Cut-off vs. avoided burden in metals' recycling: in view of environmental sustainability, risk perception and eco-efficiency

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Theses and question

- Modelling of recycling of metals is a contentious issue and involves value judgements
- Two principle opposing approaches are:
  - avoided burden approach
  - cut-off approach
- Which sustainability concepts do they serve?
- Which risk perception is related to them?
- What are their implications on eco-efficiency?

Sustainability definitions

- **Weak sustainability:**
  Manufactured capital of equal value can take the place of natural capital
- **Strong sustainability:**
  The existing stock of natural capital must be maintained and enhanced because the functions it performs cannot be duplicated by manufactured capital

Decision situations

- Information for decision support includes everything that can be influenced by the decision
- In economics:
  Costs, that cannot be influenced by a decision, should not be considered
  => **sunk costs**
- In LCA:
  principle applicable and applied on environmental impacts

Modelling of recycling according to ISO 14041/44

Distinction between

- *closed-loop allocation procedure*
  Use of recycled materials in identical products or open-loop but no change in inherent properties
  First closed-loop cycle may be treated like open-loop recycling
- *open-loop allocation procedure*
  Use of recycled materials in other products

Modelling of recycling according to ISO 14041/44 (cont.)

- closed-loop:

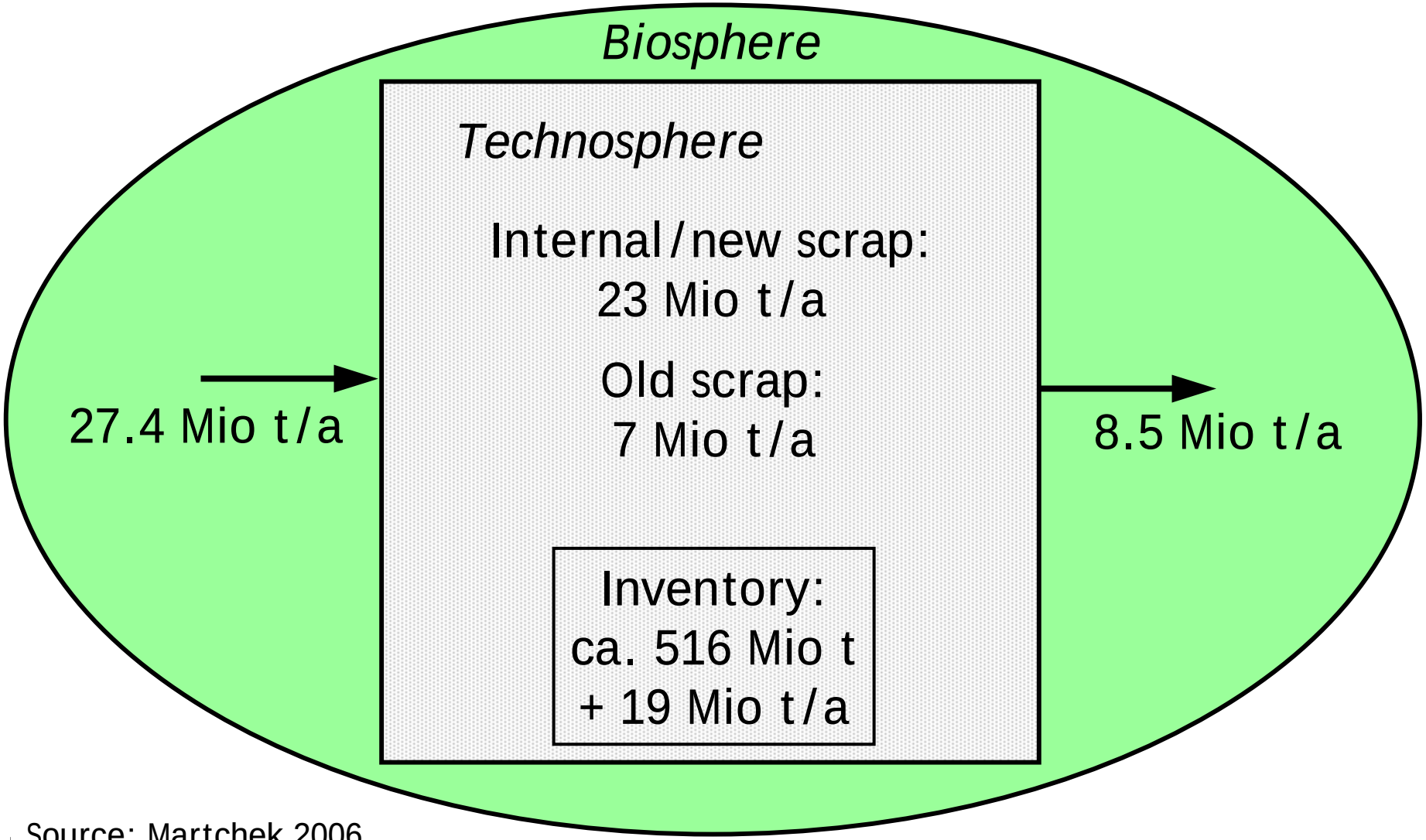
  allocation is avoided, because secondary material replaces primary material

- open-loop:

  basis for allocation:

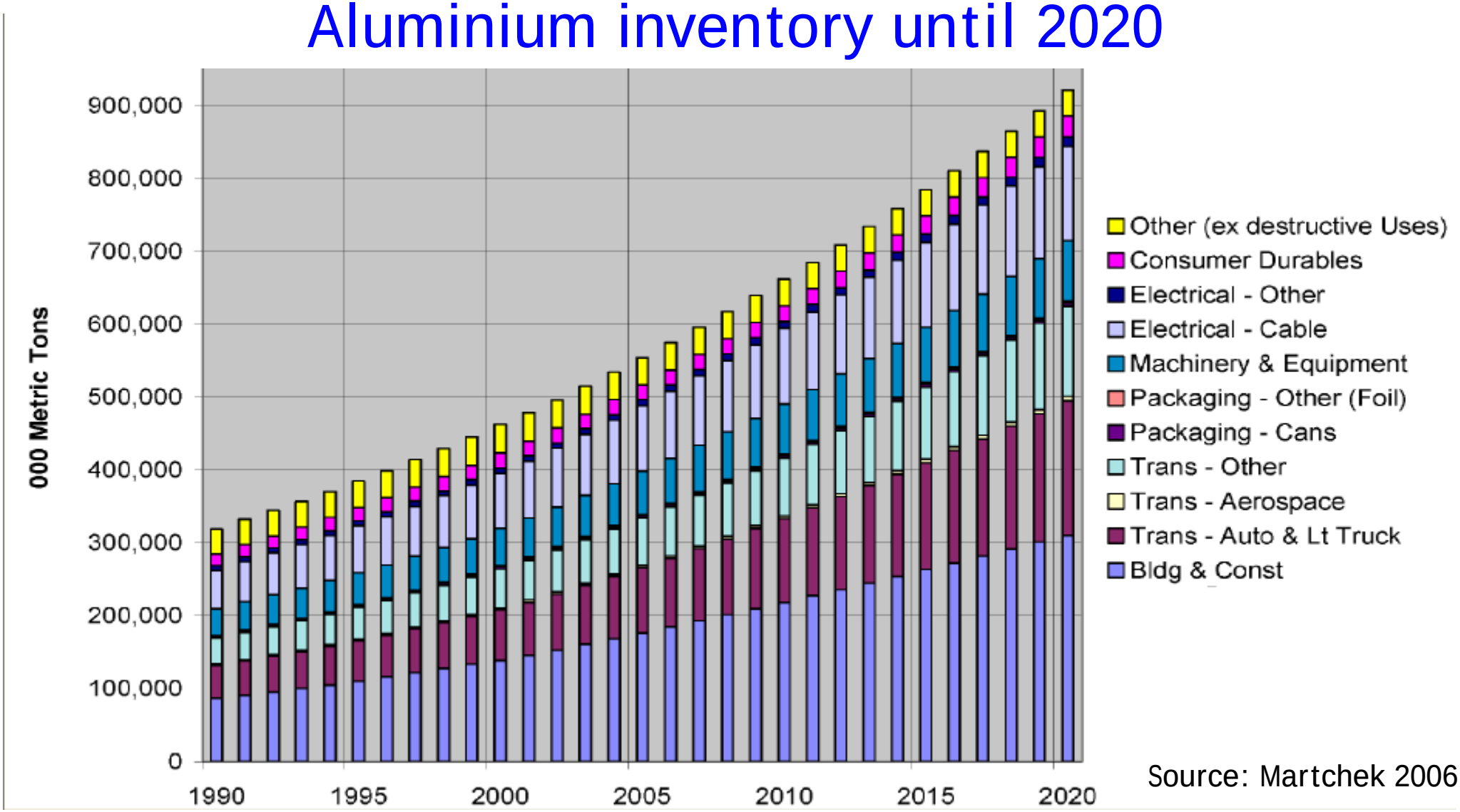
  - physical properties (e.g., mass)
  - economic value (market value of scrap compared to price of primary material)
  - number of subsequent uses of the recycled material

Example: Aluminium flows 2003



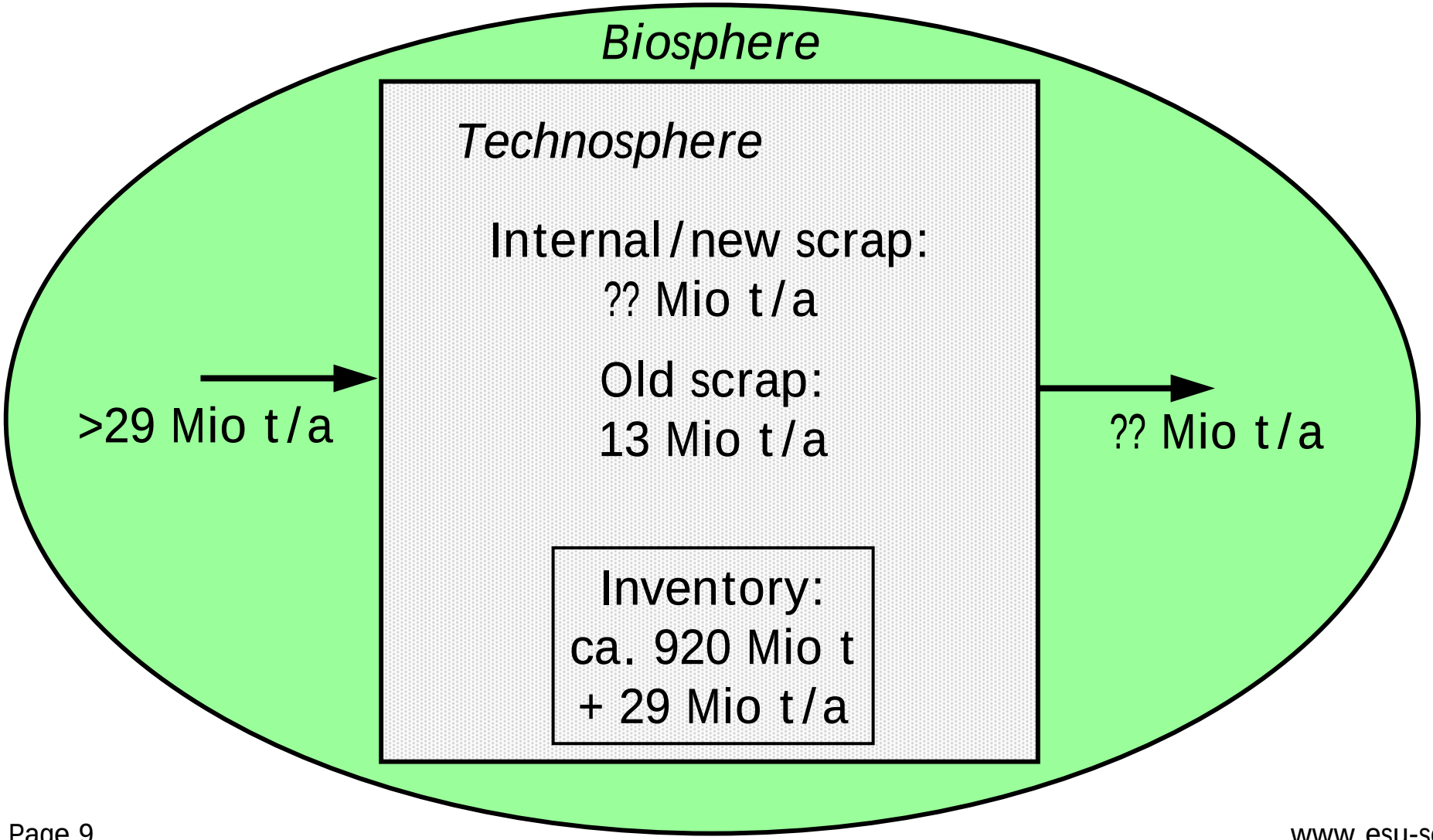
Source: Martchek 2006

Industry expert projection of Aluminium inventory until 2020



Source: Martchek 2006

Predicted Aluminium flows 2020



Greenhouse gas emissions caused by Aluminium production and recycling

- Primary aluminium (production 2003):

  320 Mio. tons CO_2-eq per year

- Secondary aluminium (reference year 2003):

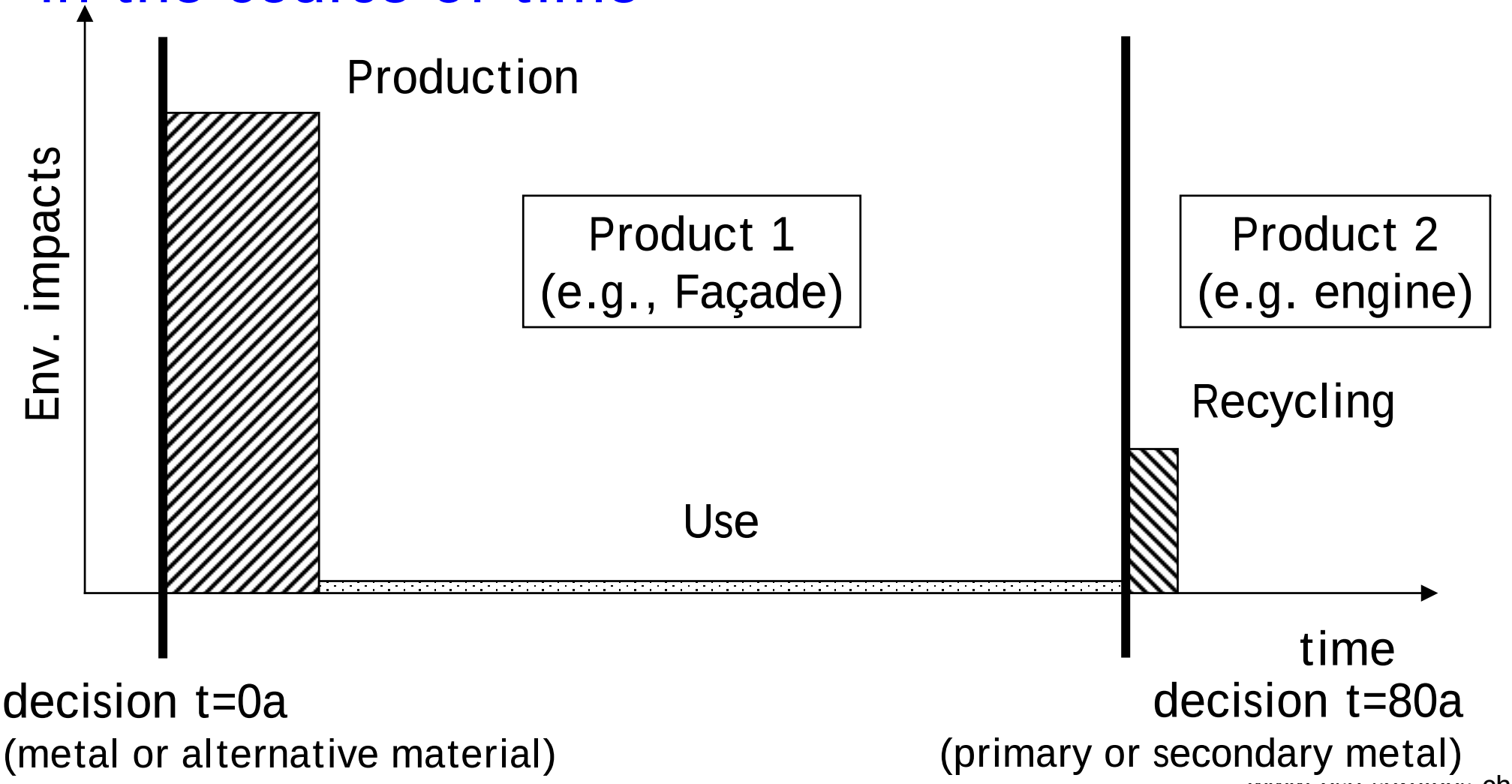
  20 Mio. tons CO_2-eq per year

  In comparison:

- Greenhouse gas emissions of Poland:

  384 Mio. tons CO_2-eq per year (2004)

Environmental impacts of a metal product in the course of time



Avoided burden approach

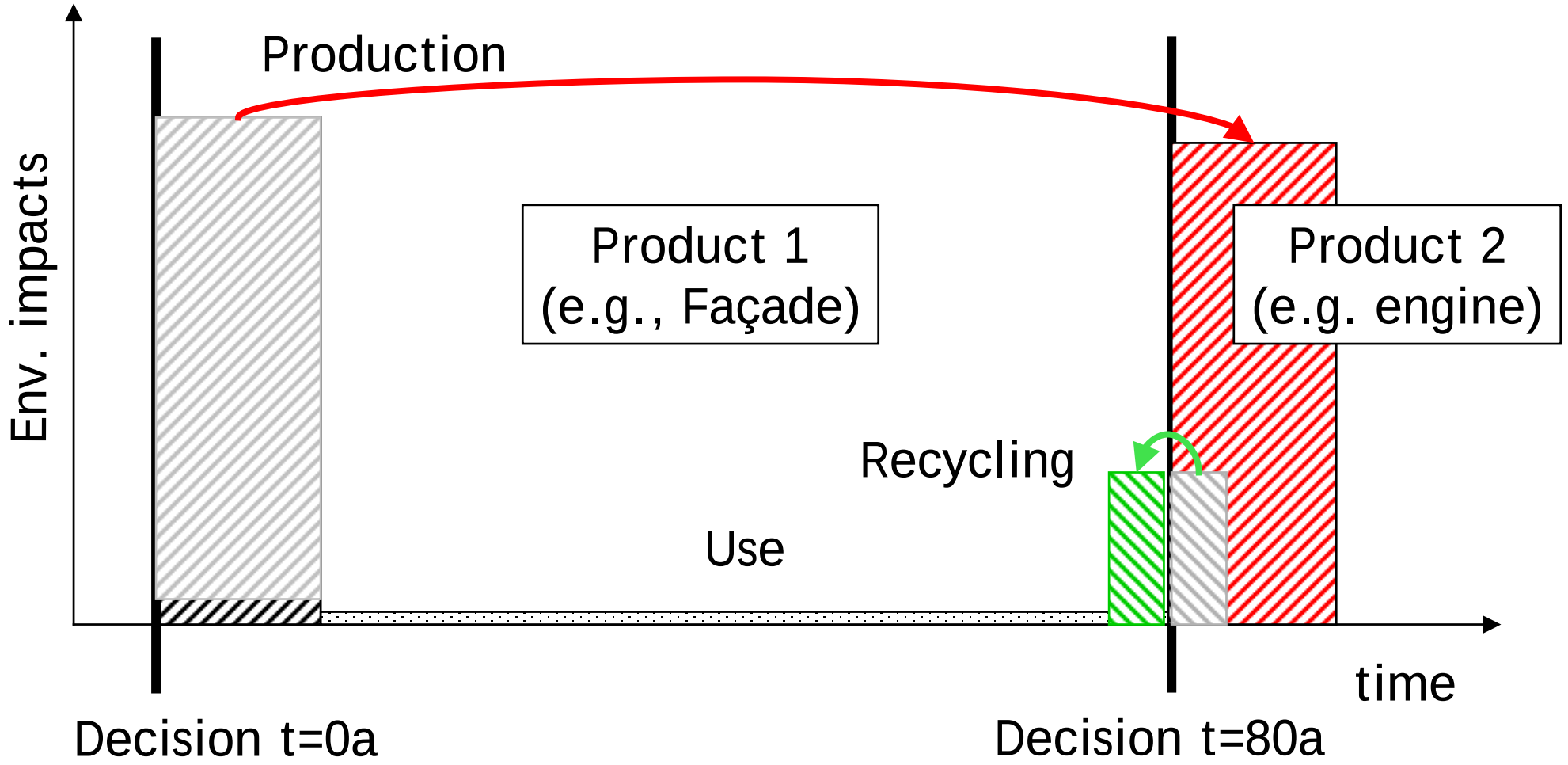
- Recycling of a metal avoids extraction and manufacturing of primary metal
- All avoided expenses and emissions are completely attributed to the product that delivers the metal scrap after its service life (common practice)

=> Precycling

(© Carbotech)

Expo 02

Environmental impacts modelled according to the avoided burden approach



Interpretation of the avoided burden approach

- Future Generations grant an “environmental loan”, used as credits on primary metal used today.
- In return, future generations receive concentrated metal in infrastructures and consumer durables
- Approach in line the **weak sustainability** concept
- Aluminium example
  “Environmental loan”:
  about 300 Mio. tons of CO_2-eq per year
  “inheritance”:
  about 19 Mio. tons concentrated aluminium per year

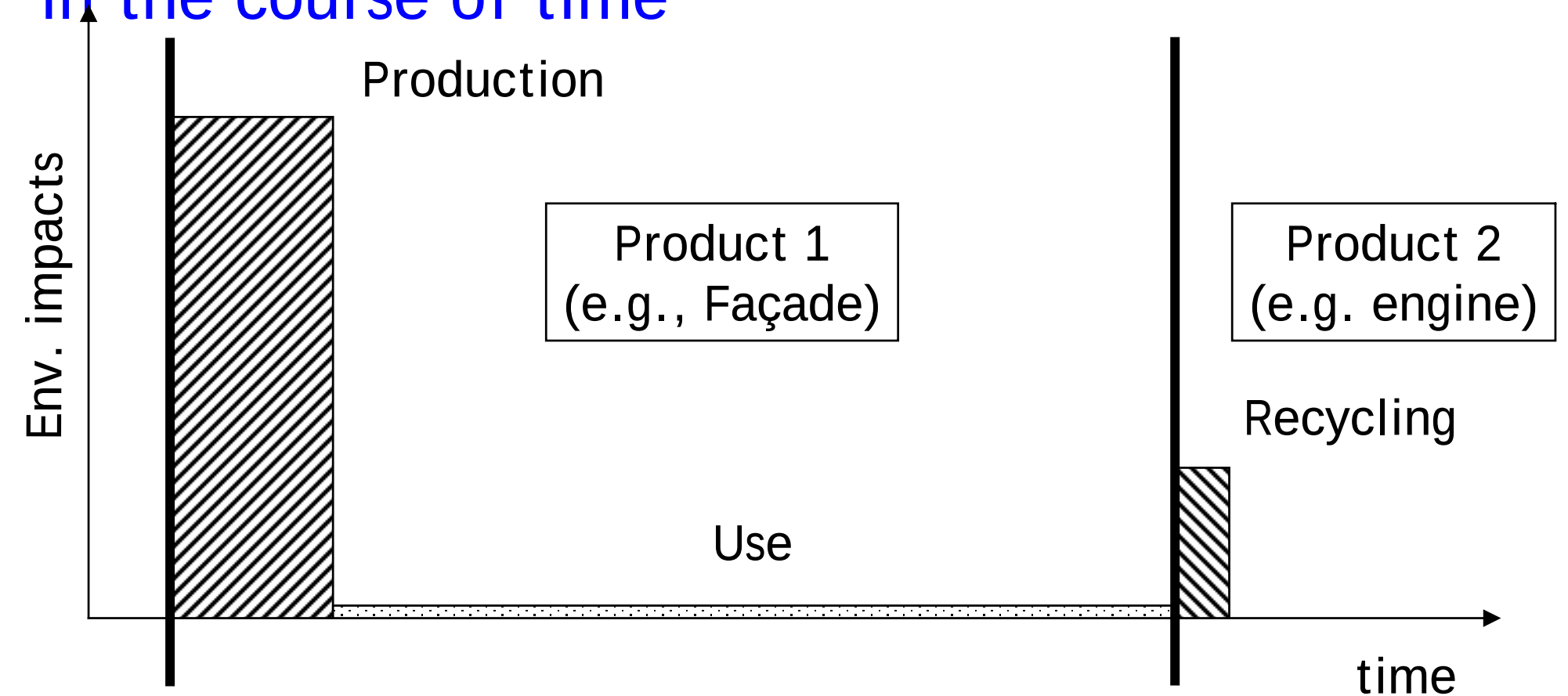
Effects of the avoided burden approach

- Actual environmental impacts occurring today are not recognized, because impacts are substantially reduced by credits granted
- Environmental impacts postponed into the future but already occurred in the past (or present) will not be considered in future decisions (sunk impacts!)

Cut off approach

- First use of (primary) metal bears environmental impacts of extraction and refinement
- Secondary metals are considered according to the recycled content in the product at issue
- Metal scrap leaves system without burdens
- No credits granted

Environmental impacts of a metal product in the course of time



Interpretation of cut off approach

- Prompt accounting of acually occuring environmental impacts
  => No burden shifting into the future
- No compensation of increased amount of concentrated metal with reduced natural capital
  In line with **strong sustainability** concept
- Secondary metals are considered according to the recycled content in the product at issue

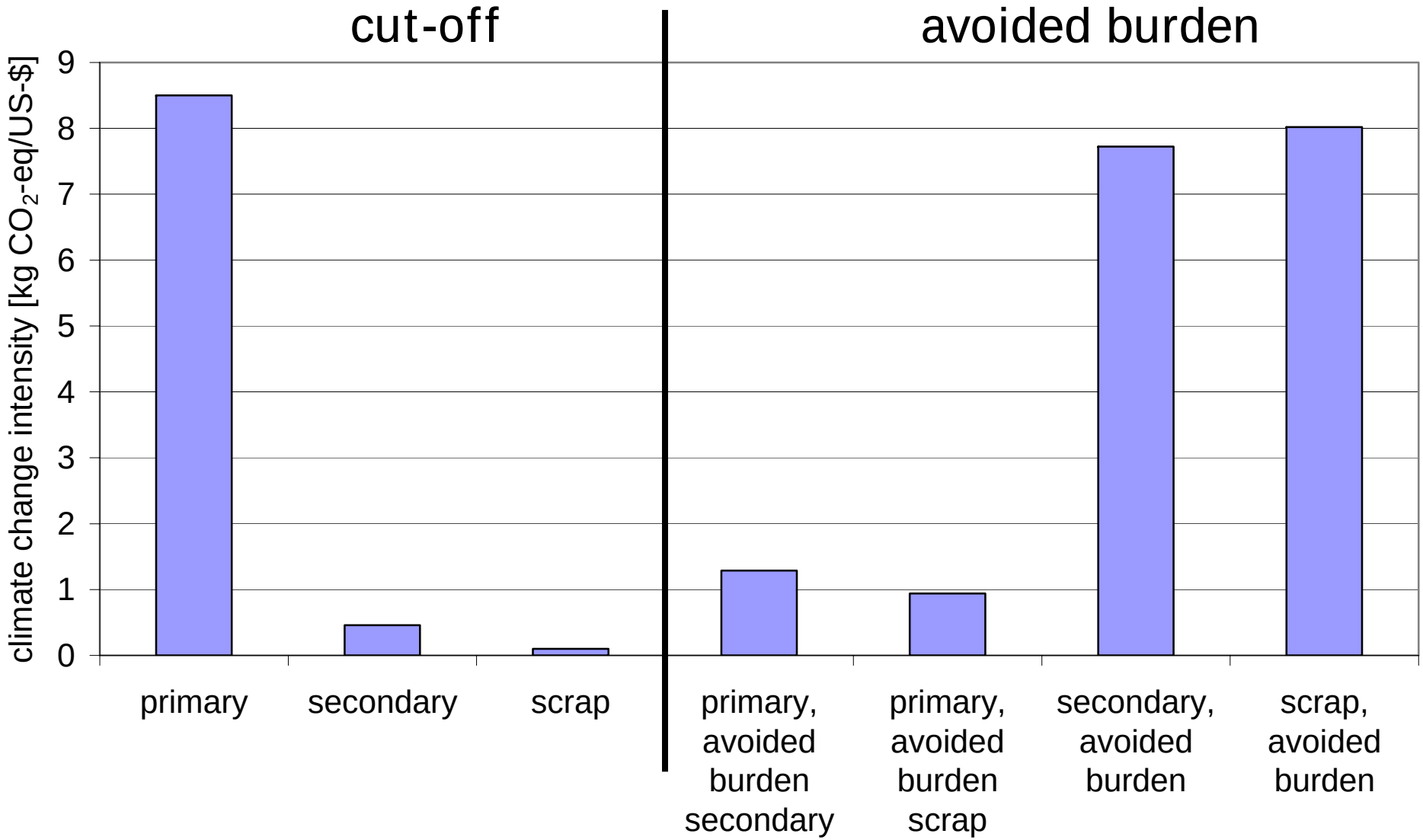
Eco-efficiency concept: Aluminium prices (2003)

- Primary Aluminium: 1’400 $/t
  (London Metals Exchange, Nov 2002 – Mar 2003)
- Secondary Aluminium: 1’350 $/t
  (London Metals Exchange, Nov 2002 – Mar 2003)
- Aluminium scrap: 765 $/t
  (bulk scrap from decommissioned building, Nov 2002 – Mar 2003)
- “Avoided burden” primary Aluminium prices:
  (1-0.9) * primary + 0.9 * secondary/scrap
  (assuming 90% recycling efficiency)

prices and climate change impact of Aluminium (2002/2003)

	price	climate change impact
	US-$/kg	kg CO_2-eq/kg
primary	1.40	11.9
secondary	1.35	0.618
scrap	0.76	0.077
primary, avoided burden, secondary	1.36	1.75
primary, avoided burden, scrap	0.83	1.26
secondary, avoided burden	1.40	10.8
scrap, avoided burden	1.34	10.7

Eco-efficiency / Climate change intensities



Appropriate Eco-efficiency indicators

- Indicators based on which concept represent eco-efficiency more appropriately?
  - cut-off, or
  - avoided burdens
- Dependent on the definition of the sustainability concept

Cut-off (sunk costs) approach to support strong sustainability

- **Choice of materials with a perspective of strong sustainability:**

  all emissions caused today are booked today,
  no burden shift into the far future (no "environmental loans" from future generations)

=> Precautionary principle

it is unsure, whether our descendants need / wish our "preinvestment" (buildup of a metal stock)

Main differences between "avoided burden" and "cut-off" approach

	avoided burden	**cut-off**
Future utility of material	yes	uncertain
Sustainability concept	weak	strong
Environ. grants from future generations	yes	no
Burden shifting into future	yes	no
Risk perception	tolerant	aware
Message of Eco-efficiency indicator	prim > sec	sec > prim

Conclusions

- Different modelling approaches for far future metals recycling exist:
  - Cut-off: strong sustainability, risk aware
  - Avoided burden: weak sustainability, risk tolerant
- Cut off: for public welfare, including interests of future generations
- Avoided burden: allocation of credits between actors is due
- Transparent unit process LCI databases able to serve both approaches
  -> ecoinvent database