



Decision-Support with LCA: Recycling

Consequences for the Design and Usage of Generic Life cycle Inventory Databases for the Example of Building Components

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Washington, October 06, 2006

Recycling - a Key Element of all Alcan Product Systems



- Alcan is a US\$20 billion company and has 65,000 employees in 60 countries and regions,
- The world's second largest alumina and primary aluminum producer
 - Bauxite mining
 - Alumina refining
 - Aluminum smelting
- A leading supplier in engineered products (aluminum, plastics, and composites) for:
 - Light-weight vehicles
 - **Building and construction**
 - Beverage cans and rigid containers
 - **Cables**
 - etc.
- A global leader in flexible and specialty packaging
 - Multi material packaging solutions



Alcan Integrated Management System



Value-Based Management



Continuous Improvement



People



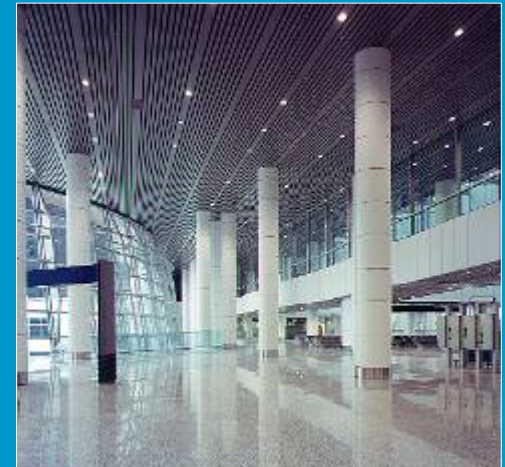
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Aluminum – The Power of Recycling



- Demand for high-quality construction materials offers an opportunity for aluminium in buildings:
 - Formability, functionality, flexibility, light weight, corrosion resistance and **excellent recycling performance**
- But planners and authorities often hesitate to accept readily aluminium as a building material, mainly because of high energy consumption for primary aluminum production
- Consideration of the total life cycle of a building demonstrates:
 - Excellent durability
 - Low (if any) maintenance
 - High scrap value
 - High recycling rates
 - Recycling with minimum energy



The Importance of Aluminum Recycling



■ Production of 1 t Primary Aluminium ingots (main environmental aspects)*:

- Resource use: bauxite 4111 kg
- Waste disposal: bauxite residues 1286 kg, SPL 22.9 kg
- Energy use: 150'000 MJ
- GHG: 14'600 kg CO₂

■ Production of 1 t Recycled Aluminium ingots:

- Resource use: small quantities of auxiliary materials
- Waste disposal: ca. 50 kg various materials
- Energy use: ca. 5% of primary production
- GHG: ca. 5% of primary production

- End-of-life recycling of aluminum products substitutes primary aluminum and leads to high reduction of environmental impacts

* Source based on EAA /IAI

Aluminum Industry Supplier of Data to Public and Commercial databases



- The aluminum industry recognized the benefits of LCA early
- Standardized data gathering throughout the industry
- Peer-reviewed datasets
- Supply of the data sets through the associations to public and commercial databases free of charge

- **But use of the correct data don't guarantee correct results**
→ appropriate modeling for the goal and scope of an assessment essential!



Modeling of Recycling for Aluminum Products



■ Methodological approaches

- Attributional (historic) LCA approach:
focus on recycled content
→ should be maximized

OR

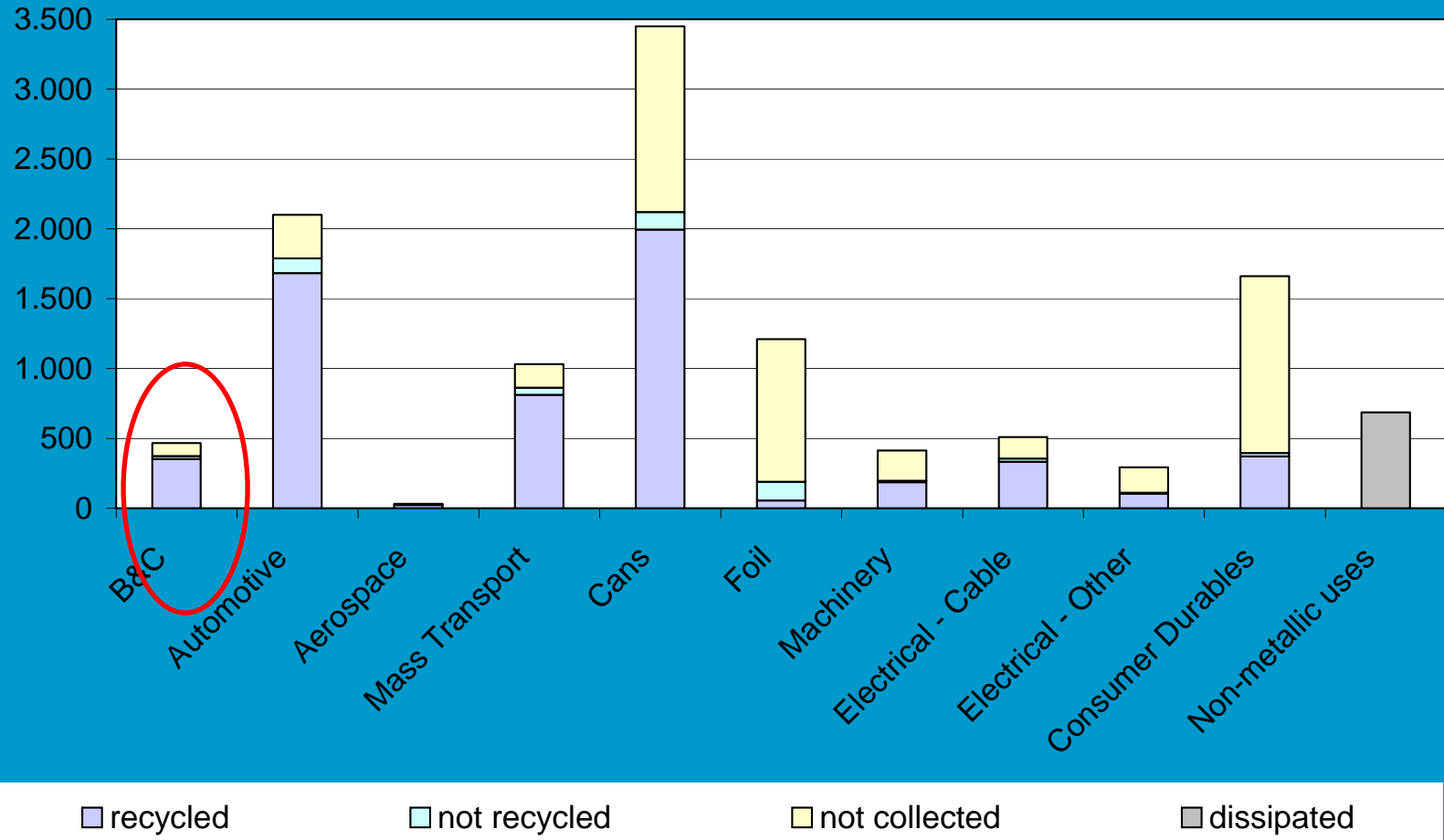
- Consequential (prospective) LCA approach:
focus on recycling at end-of-life of products
→ should be maximized



Collection and Recycling Efficiency of End of Life Aluminium



Values in 1000 tonnes per year

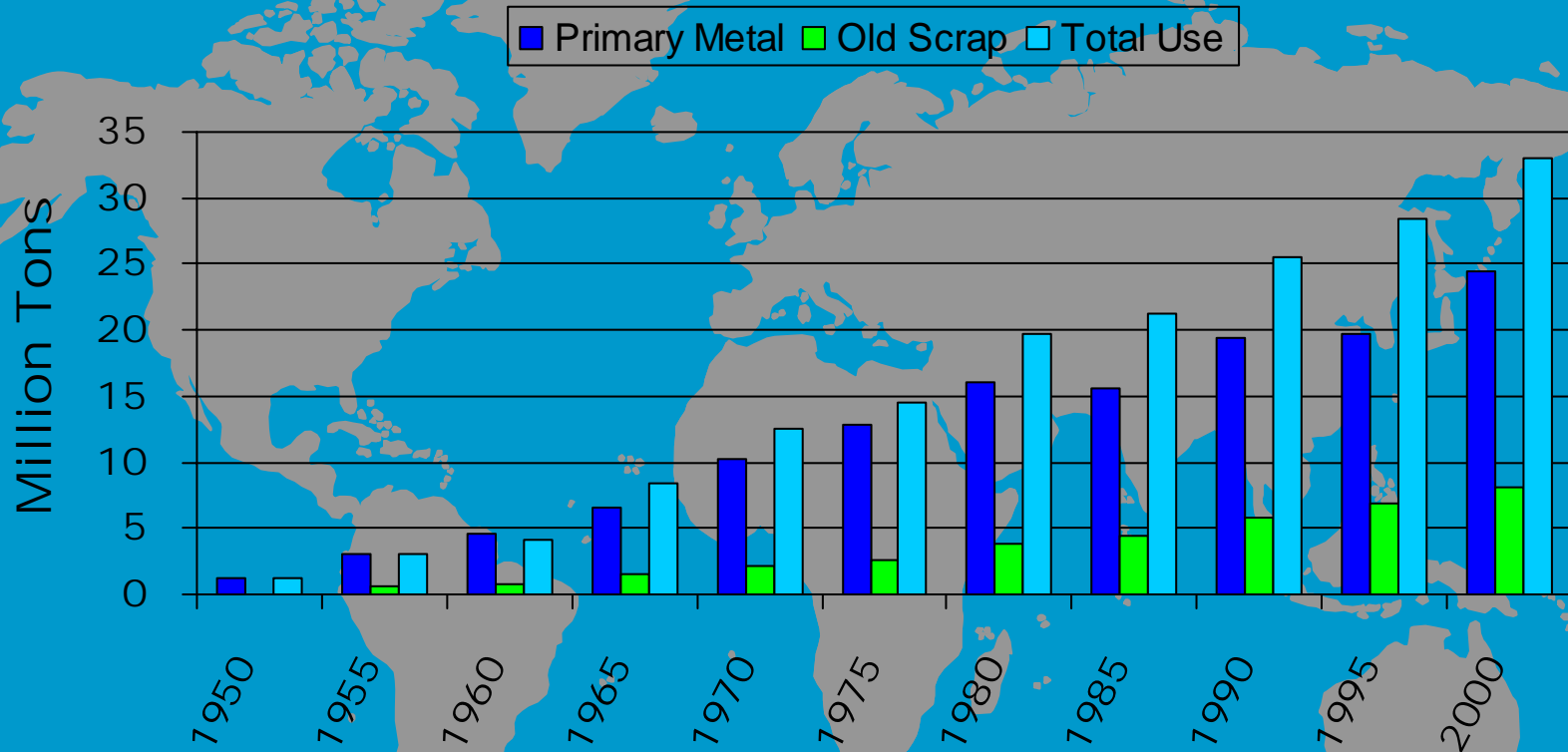


Source: GARC Model / OEA 2002

Global Aluminum Use 1950 - 2000



World aluminum use needs both primary and recycled metals supply

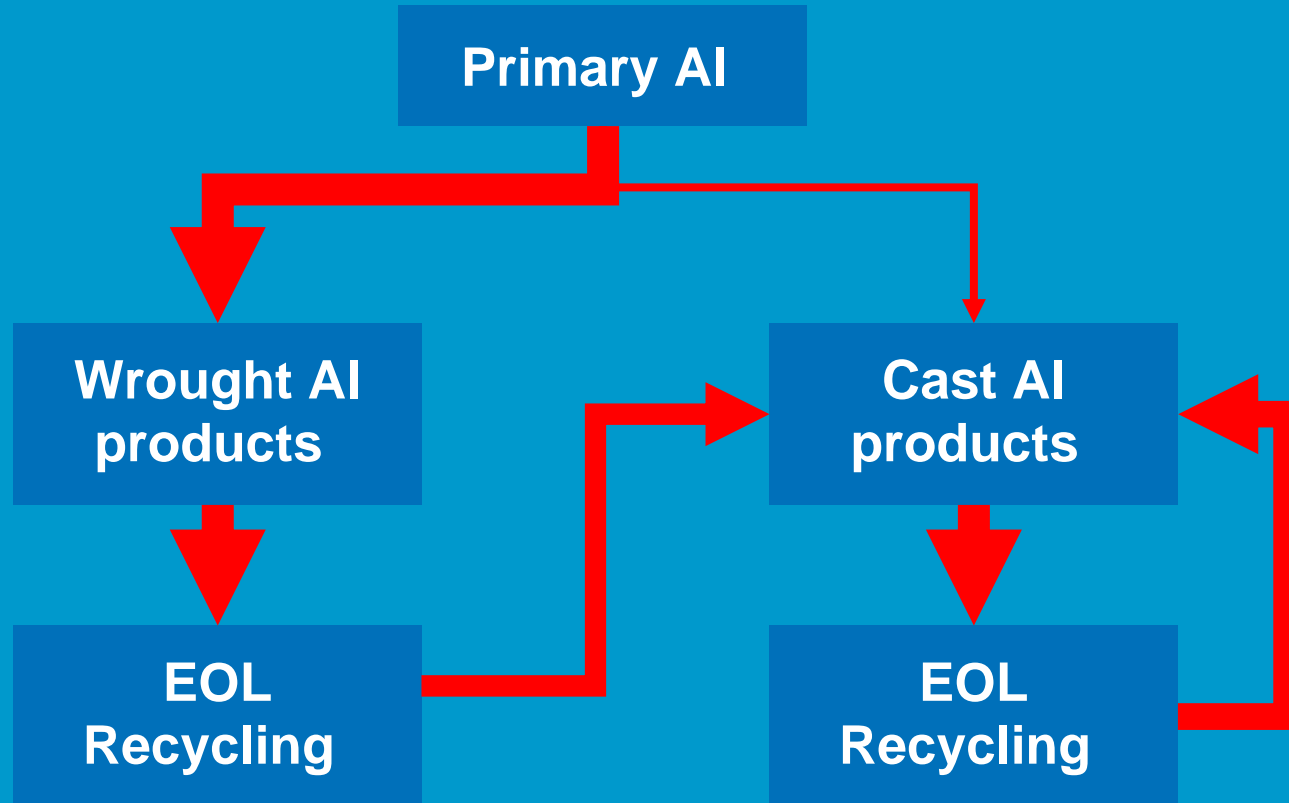


Source:Metallgesellschaft AG / World Bureau of Metal Statistics

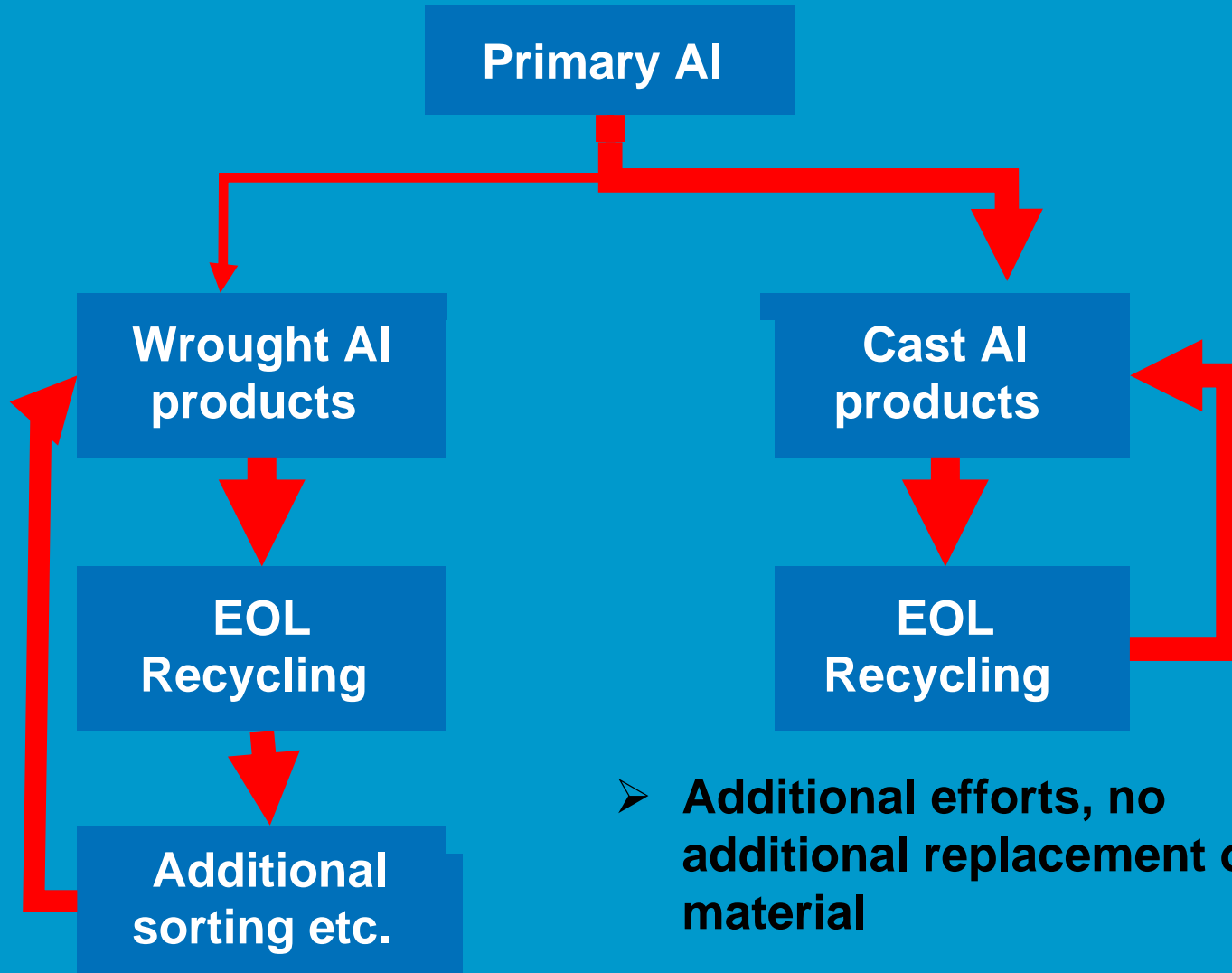
Recycling via Closed Material Loops



➤ An Efficient and Working System

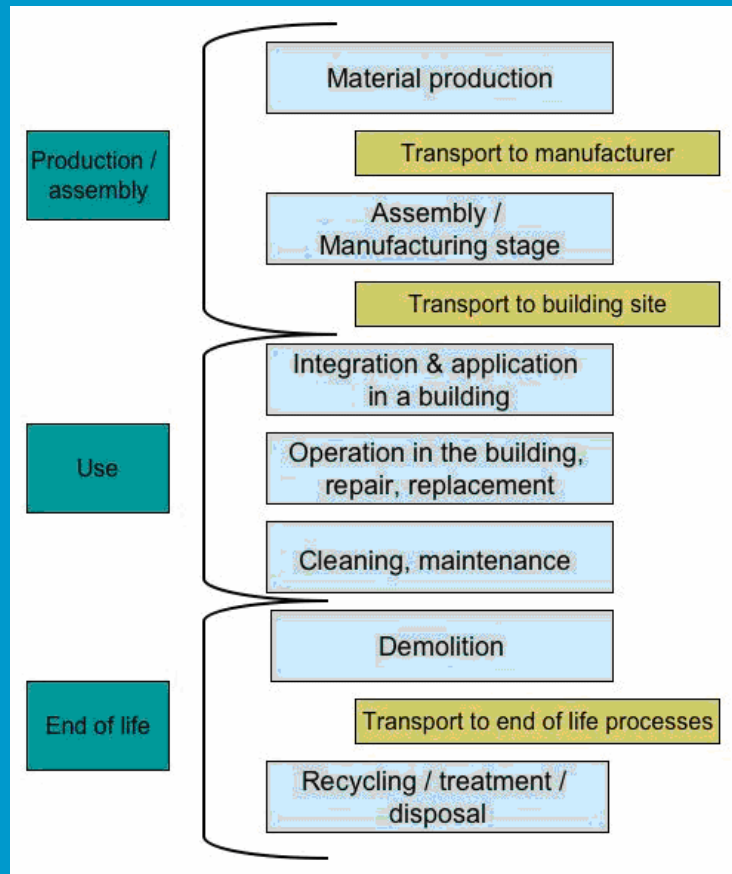


Recycling via Closed Product Loops



- **Additional efforts, no additional replacement of material**

Environmental Product Declaration (EPD) of Aluminum Window Frames:

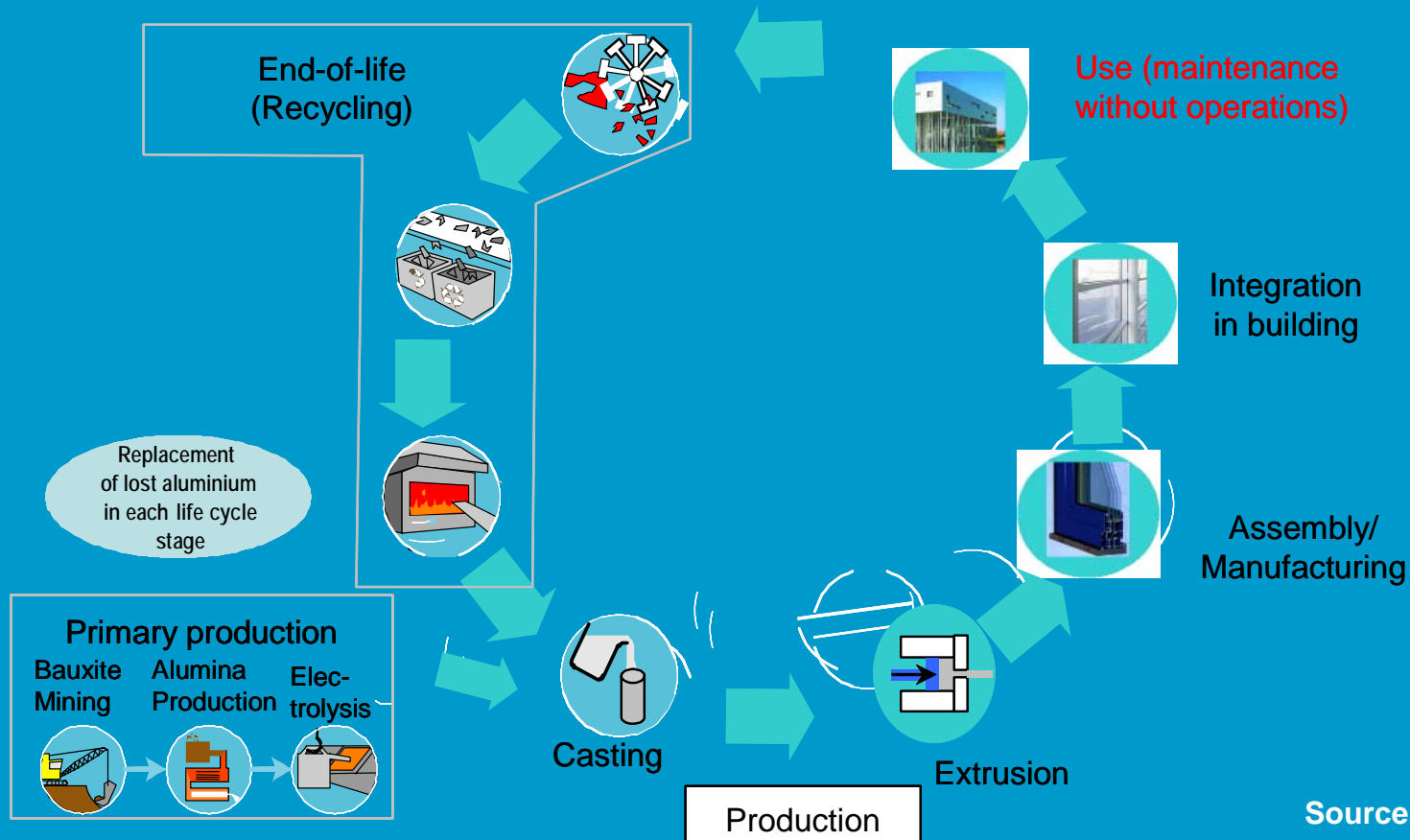


An Example from Europe : This EPD considers the following life cycle stages:

- Material production, component production and surface treatment
- Transports to manufacturer
- Assembly of window
- Transport to building site
- Cleaning and maintenance
- Demolition/disassembly of the window
- Transport to recycling site
- Recycling of the window and disposal of the residues

System Expansion: Life Cycle of an Aluminum Window Frame

Recycled aluminum is credited in this EPD as substituting primary aluminum. Only aluminum losses in each stage of the life cycle need to be balanced by primary aluminum



Recycling Aluminium Window Frames



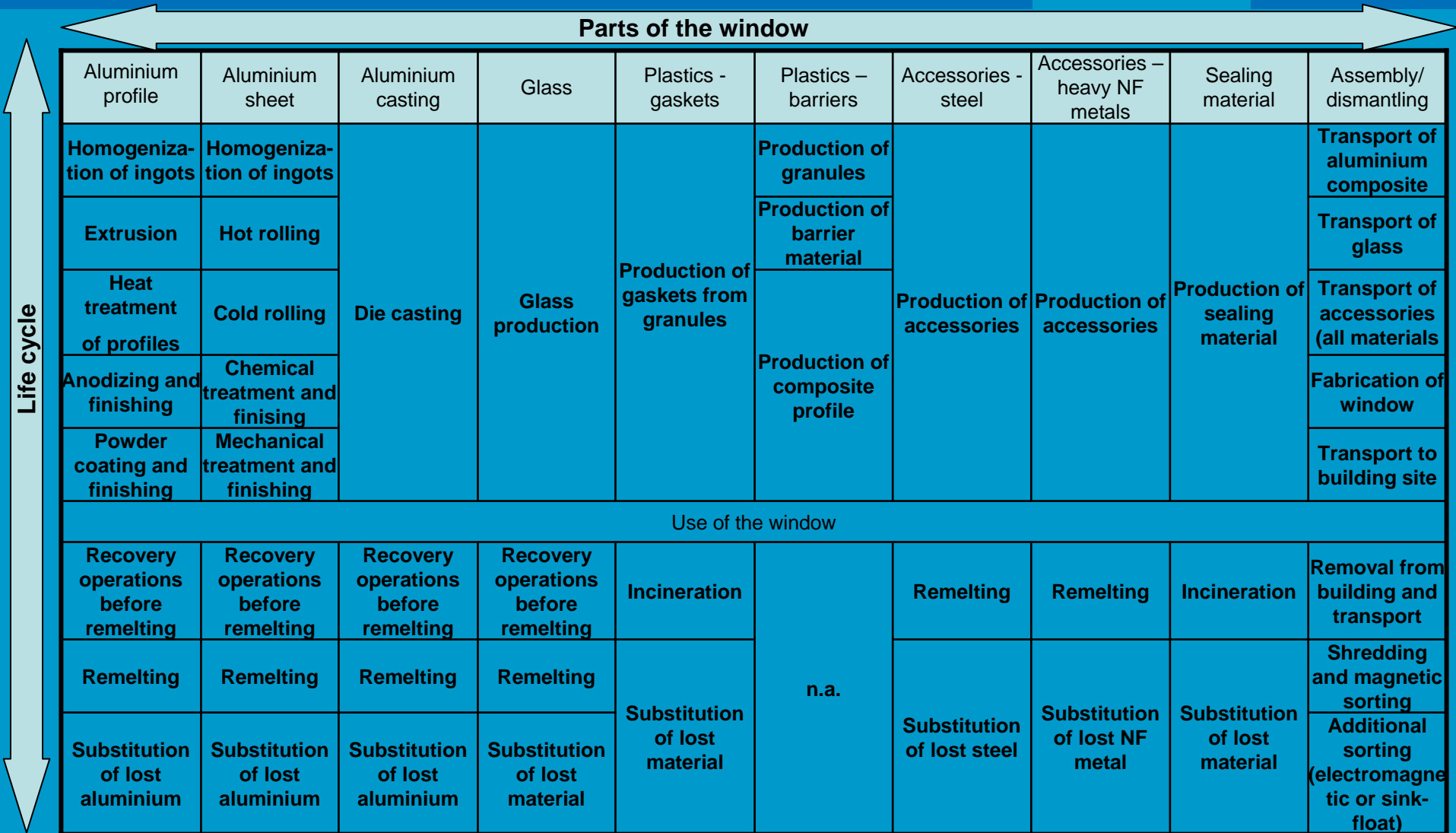
- The following recovery rates (after demolition and shredding) have been determined and are basis for the calculation of the LCA:
 - Aluminium 96%
 - Steel, stainless steel and zinc: 95%
 - Glass: 95%
 - Thermal bars and gaskets: 90%
 - All other materials: 0%
- The recycled content of an aluminium window has no influence on the life cycle energy (and other impacts) of an aluminium window frame!

Data for the EPD



Data quality			
Material / process	Geographical representativity	Time coverage	Data source
Aluminium	high	2002	EAA
Surface treatment	medium	1995	GaBi 4
Glass	medium	2000	Ecoinvent
Thermal bars	high	1995	GaBi 4 / industry
Gaskets	medium	1995	GaBi 4 / industry
Steel / stainless steel	high	2000	Eurofer
Window assembly	medium	1995	GaBi 4 / industry
Use phase	medium	2005	GaBi 4
EOL / demolition & shredder	high	1995	GaBi 4 / industry
EOL / recycling of metals	high	2002	EAA / GaBi 4 / industry
EOL / incineration	high	2005	GaBi 4

Information modules of an aluminum window (from ISO/FDIS 219309)



EPD aluminium window frame



- Total cycle primary energy: 29 MJ/kg
 - Production of the window frame from the extrusion ingot and for the remelting of the end-of-life window frame: 20.5 MJ/kg
 - Substitution of the 6 % metal loss (recovery losses and losses when remelting) of the end-of-life operations: 8.5 MJ/kg
- Total cycle primary energy without consideration of recycling: 161 MJ/kg

Public and Commercial Databases: How to Include Recycling



- **Databases should include data about recycling**
 - End-of-life recovery rates (collection, sorting, etc.)
 - Information on recycling processes itself
- **Databases should supply data modules with transparent structure**
 - Related to product groups
 - overall recycling rates are a function of the material AND the product group for which it is used) AND
 - Disaggregated primary production and recycling processes
 - for modeling of very specific products/scenarios
- **Best available data should be included in all databases**

Conclusions

- Recycled content approach can be misleading, specifically if market uptake (demand) is growing fast
- LCA should be used to influence consequences in the future (for End-of-life: Design for Recycling, Collection schemes)
- Public and commercial databases must provide the required data modules to appropriately model the complete life cycle, including end-of-life recycling



