Cost Management System
for greening Electrical and
Electronic Equipment

EGG 2004+ New Materials: Flame Retardants

Environmental and economic implications of a shift to halogen-free printed wiring boards

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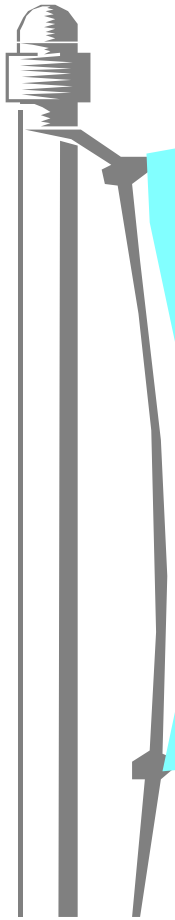
www.grEEEn.it

grEEEn consortium

Funded by the European Commission

grEEEn is partner of the CARE network



10 Partners representing 5 European countries

(Germany, Spain, Sweden, United Kingdom, Italy)

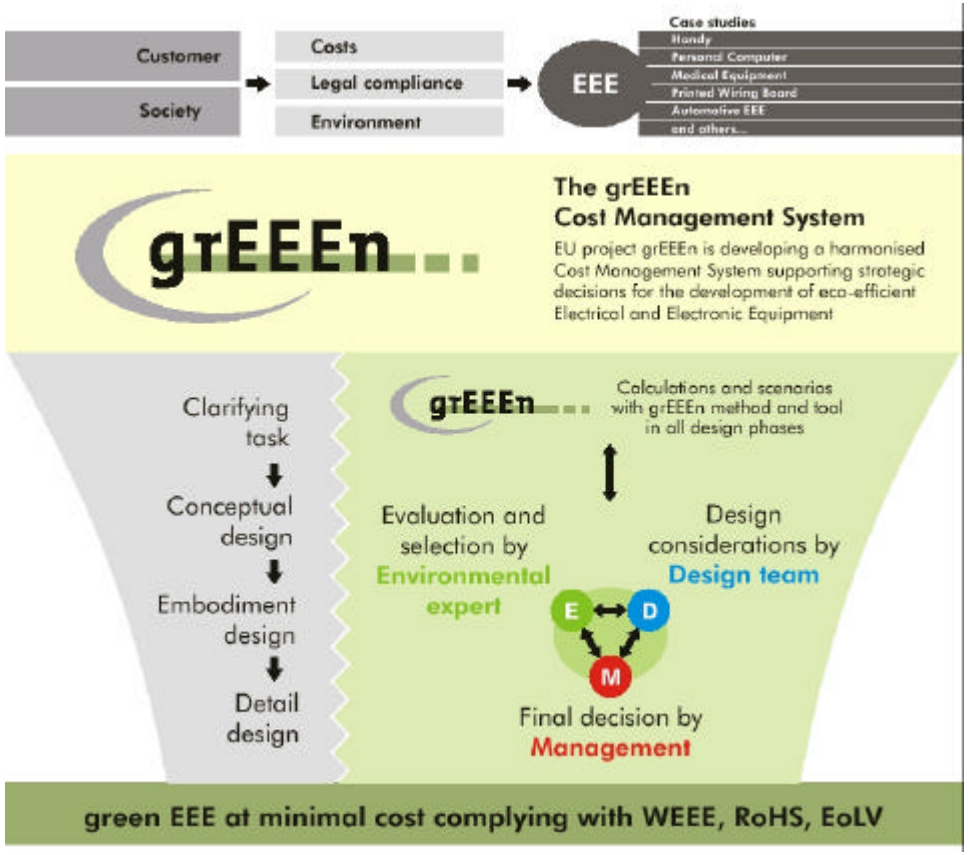
2 University institutes:

2 Research institutes:

4 Industrial partners:

2 Service providers:

grEEEn cost management system



grEEEn target group

Environmental experts supporting the product design team

grEEEn method and tool provide

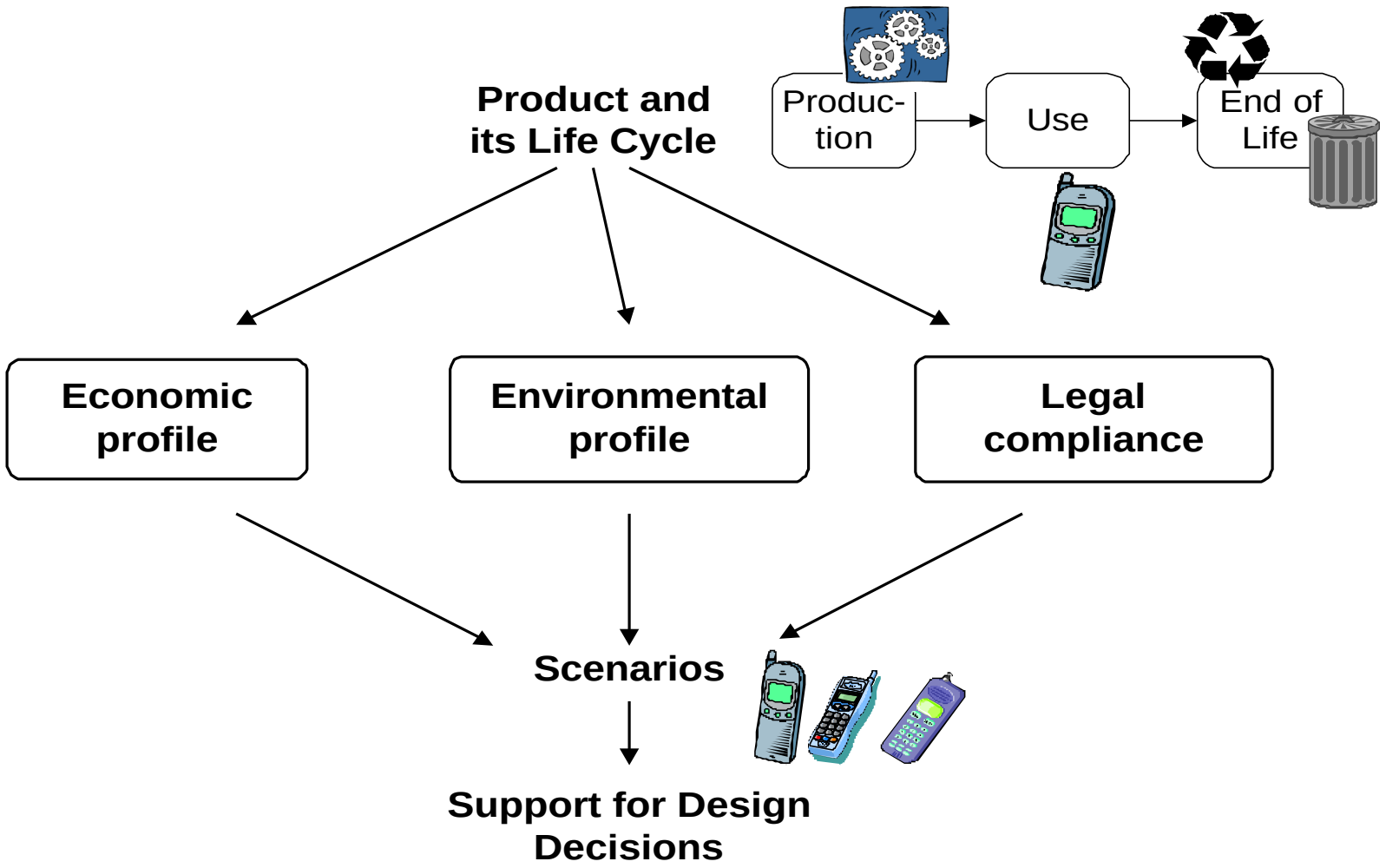
Calculation of results

- Economic profile
- Legal compliance with WEEE, RoHS, EoLV
- Environmental profile

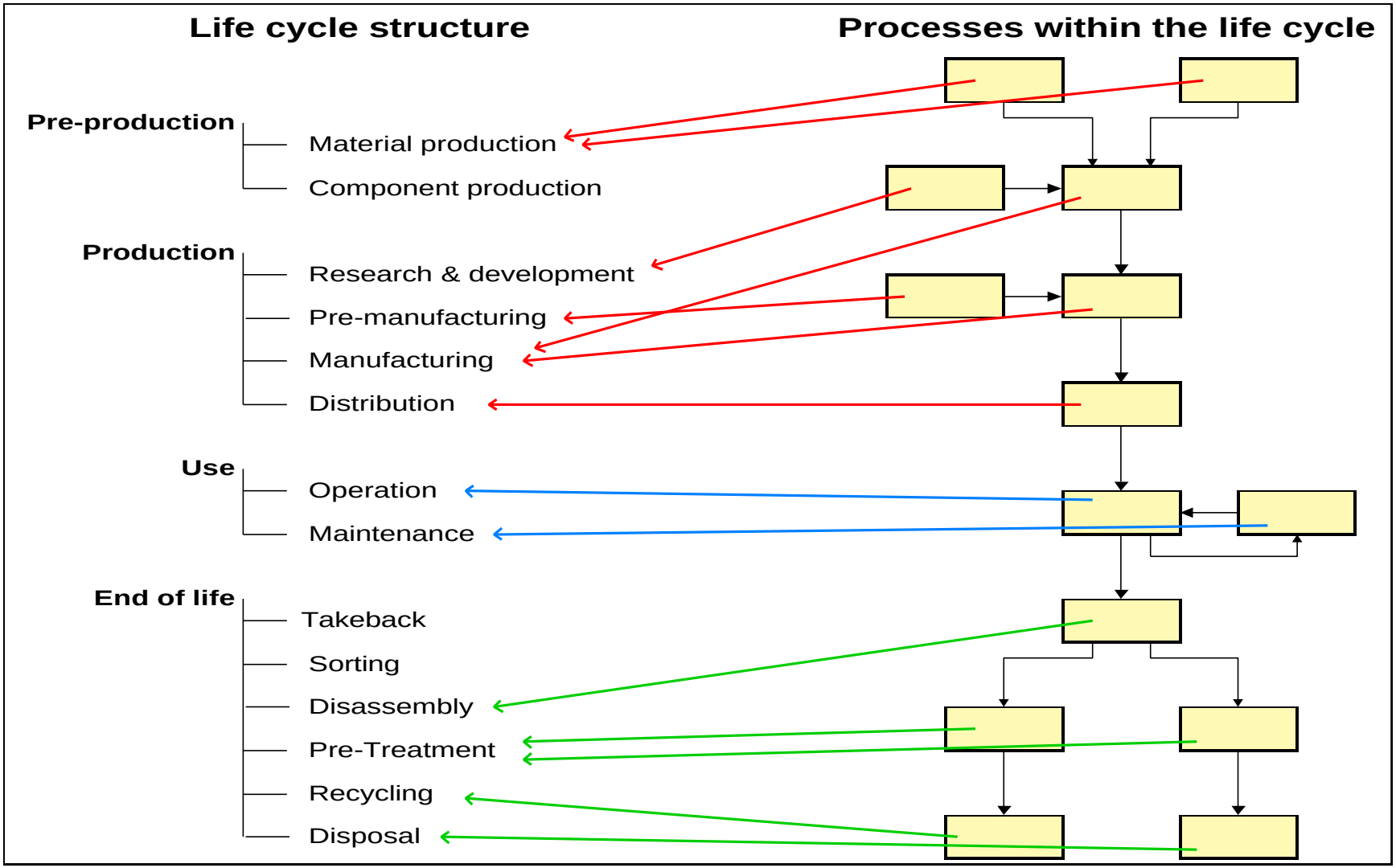
Scenario definition and recalculation

Design recommendations

Method: grEEEn method



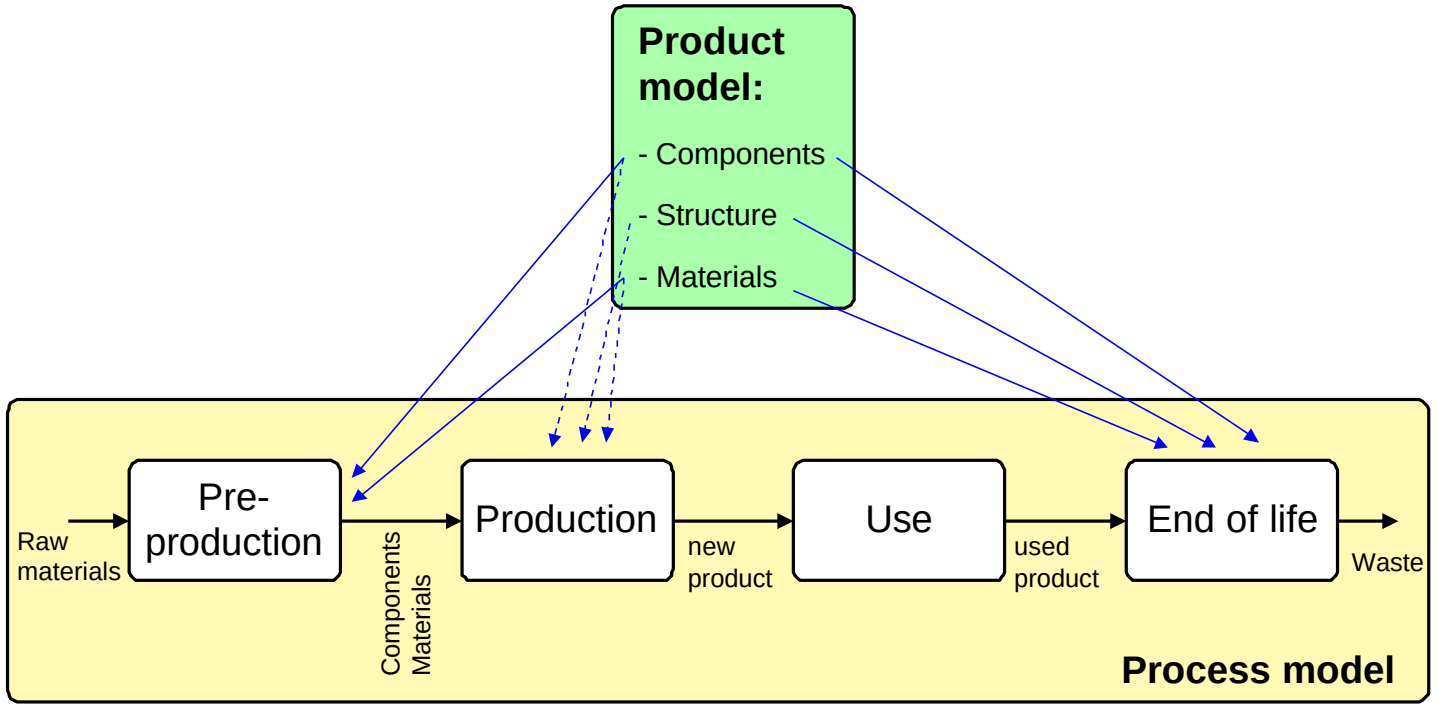
Method: Process Model



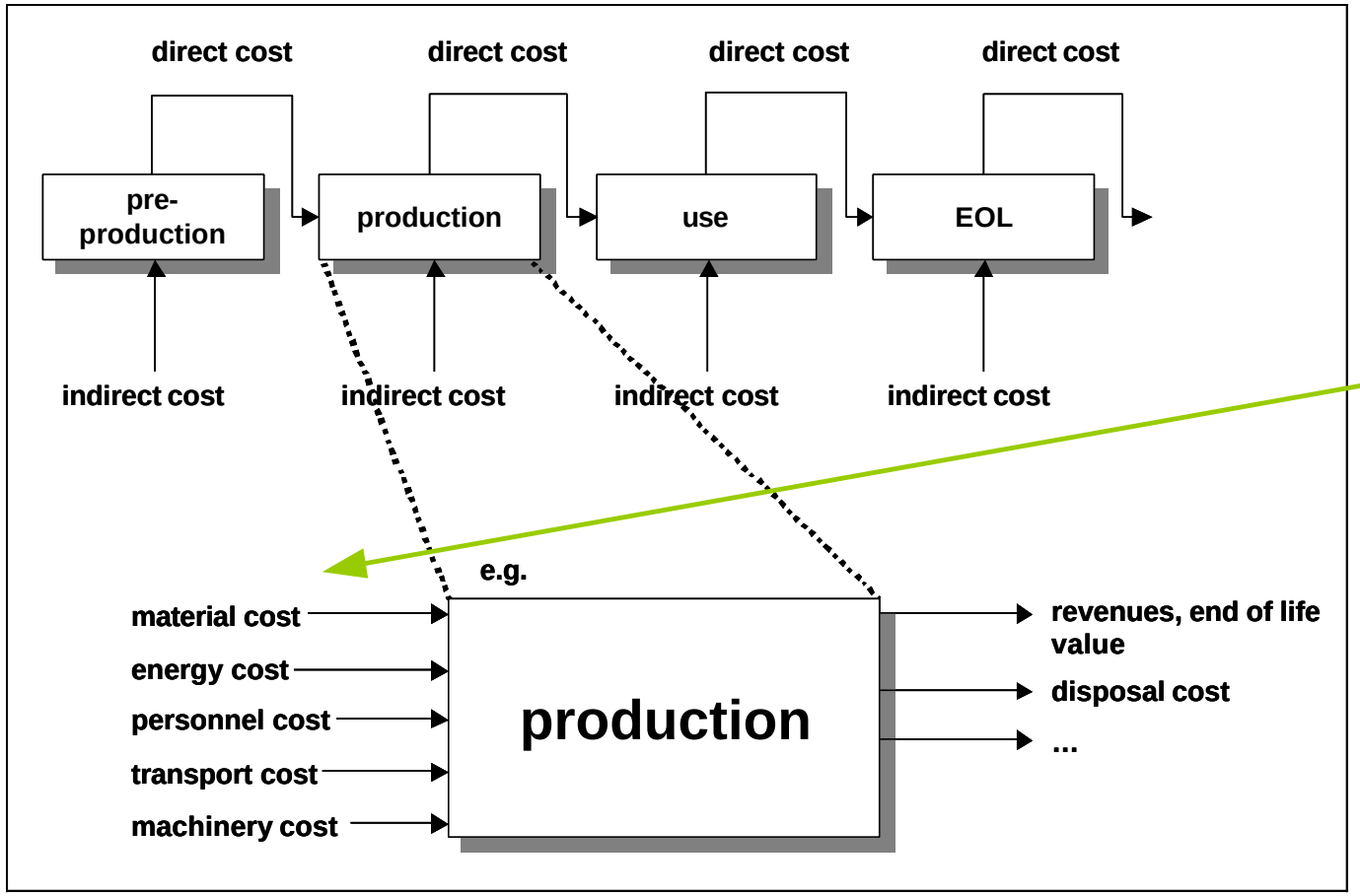
Method: Product Model

Product Model definition

- Material definition
- Product hierarchy
- Connections/ disassembly operations



Method: Economic Profile



Main cost elements

materials
energy
personnel
transport
machinery

Supplementary cost elements

service
tooling
storage
taxes
...

Method: Environmental Profile

Simplified Indicators Number of materials Mass Toxicity index	**Inventory Indicators** Energy consumption Total waste generated
Design for Recycling Rate of recovery Rate of re-use and recycling Rate of energy recovery Recycling efficiency rate	**Impact Assessment Indicators** Raw material consumption Greenhouse index Ozone depletion index Aggregated single score

Eco-indicator 99

Method: Eco-indicator 99 (1/2)

- Consolidation of an LCA Inventory to a single score
- Aggregation based on damage analysis for three damage categories:
  - human health
  - ecosystem
  - mineral and fossil resources
- Marginal damages concept
- Integration of cultural theory, calculation based on different perspectives possible (egalitarian, individualist, hierarchist)
- Weighting based on results of a panel procedure among Swiss LCA interest group

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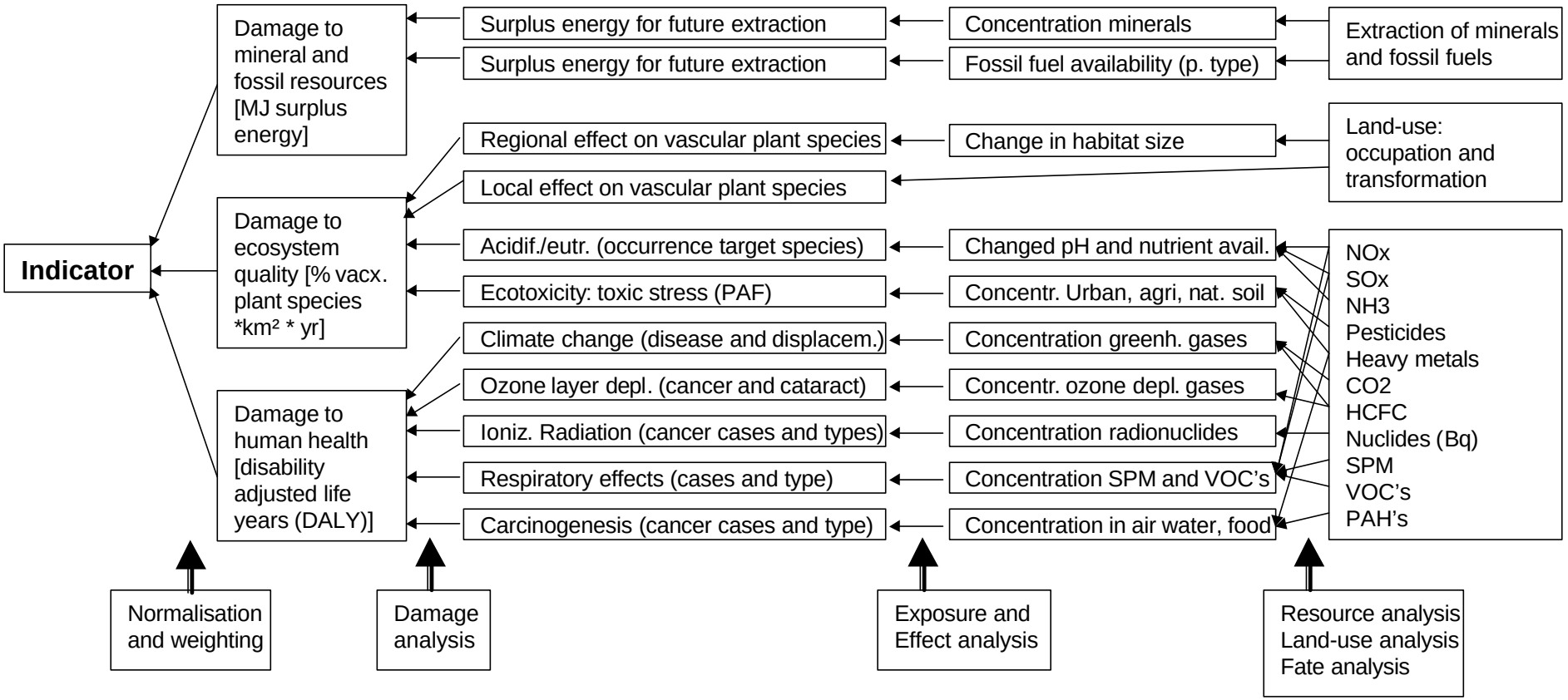
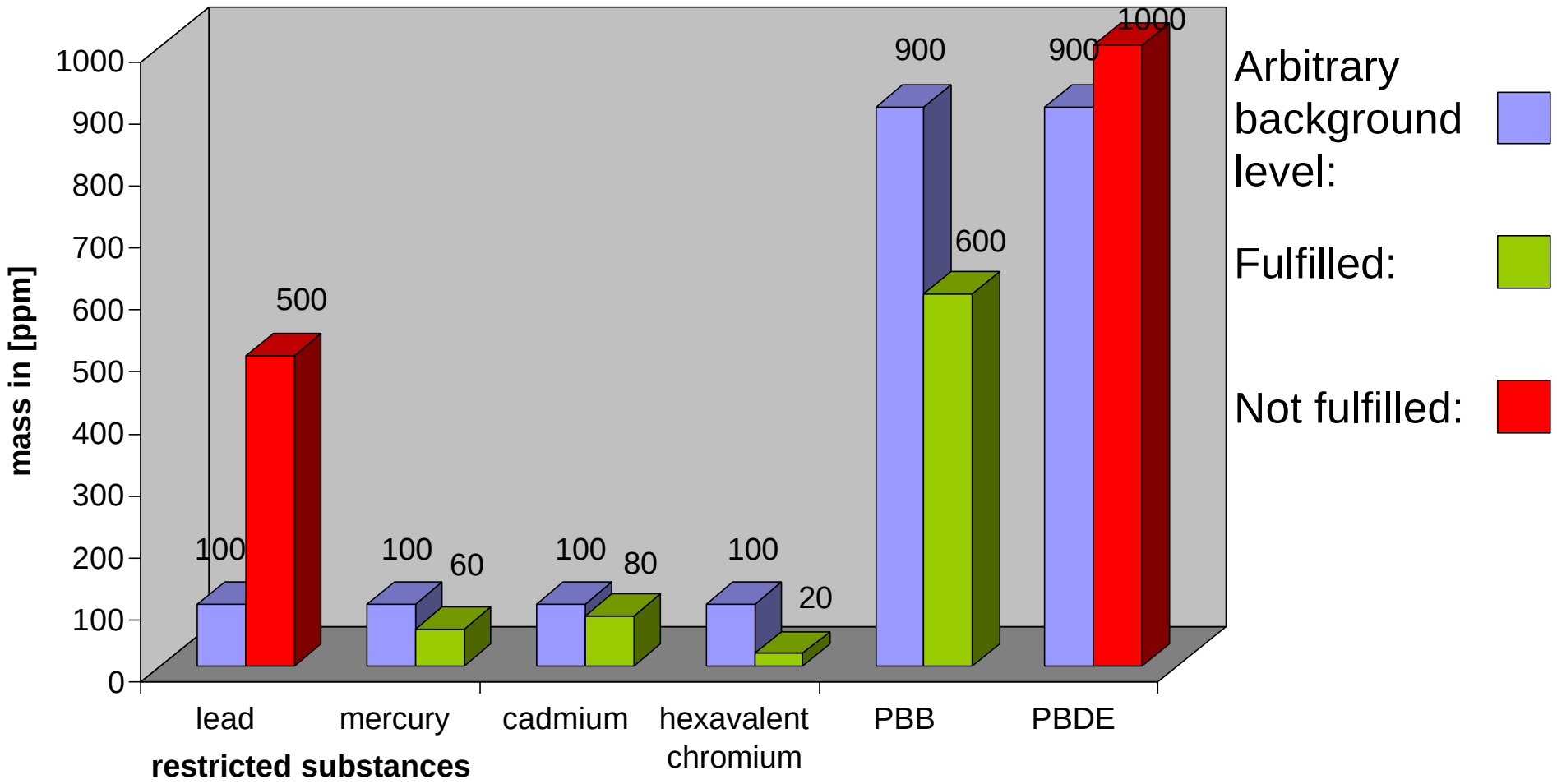
Method: Eco-indicator 99 (2/2)



Source: The Eco-indicator 99 Methodology Report 3rd Edition, Goedkoop & Spriensma, 2001, electronic version downloaded from www.pre.nl

Method: Legal Compliance



Compliance with RoHS: No ☑ Yes ☐

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Case Study: Product

Product

Traditional PWBs containing a halogenated flame retardant vs. PWBs containing a halogen-free flame retardant

Functional unit

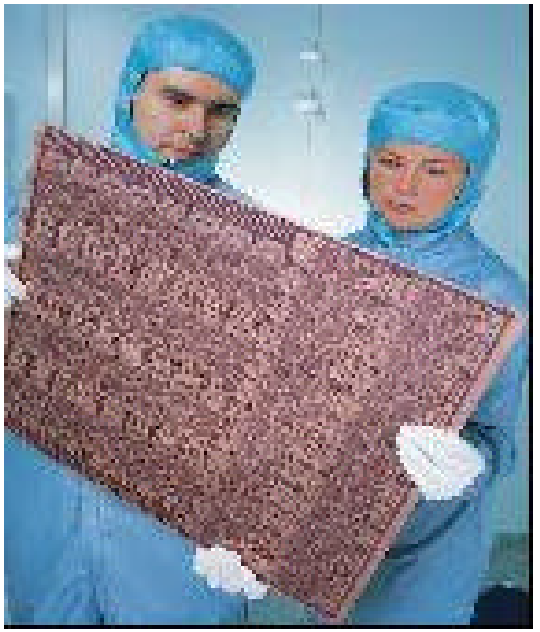
A PWB production panel containing 54 repeated 4-layer laser drilled PWBs for mobile phones

Focus

Two life cycle phases

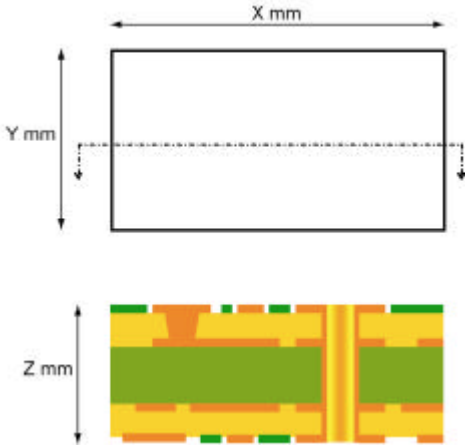
- The design phase
- The manufacturing phase (including pre-production)

Research design



Case Study: Modelling

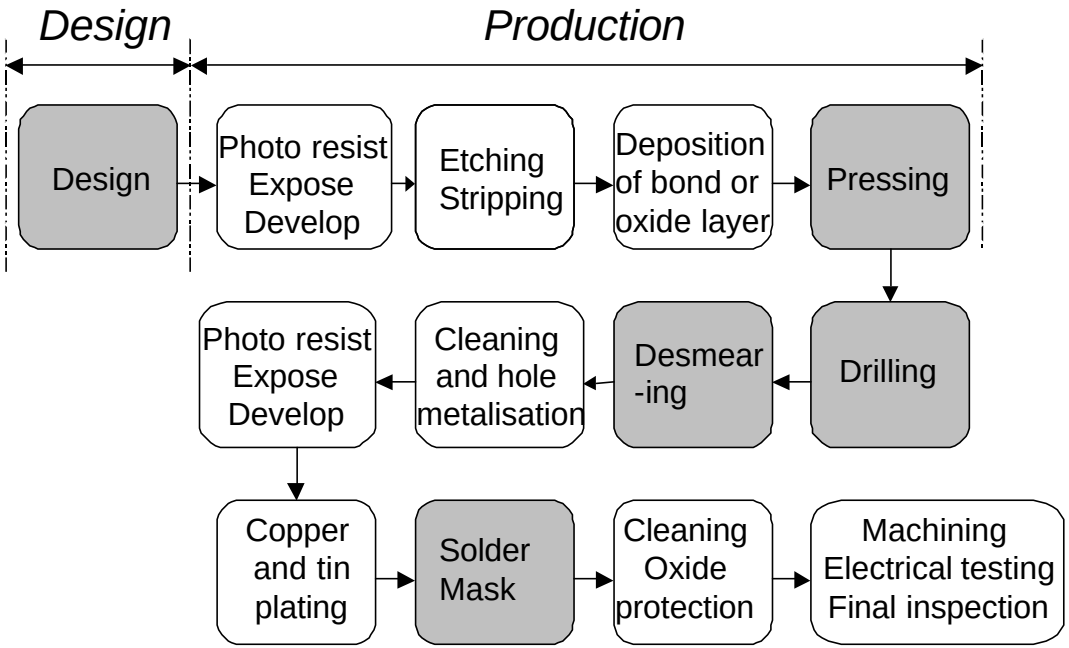
Product model



X = 555 mm
Y = 610 mm
Z = 0,9 mm

Product consists of copper-foiled laminate, prepreg and copper-foil

Process model



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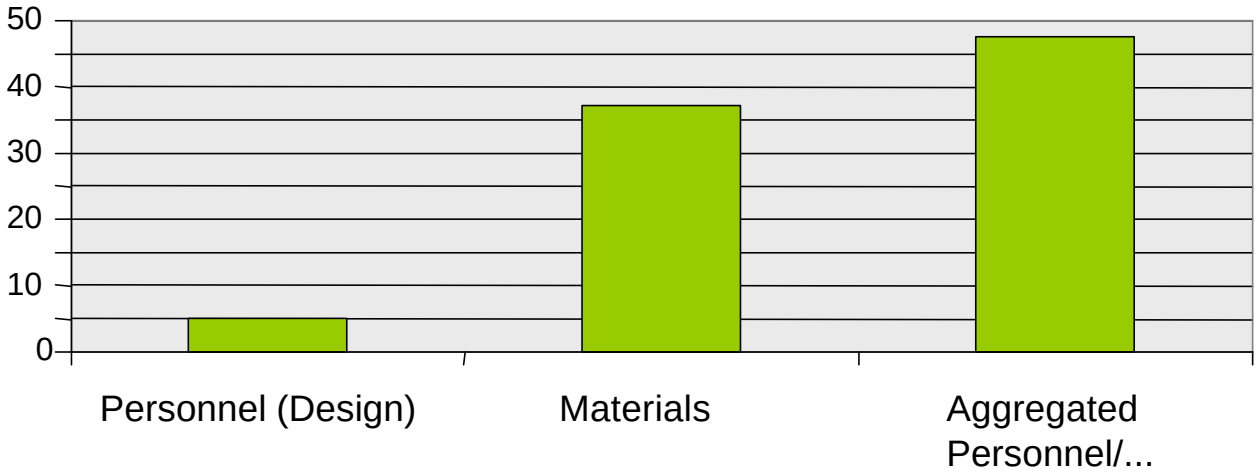
Case Study: Scenarios

Process step	Traditional PWB	Halogen-free PWB	
		Worst case	Best case
Design	Original process	Increased design cycle time	No increase in design cycle time
Pressing	Original process	Increased cycle time	Increased cycle time
Drilling	Original process	Reduction in number of panels that can be drilled at the same time	No reduction in number of panels that can be drilled at the same time
Desmearing	Original process	Increased cycle time	No increase in cycle time
Solder mask	Original process	Increased cycle time	Increased cycle time

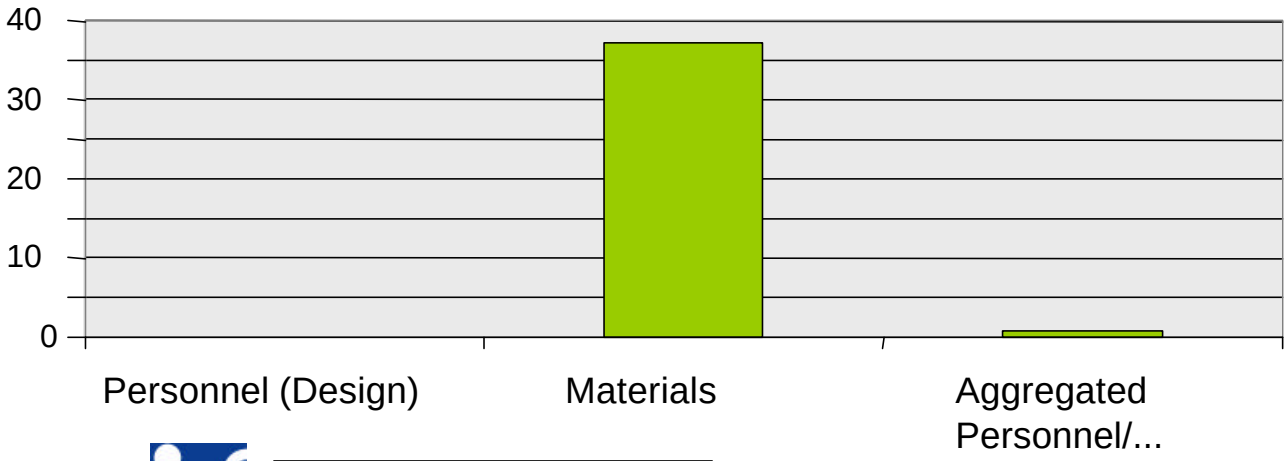
Case Study: Economic Profile (1/2)

Cost increase in percentage per cost element

(a) %



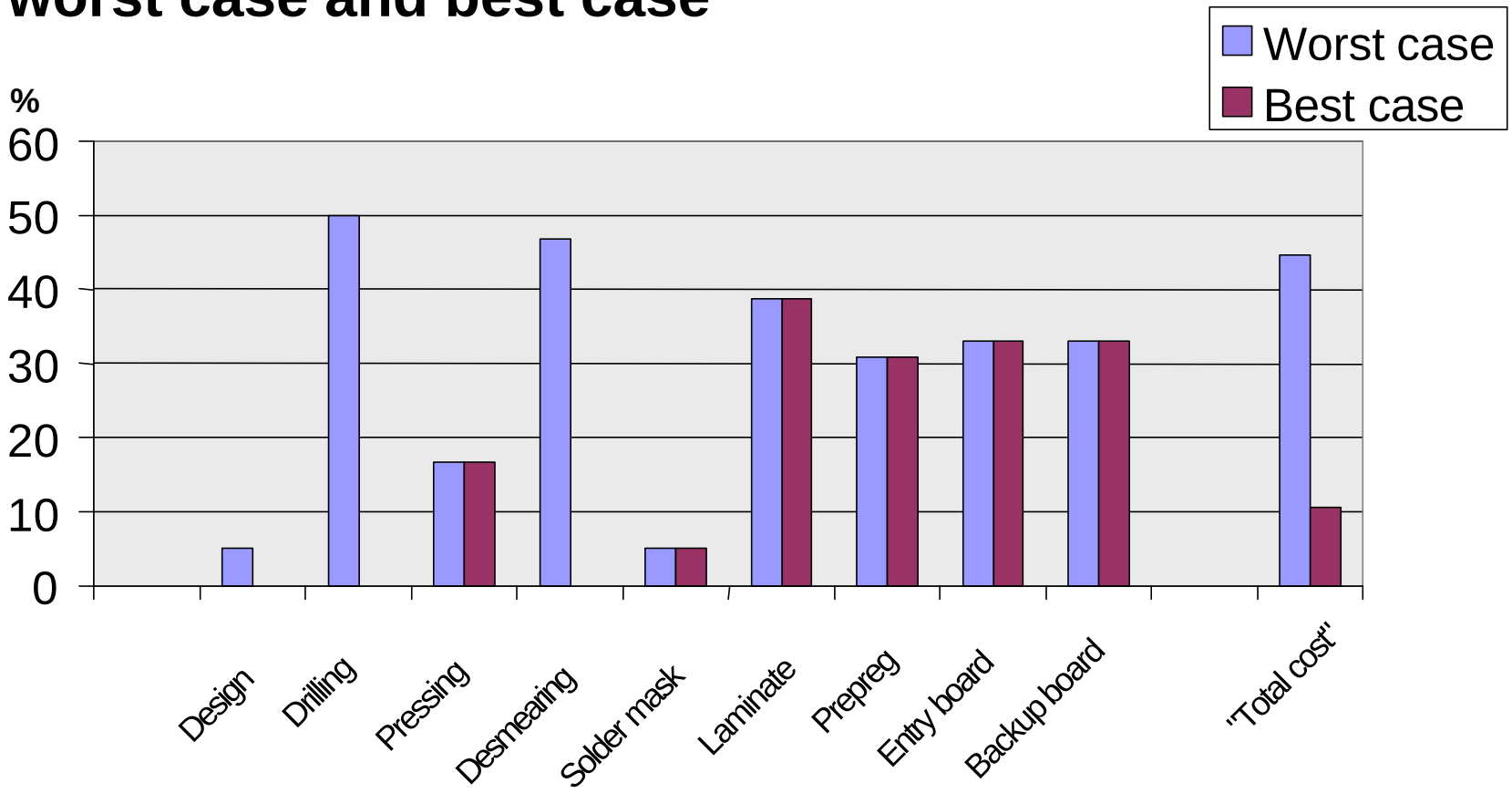
(b) %



Worst case (a) and best case (b)

Case Study: Economic Profile (2/2)

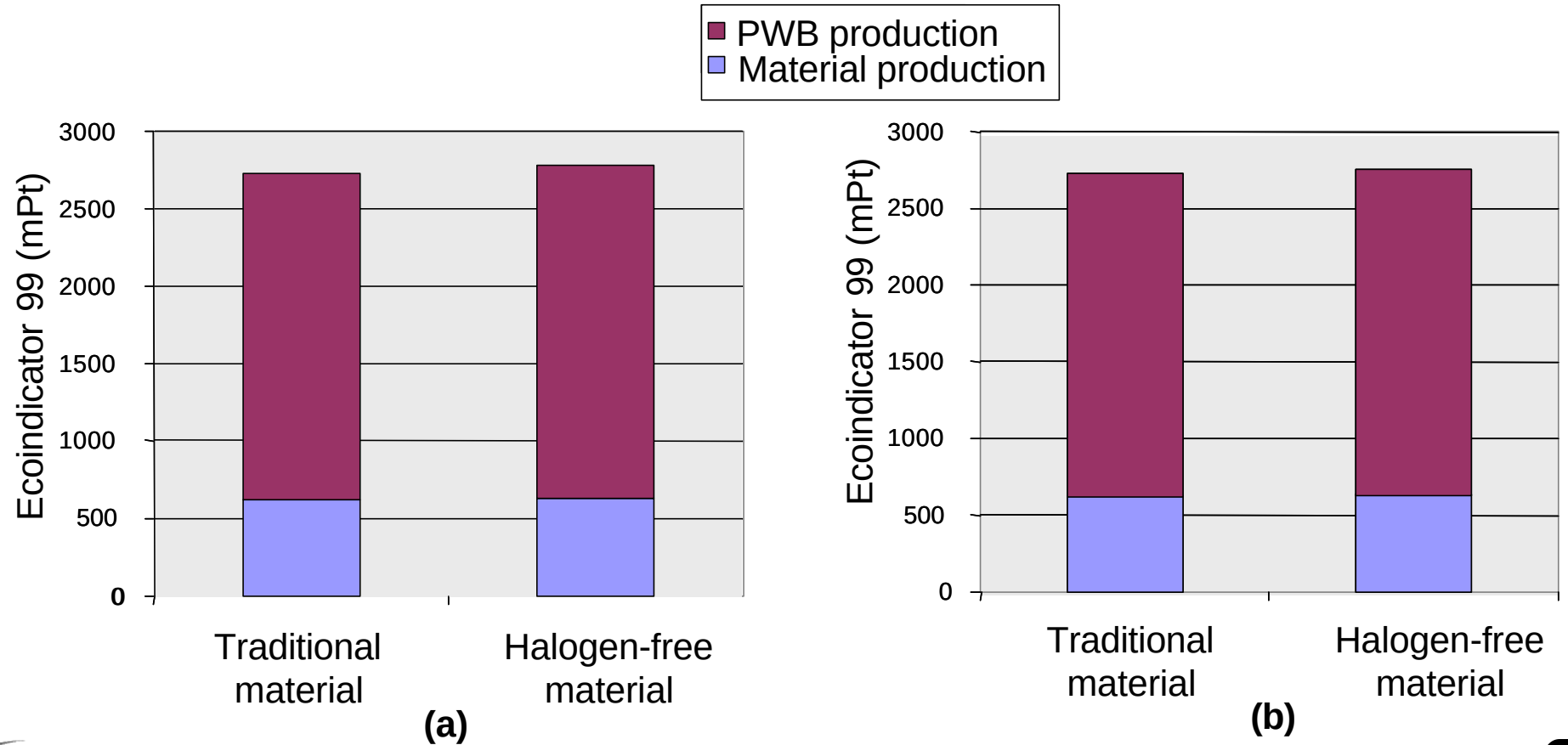
Comparison of cost effects in % between worst case and best case



Case Study: Environmental Profile (1/2)

Analysis of the environmental profile

Worst case (a) and best case (b)



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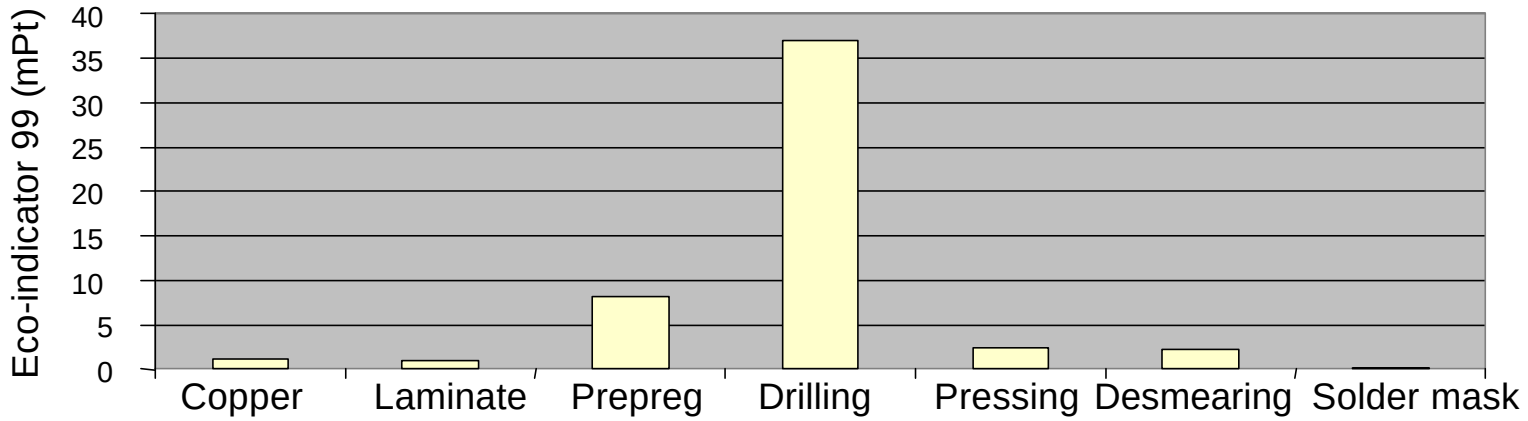
Case Study: Environmental Profile (2/2)

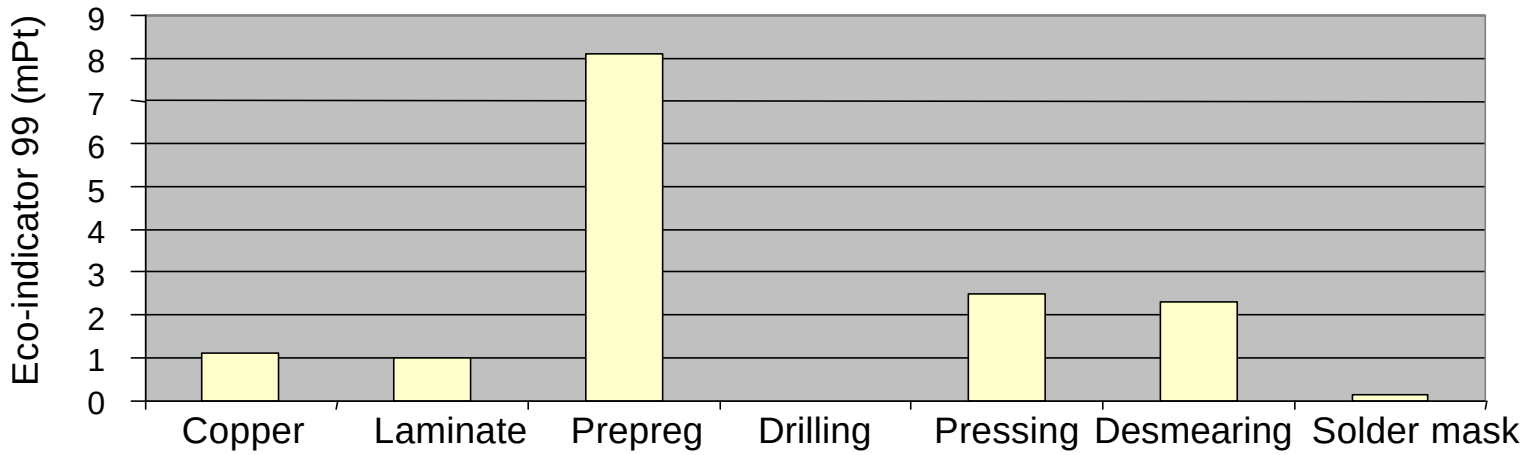
Increase in environmental impact.

Worst case (a) and best case (b)

(a)



(b)



Conclusions

- The shift to halogen-free material should mean that toxic substances are eliminated or decreased (the positive effect of this has not been quantified in the case study due to lack of data).
- This elimination does however lead to slight increases in environmental burden in the pre-production and production phases.
- In the ‘worst case’: increase in environmental burden in the production phase primarily due to the increased energy use during drilling.
- In the ‘best case’: increase in environmental burden is mainly related to pre-production phase (material production).
- With increasing manufacturing volumes the materials cost for halogen-free laminates is expected to decrease.
- Cost ranging between nearly zero and 10 € per panel.