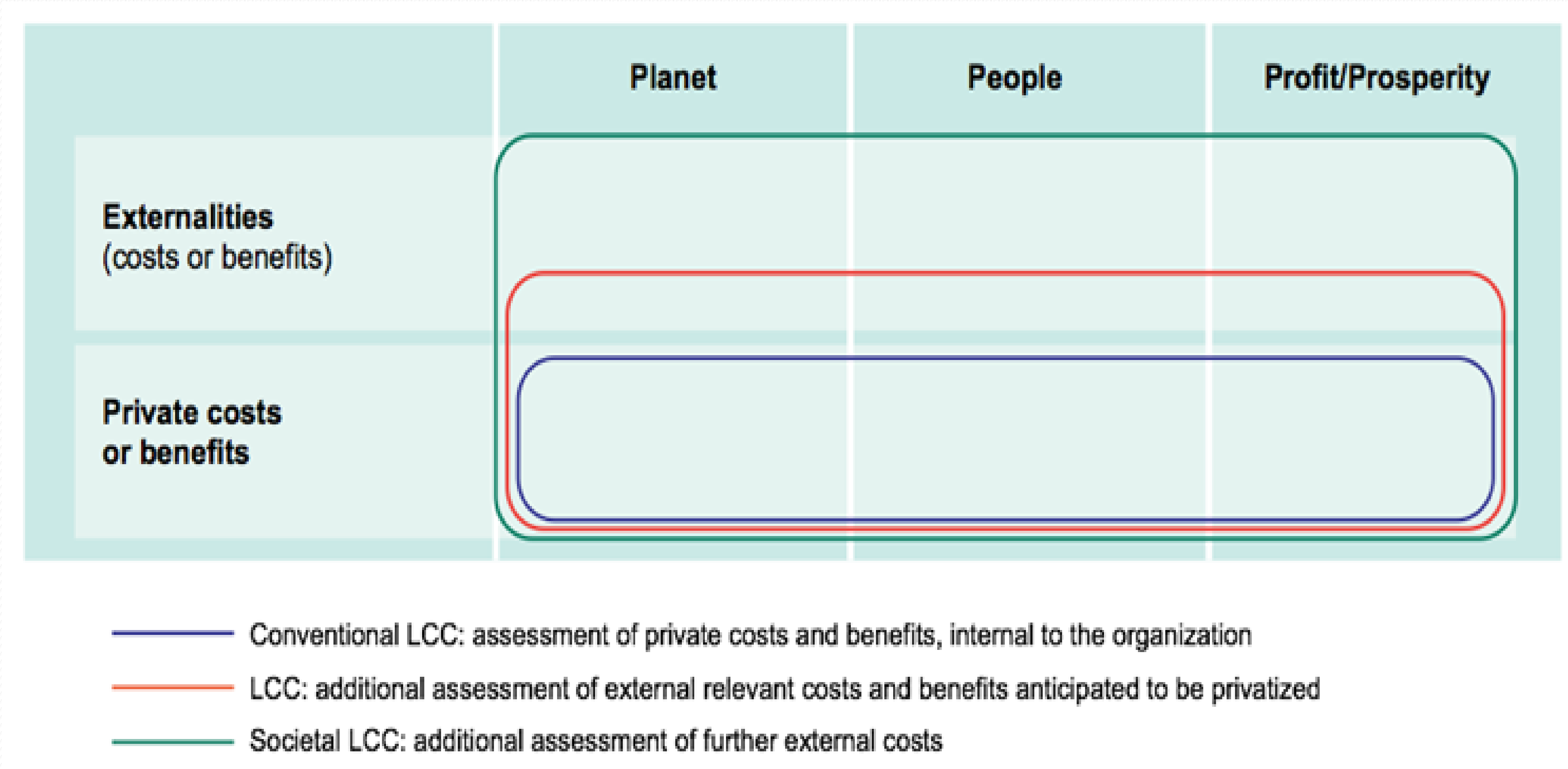
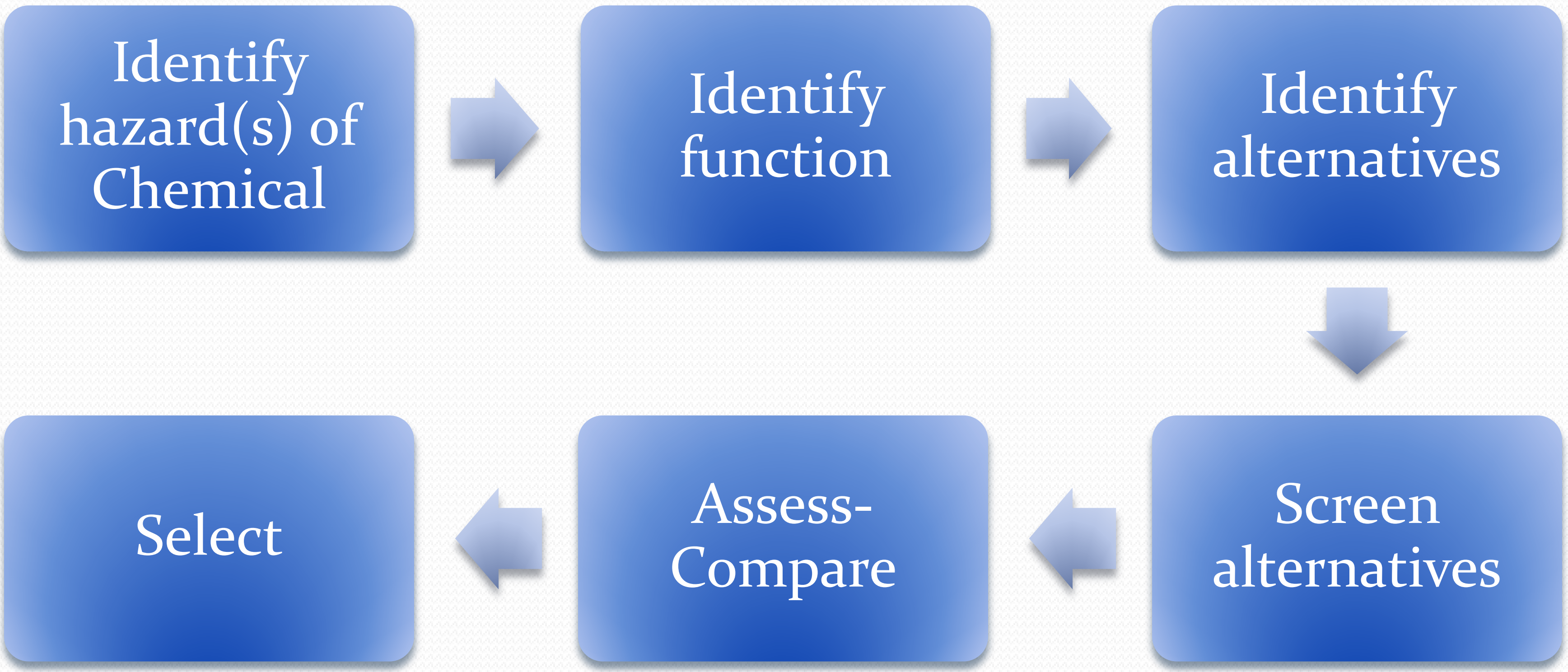
Application of LCA in safer products alternatives analysis - a California perspective

AA 108 Webinar- Tuesday, November 20th

Goal?
Safer Alternatives



Typical Assessment Framework



Alternative Assessment Frameworks

Identify functionality requirements
Identify potential alternatives
Availability/Feasibility/Manufacturability/Safety
Human Health Profile
Environmental Profile
Exposure Potential
Performance/Market/Economic acceptability
Life Cycle Impacts (energy/water/emissions/costs)
Social Considerations/Stakeholder Buy-In
Decision making

Statutory mandates

Requires evaluation of the availability of potential alternatives and potential hazards posed by those alternatives, as well as an evaluation of critical exposure pathways.

… "multimedia life cycle evaluation" means the identification and evaluation of a significant adverse impact on public health or the environment, including air, water, or soil, that may result from the production, use, or disposal of a consumer product or consumer product ingredient.

Statutory criteria

This process shall include life cycle assessment tools that take into consideration, but shall not be limited to, all of the following:

- (A) Product function or performance.
- (B) Useful life.
- (C) Materials and resource consumption.
- (D) Water conservation.
- (E) Water quality impacts.
- (F) Air emissions.
- (G) Production, in-use, and transportation energy inputs.
- (H) Energy efficiency.
- (I) Greenhouse gas emissions.
- (J) Waste and end-of-life disposal.
- (K) Public health impacts, including potential impacts to sensitive
- subpopulations, including infants and children.
- (L) Environmental impacts.
- (M) Economic impacts.

Life Cycle Assessment

- (A) Product function or performance.
- (B) Useful life.
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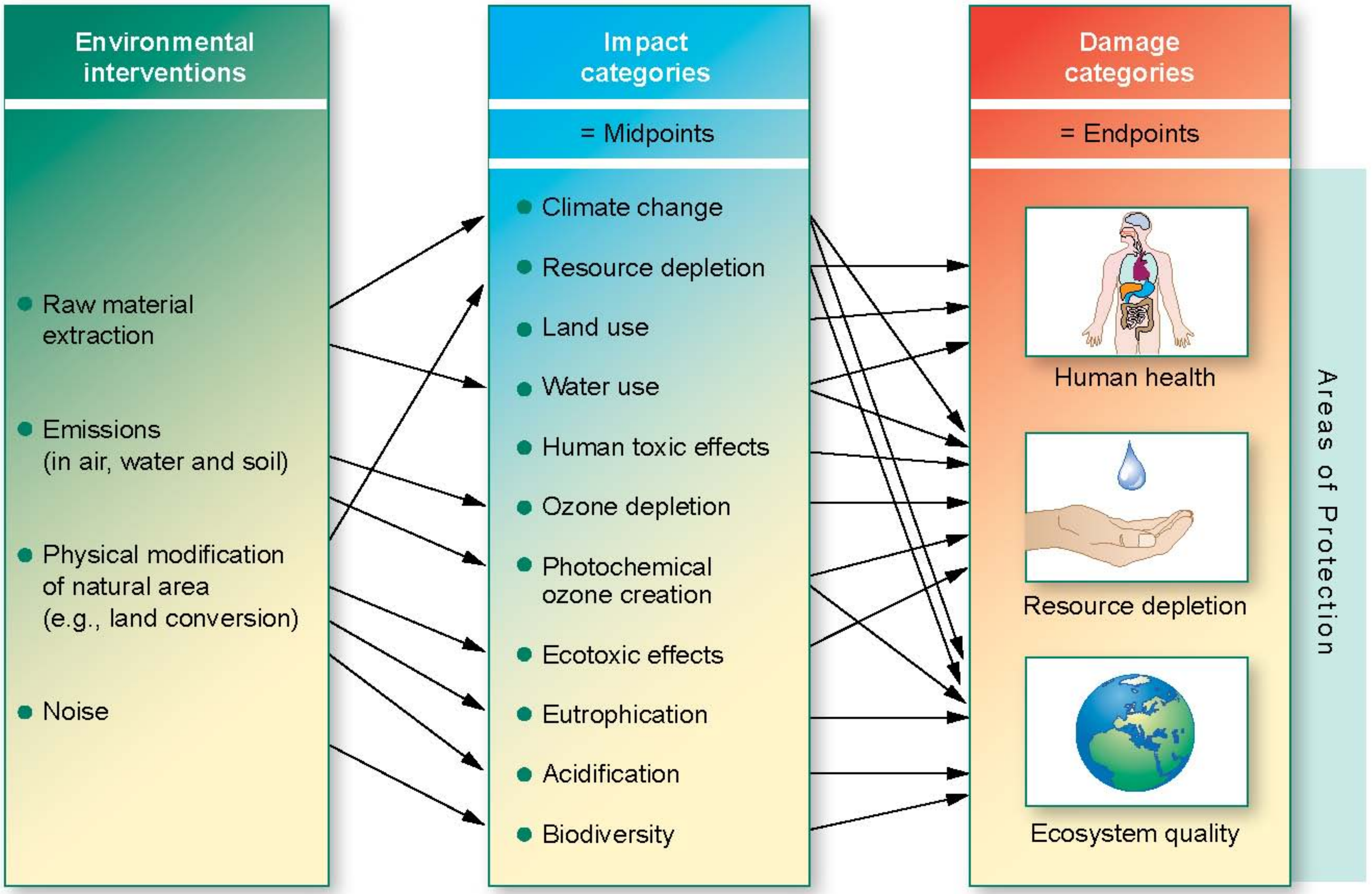

Figure 2. Overall UNEP/SETAC scheme of the environmental LCIA framework, linking LCI results via the midpoint categories to damage categories (adapted from Jolliet et al., 2003a).

LCA outputs

- (A) Product function or performance.
- (B) Useful life.
- (C) Materials and resource consumption.
- (D) Water conservation.
- (E) Water quality impacts.
- (F) Air emissions.
- (G) Production, in-use, and transportation energy inputs.
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- (J) Waste and end-of-life disposal.
- (K) Public health impacts, including potential impacts to sensitive
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- (M) Economic impacts.

Gaps

- (A) Product function or performance.
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- (C) Materials and resource consumption.
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Alternatives Analysis Guidance considerations

- Framework
- 'Adverse' definitions, mapping
- Screening HA, EA and LC approach
- Iterative approach for what is relevant
- EA, HA, LC tools/methods
- Data Gaps/Quality/Uncertainty
- Decision making

Alternative Assessment Frameworks

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Social Considerations/Stakeholder Buy-In
Decision making

Guidance- likely scenarios

Assessment Criteria	Examples of scenarios where further analysis needed. If alternatives:
(A) Product function or performance	- function worse or better in some applications - affect sales or market share due to performance
(B) Useful life	- have shorter or longer life spans - require additional maintenance to achieve the same life - are more likely to be reused, offseting future sales.
(C) Materials and resource consumption	- consumes more (or less) volume of materials - use of a limited, non-renewable resource - are more likely to recycle waste during manufacture
(D) Water conservation	- require different water volumes for manufacturing or maintenance/ cleaning - need higher quality water (i.e., further treatment) - can reuse water, reducing overall consumption
(E) Water quality impacts	- discharge chemicals/contaminants to water during manufacture, use, or disposal - may be disposed directly to water (e.g., home car wash soap)
(F) Air emissions	- emit chemicals/contaminants to air during product manufacture, use, or disposal
(G) Production, in-use, & transportation energy	- have different energy needs in manufacture or use - require different fuel input due to material weight, transport mode, and/or distance
(H) Energy efficiency	- have potential for energy efficiency or recovery compared to other options

Relate LC phase to criteria

AA criteria	Upstream Activities (Production Phase)	On-site Activities (Use Phase)	Downstream Activities (Disposal Phase)
(A) Product function.	• Changes in yield rates		• Co-products/ by-product value
(B) Useful life.	• Change in costs of raw material with different life • *Associated transport*	• Change in costs of input material with different life • *Associated transport*	• Changes in disposal costs of used products • *Associated transport*
(C) Materials & resource consumption.	• Changes in mass/volume of inputs manufactured • *Associated transport*	• Changes in mass/volume of materials processed • *Associated energy use (e.g., additional handling, pumping)*	—
(D) Water conservation.	• Upstream variations (e.g., process water recycling) • *Water scarcity conditions*	• Water requirements • Recycling/ reuse capacity • *Water scarcity conditions*	—
(E) Water quality impacts.	• *Upstream process emissions* • *Receiving water sensitivity*	• *On-site process emissions* • *Receiving water sensitivity*	• *Disposal emissions/leaks* • *Receiving water sensitivity*
(F) Air emissions.	• *Upstream process emissions* • *Sensitivity of local and/or*	• *On-site process emissions* • *Sensitivity of local and/or*	• *Disposal emissions/leaks* • *Sensitivity of local and/or*

Screening approach

Step	Goals of Analysis	Parameter Uncertainty Characterization	
		Empirical quantities	Value and model domain parameters
Parameter Triage	Find influential parameters. Comment on robustness of differences given uncertainty across a range of scenarios.	Rough characterization for parameters.	Broad range of discrete values.
Comparative Assessment	Comment on scenario characteristics that have the most influence on robustness.	For influential parameters, obtain more detailed range of discrete values.	For influential parameters, refine range of values.

Human Health / Public Health

Q Under normal use conditions, would the product be expected to be applied directly to the skin (e.g. personal care products)?

☐ No

☐ Yes

If yes, complete the Human Health and Occupational Exposure Worksheet.

Iterative approach

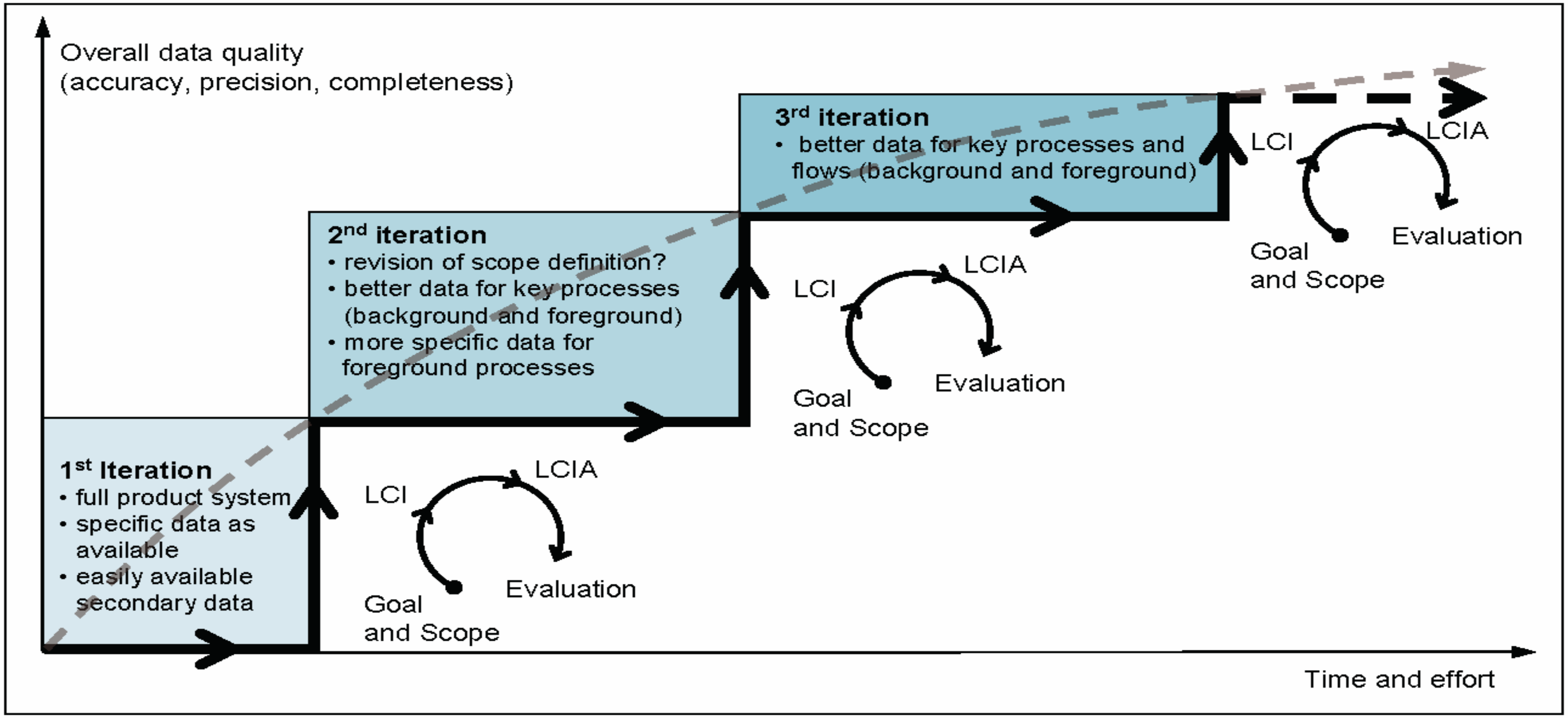

Figure 4 Iterative nature of LCA (schematic). LCAs are performed in iterative loops of goal and scope definition, inventory data collection and modelling (LCI), impact assessment (LCIA), and with completeness, sensitivity and consistency checks (Evaluation) as a steering instrument. This is done - with a possible, limited revision of the goal and scope - until the required accuracy of the system's model and processes and the required completeness and precision of the inventory results has been attained.

Data Quality

Data quality assessment pedigree matrix (based on Lindfors, 1995 and Weidema, 1996)

	Indicator score				
	1	2	3	4	5
Acquisition method	Measured data	Calculated data based on measurements	Calculated data partly based on assumptions	Qualified estimate (by industrial expert)	Non-qualified estimate
Independence of data supplier	Verified data, information from public or other independent source	Verified information from enterprise with interest in the study	Independent source, but based on non-verified information from industry	Non-verified information from industry	Non-verified information from the enterprise interested in the study
Representativeness	Representative data from sufficient sample of sites over an adequate period to even out normal fluctuations	Representative data from smaller number of sites but for adequate periods	Representative data from adequate number of sites, but from shorter periods	Data from adequate number of sites, but shorter periods	Representativeness unknown or incomplete data from smaller number of sites and/or from shorter periods
Temporal correlation	Less than 3 years of difference to year of study	Less than 5 years difference	Less than 10 years difference	Less than 20 years difference	Age unknown or more that 20 years of difference
Geographical correlation	Data from area under study	Average data from larger area in which the area under study is included	Data from area with similar production conditions	Data from area with slightly similar production conditions	Data from unknown area or area with very different production conditions
Further technological correlation	Data from enterprises, processes and materials under study	Data from processes and materials under study, but from different enterprises	Data from processes and materials under study, but from different technology	Data on related processes or materials, but same technology	Data on related processes or materials, but different technology

Tools/Methods

- Hazard assessment
- Exposure assessment
- Life Cycle Inventory/Database
- Life Cycle Impact Analysis
- Life Cycle Assessment Methods
- Water Footprinting
- Carbon Footprinting
- Life Cycle Costing/CBA

Life Cycle Tools -Key Descriptors -

- LCA Stage
- LCA Focus
- Free/Fee
- Life-cycle Phases
- Processes
- Indicators Evaluated
- Geography
- Relevant Analysis Time Period

Social Life Cycle Assessment

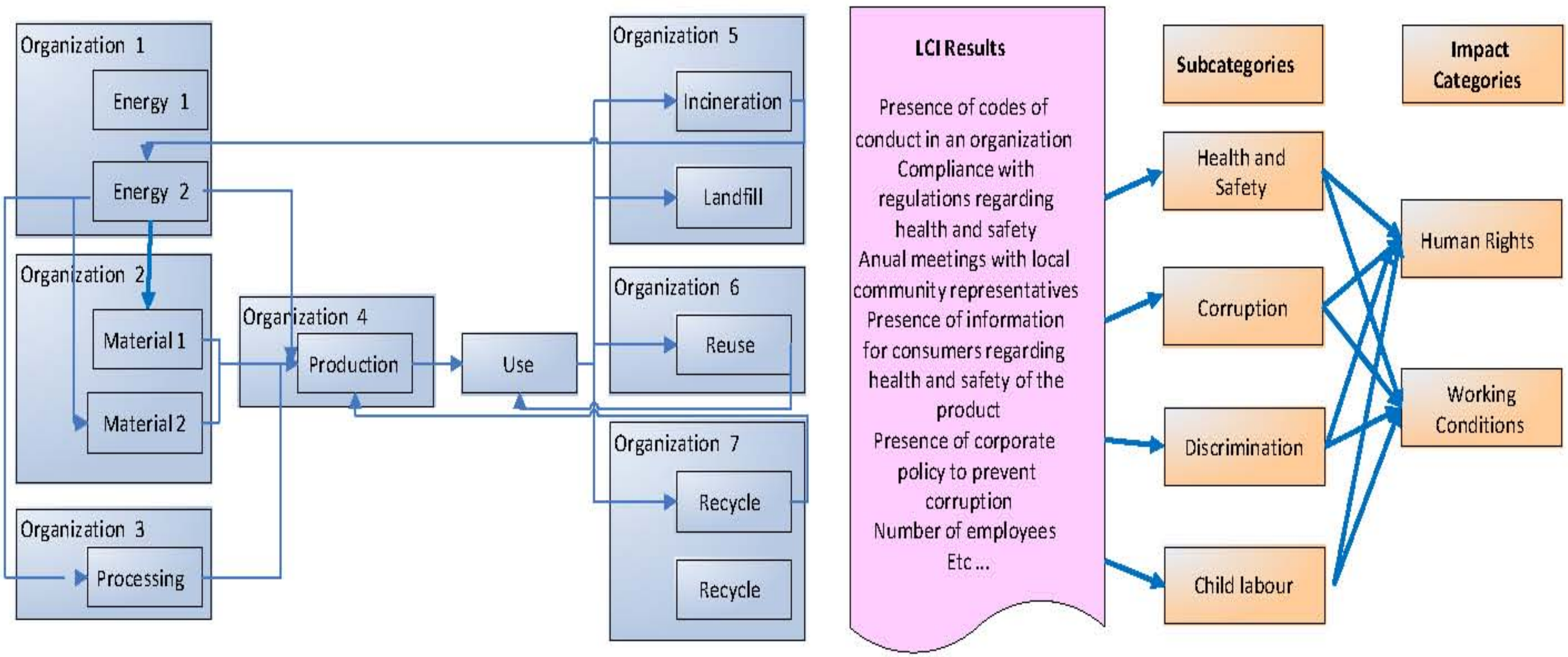

Figure 9. Examples of a social life cycle inventory (S-LCI) and interrelationships to subcategories and impact categories.

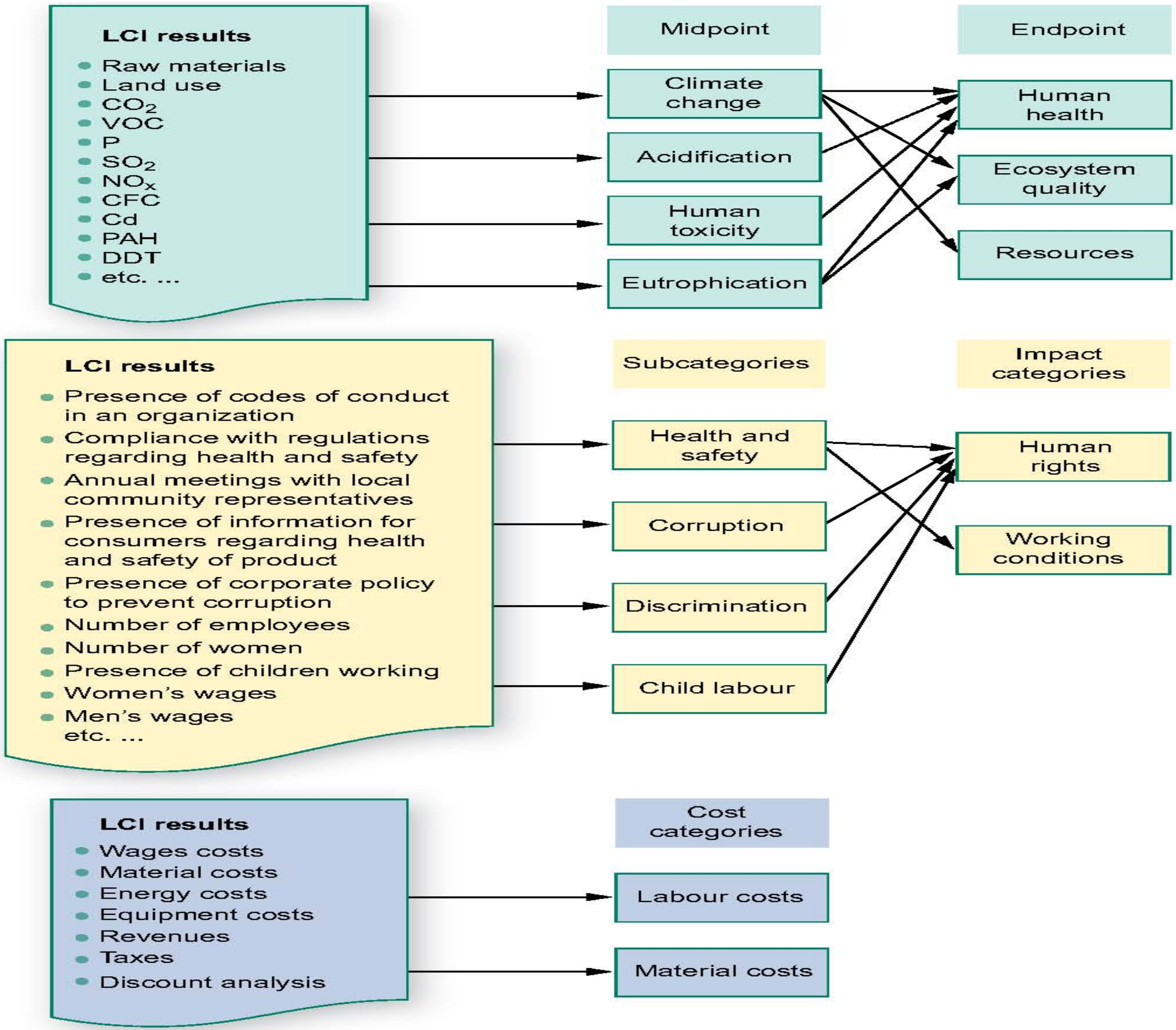

Figure 16. Examples of midpoint and endpoint categories, subcategories of stakeholders and cost categories when starting a life cycle sustainability assessment (LCSA).

Application of LCA in safer products alternatives analysis - a California perspective

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bob.boughton@dtsc.ca.gov

Discussion Questions

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- How can lifecycle thinking help to avoid unintended consequences of chemical substitutions?
- How can lifecycle considerations be included in alternatives assessments without unnecessarily bogging down the assessment in analytic details and debates?
- What tools and approaches are most promising for incorporating lifecycle considerations in alternatives assessments.

Next Webinars

Lowell Center for Sustainable Production
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- Alternatives Assessment 109:Alternatives Assessment in Procurement
  - December 2012- Date and Time TBA
- Alternatives Assessment 110: Collaborations to Advance Safer Alternatives: Examples and Models
  - Winter 2013- Date and Time TBA

Webinar Audio & Slides

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The audio recording and slides shown during this presentation will be available at:

http://www.chemicalspolicy.org/alternativesassessment.webinarseries.php