„Environmental Benefits Through Lifecycle Assessment“

by Jörg H. Schäfer, Head of Recycling and Sustainability, GDA

March 19th 2015 at AMAP Colloquium, Aachen
Introduction of GDA - Organisation

**Gesamtverband der Aluminiumindustrie e.V.**

- Public Relations
- Market Analysis - Statistics
- Sustainable Development
- Technical Marketing

**Departments / Divisions GDA**

- FV Primary aluminium
- FV Aluminium semis
- FV Aluminium foil
- FV Tubes, Cans
- FV Metal powders
- FV Aluminium recycling
- FV Aluminium castings

**Membership in 20 technical, scientific, and standardization institutes**

- Wirtschaftvereinigung Metalle e.V.
- Membership in 20 technical, scientific, and standardization institutes

**European Aluminium Association**

- BDI e.V.
- EUROMETAUX

**Management GDA**

- BDGuss e.V. Casting Association
Content

- Introduction
- Sustainable Development
- Life Cycle Assessment
- Carbon Footprint
- LCAs for packaging applications
- The role of recycling
- Food Supply chain
- Environmental Product Declarations für Buildings & Constructions
- LCAs in automotive applications
- Conclusions
From technical considerations to a Sustainable Development – Example aluminium

~ 1880
Engineering capacity at the forefront
Environment and costs are subordinate

~ 1970
Oil crisis
Aluminium turns into energy glutton and emissions producer

~ 1992
Opportunity to position aluminium above sustainability

This is the political context in society in which we find ourselves today. Environmental questions must not be neglected.
Sustainable development means…

The three components of sustainability are equally important.

- It’s NOT about maximizing only one of the components.
- The aim is to achieve an optimum situation.

Sustainable development as optimum of all three components
Illustration: sustainability as stool on three legs

A stool on three legs:
- stable

Social
Economy
Ecology

A stool on two legs:
- falls down

Social
Economy
Ecology

Sustainable development which neglects one of the components doesn’t work
Everyone’s talking about sustainability – what does it mean?

“Sustainability is based on a clear assumption: In order to ensure that future generations have development opportunities, we need to think of economic competitiveness, social responsibility and the conservation of nature together. What we do or don’t do today must not be allowed to take away from the opportunities of our children and grandchildren to live a life of prosperity in an intact environment. … .”

Ensuring development potential for future generations
Sustainable development in the German constitution

In Germany the principle of sustainability was anchored in article 20a in the constitution in 1994 as state objective.

Article 20a:

As responsibility for future generations the state will conserve nature … in the framework of the constitutional order by legislation and according to the law… .

A social market economy is replaced by a sustainable market economy.

SD implemented as an overarching societal objective
Beginning 90th: Standardization of Life Cycle Assessment

Today: LCA is the only tool to assess environmental performance of products
The Importance of LCAs for Al

Consideration of the entire life cycle:

aluminium offers e.g.

- high energy demand for electrolysis
- relative energy savings for transport, recycling

Consideration of the entire life cycle is essential for aluminum to get a balanced picture.
Sustainability and life cycle assessment as basis for making an evaluation...

Life cycle

Economic

Bauxite mining

Technical

Recycling

Ecological

Al₂O₃ production

Electrolysis

Processing/forming

Social

Use phase

Distribution/Transport

... of our industry and our products
Other approaches / Concepts: The Carbon Footprint

The Aluminium Industry

- is dedicated to a Sustainable Development.
- uses LCAs to optimize and evaluate the environmental performance of its products.

The Carbon Footprint is a single indicator in an LCA and does not reflect other environmental aspects than Climate Change.

The Carbon Footprint is a single indicator and one part of an LCA. This has to be reflected in the sustainability debate and environmental discussions.
Environmental indicators in an LCA

- Greenhouse effect
  - Eutrophication
  - Acidification
  - Summer smog
  - Ozone depletion
  - Fossil resources
  - Cumulative energy use (renewable/non-renewable)

If only the Carbon Footprint is investigated no fields of tension are visible or if information is lacking
What happens if other indicators are considered?

Example of a car

Significance of the use phase differs tremendously! The CF alone can not highlight the tensions.

Dr. Gerald Rebitzer, Alcan, Data from [USCAR AMP Project 1998] (generic US family sedan)
What about the building sector – LCA of roofing materials

Global Warming Potential in kg - GWP Equivalent

- **Zink**
- **Copper**
- **Aluminium**
- **Stainless Steel**

95% Recycling Rate!

Use phase not included!

Source: Fraunhofer Institute, ISI

Chart 15
Other Indicators than Global Warming Potential

Human Toxicity Potential per m² roofing

LCA of roofing materials

Methodology under discussion

Source: Fraunhofer Institute, ISI

What is more important „health“ or „Climate“?

Source: www.aluinfo.de

Chart 16
LCA in the packaging area – beverage cans
LCA for beverage containers – UBA III

UBA I 1995
Al beverage can
negative

UBA II 2001
Al beverage can
negative/neutral

UBA III 2012-15
Al beverage can
??

Climate change
Centralized filler, trans-regional
distribution (400 km)

Key parameters are
- distribution distance
- recycling approach
- tripage rate

Conclusions are the base for the deposit system in Germany
The recycling approach of UBA

So far, UBA preferred the 50/50% allocation approach.
The effects of the choice of the recycling approach

50%/50%: Gives credits for the use of recycled metal and end-of-life recycling equally shared

0%/100%: Gives credits exclusively for end-of-life recycling

Considerable difference
The 0/100 approach creates a far greater incentive to recycle aluminum scrap.

Recycled aluminum is always the maximum replacement for primary aluminum, which is reflected in the 0/100 method.

A product that absorbs large amounts of recycling aluminum, but does not itself emit any aluminum recycling, contributes to a situation, whereby aluminum is no longer available to future generations.

Due to the circumstances of the aluminum markets, increasing the recycling metal content (RMC) in a product would only shift the unavoidable use of primary aluminum to other products. The ecological consequences on the system of the total aluminum market (aluminum pool) would not change overall.

Due to the fact that aluminum demand is continuing to grow and metal products frequently have a very long service life, the scrap supply is limited for the production of new products.

Strong arguments in favour of end-of-life recycling
Global Warming Potential 0,5 l beverage can

Higher collection rate means better performance for Al beverage can.
Carbon Footprint – break down for a 0,5 liter can: 60% recycling rate

<table>
<thead>
<tr>
<th>Material</th>
<th>Distribution, Use and Recovery</th>
<th>Can Stock and Manufacturing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminium 0,5 l</td>
<td>97 kg</td>
<td>21 kg</td>
</tr>
<tr>
<td>Tinplate 0,5 l</td>
<td>112 kg</td>
<td>22 kg</td>
</tr>
</tbody>
</table>

[kg CO2-Equiv] / 1000 cans
Carbon Footprint of 500 liter beer supply ready for consumption in 0,5 liter cans*

841 kg CO₂-Equiv. (aluminium can 0,5 liter)

857 kg CO₂-Equiv. (tinplate can 0,5 liter)

Distribution, Use and Recovery
Can Stock and Manufacturing
beer

*60% recycling rate

Beer more climate intensive than packaging
How to consider sustainability of packaging?

Consideration of
- life cycle of packaging
- life cycle of food supply
- role of the consumer

Evaluation of sustainability performance needs more than just looking into packaging.
Integrating supply chain and downstream activities

Supply chain of packaging

Extension to complete system
Example Coffee: GHG-Emissions

<table>
<thead>
<tr>
<th>kg CO₂-equ. per cup of coffee</th>
<th>Cup of coffee from 500 g bag (PET12/alu7/PE100)</th>
<th>Cup of coffee from 2 g stick (PET12/alu7/PE55)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Espresso</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instant Black</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Instant White</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Milk
- Hotwater (Brewing)
- Transport (Roastery to household)
- Retail Packaging
- Coffee Production

ESU-services, 2008
Conclusions – Coffee

- CO₂ contribution of the packaging in the food supply system is relatively low
- Production of coffee (due to high processing) has a relatively high share

A small investment in packaging saves already a large amount of resources used in the supply chain before consumption
Conclusions – Coffee (2)

- Portion packed (stick pack) has a relatively higher share compared to family packs.
- However, they may contribute to the prevention of wastage and spoilage, thus even saving “overall” resources.

„Best“ packaging depends on the specific consumption pattern and application
WHAT IS ENVIRONMENTALLY SPEAKING BETTER: REFILLABLE GLAS OR ALUMINIUM BEVERAGE CAN?

HAVE A GUESS!
GERMAN EPA*: LCA of drinks packaging II, 1 – results (0,33l systems, CO₂ containing drinks)

Resource Depletion

- Glass-RF - 0,33l
- Glass- One Way - 0,33l
- steel can-0,33l
- alu can-0,33l
- OW
- ST
- Alu

GWP

- Glass-RF - 0,33l
- Glass- One Way - 0,33l
- steel can-0,33l
- alu can-0,33l
- OW
- ST
- Alu

AP

- Glass-RF - 0,33l
- Glass- One Way - 0,33l
- steel can-0,33l
- alu can-0,33l
- OW
- ST
- Alu

Umweltbundesamt, study of 2000
GERMAN EPA*: LCA of drinks packaging II, 1 – results (0.33l systems, CO2 containing drinks)

*Umweltbundesamt, study of 2000
WHAT IS ENVIRONMENTALLY SPEAKING BETTER: REFILLABLE GLAS OR ALUMINIUM BEVERAGE CAN?

DIFFICULT TO JUDGE!
The role of EPDs (Environmental Product Declarations)

EPD are an information system to supply harmonized environmental information.
The GDA EPD Programme for Building & Construction

4 EPDs on building products
5. LCA: Results

<table>
<thead>
<tr>
<th>SYSTEM BOUNDARIES (X = INCLUDED IN THE LCA; MND = MODULE NOT DECLARED)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product stage</td>
</tr>
<tr>
<td>----------------</td>
</tr>
<tr>
<td>Raw material supply</td>
</tr>
<tr>
<td>A1</td>
</tr>
<tr>
<td>X</td>
</tr>
</tbody>
</table>

**LCA RESULTS – ENVIRONMENTAL IMPACT: 1m²**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1 - A3</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming Potential</td>
<td>[kg CO₂ equiv.]</td>
<td>3.7E+1</td>
<td>-2.4E+1</td>
</tr>
<tr>
<td>Ozone Depletion Potential</td>
<td>[kg CFCl3 equiv.]</td>
<td>8.1E-7</td>
<td>-7.4E-7</td>
</tr>
<tr>
<td>Acidification Potential</td>
<td>[kg SO₂ equiv.]</td>
<td>1.7E-1</td>
<td>-1.4E-1</td>
</tr>
<tr>
<td>Eutrophication Potential</td>
<td>[kg (PO₄)₃ equiv.]</td>
<td>1.0E-2</td>
<td>-7.1E-3</td>
</tr>
<tr>
<td>Photochemical Ozone Creation Potential</td>
<td>[kg ethene equiv.]</td>
<td>1.2E-2</td>
<td>-7.9E-3</td>
</tr>
<tr>
<td>Abiotic Depletion Potential non-Fossil Resources</td>
<td>[kg Sb equiv.]</td>
<td>2.1E-5</td>
<td>-1.3E-5</td>
</tr>
<tr>
<td>Abiotic Depletion Potential Fossil Fuels</td>
<td>[MJ]</td>
<td>5.5E+2</td>
<td>-2.8E+2</td>
</tr>
</tbody>
</table>

**LCA RESULTS – USE OF RESOURCES: 1m²**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>A1 - A3</th>
<th>D</th>
</tr>
</thead>
<tbody>
<tr>
<td>Renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>1.4E+2</td>
<td>-1.3E+2</td>
</tr>
<tr>
<td>Renewable primary energy as material utilisation</td>
<td>[MJ]</td>
<td>0.0E+0</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>Total use of renewable primary energy sources</td>
<td>[MJ]</td>
<td>1.4E+2</td>
<td>-1.3E+2</td>
</tr>
<tr>
<td>Non-renewable primary energy as energy carrier</td>
<td>[MJ]</td>
<td>6.6E+2</td>
<td>-3.0E+2</td>
</tr>
<tr>
<td>Total use of non-renewable primary energy sources</td>
<td>[MJ]</td>
<td>2.0E+1</td>
<td>0.0E+0</td>
</tr>
<tr>
<td>Total use of non-renewable primary energy sources</td>
<td>[MJ]</td>
<td>6.2E+2</td>
<td>-3.0E+2</td>
</tr>
<tr>
<td>Use of secondary materials</td>
<td>[kg]</td>
<td>0.0E+0</td>
<td>-</td>
</tr>
<tr>
<td>Renewable secondary fuels</td>
<td>[MJ]</td>
<td>1.8E-2</td>
<td>-1.6E-2</td>
</tr>
<tr>
<td>Non-renewable secondary fuels</td>
<td>[MJ]</td>
<td>1.7E-1</td>
<td>-1.4E-1</td>
</tr>
<tr>
<td>Net use of fresh water</td>
<td>[m³]</td>
<td>4.0E-1</td>
<td>-3.7E-1</td>
</tr>
</tbody>
</table>

**LCA RESULTS – OUTPUT FLOWS AND WASTE CATEGORIES: 1m²**
Ressource efficiency in buildings

Energy demand „System Administration Building“ (50 years, 4400m²)

Use phase is dominant.

Use phase offers potentials for improvement
Environmental performance of cars

Gewicht trotz Aluminiumkarosserie und Al-Motor ca. 2,5 t

Quelle: Auto-Legenden

Farman A6B Super Sport, 1919
Background

- 19% of greenhouse gas emissions are dedicated to transport.
- It seems to be evident that transport activities even increase (China, India and Middle East).
- Reduction of fuel demand of cars gains importance.
- Weight reduction of cars is part of the solution.

Aluminium as part of the solution
Driving performance of transport

Driving performance in Mio km

- Cars (fuel): 0.2 Mio km
- Cars (Diesel): 0.2 Mio km
- Bus: 1 Mio km
- Metro: 3 Mio km
- Regional train: 4 Mio km
- High speed train: 15 Mio km

Source: ifeu
CO2-Reduction potential related to 100 kg weight reduction

**CO2 Reduction potential [t/100 kg]**

- Cars (fuel): 2 t/100 kg
- Cars (Diesel): 1.8 t/100 kg
- Bus: 4.5 t/100 kg
- Metro: 7.1 t/100 kg
- Regional train: 8.3 t/100 kg
- High speed train: 5.7 t/100 kg

*Quelle: ifeu*
Use phase transport

Production

Energy demand

www.aluinfo.de

50,000 km  100,000 km  150,000 km  200,000 km
Products in cars: bumper

- Car:
  - Weight: 1.100 – 1.200 kg
  - Consumption: 6 L/ 100 km
  - Performance: 200,000 km
- Weight Aluminium: 3.2 kg
- Weight HS Steel: 5.8 kg
- Weight reduction: 45%
- Fuel reduction: 0.36 L / (100 km 100 kg)

48 kg CO2 reduction in comparison with steel

Production of Al part: 36 kg CO2

www.aluinfo.de

Chart 43
Products in cars: front hood

- Car:
  - Weight: 2.000 – 2.100 kg
  - Consumption: 11 L / 100 km
  - Performance: 200,000 km

- Weight Aluminium: 10.1 kg

- Weight HS Steel: 17.5 kg

- Weight reduction: 43%

- Fuel reduction: ~ 0.30 L / (100 km 100 kg)

130 kg CO2 reduction in comparison with steel

Production of Al part: 120 kg CO2
Products in cars: Body-in-White

- **Car:**
  - **Weight:** 1.700 kg
  - **Consumption:** 10,2 L/ 100 km
  - **Performance:** 200,000 km

- **Weight Aluminium:** 295 kg
- **Weight HS Steel:** 475 kg
- **Weight reduction:** 45%
- **Fuel reduction:** ~ 0,30 L / (100 km 100 kg)

4.300 kg CO2 reduction in comparison with steel
Production of Al part: 3.830 kg CO2
Aluminium in cars (Western Europe)*

kg

- Karosserie
- Ausstattung
- Motor/Antrieb
- Räder/Fahrwerk

- Knetlegierungen
- Gusslegierungen

*estimated
Conclusions

- Sustainable Development is an overarching societal objective.

- Environment is only one dimension besides the economical and societal aspects in SD.

- LCA is a useful tool which is internationally accepted. Nevertheless, it covers only parts of the environmental dimension of SD.

- The Carbon Footprint is a single indicator and does not reflect the environment but climate change.

- Questions such as to what environmental costs the Carbon Dioxide is reduced cannot be answered.
Conclusions

- Recycling is decisive for aluminium applications in order to achieve a good environmental performance.

- LCA do include recycling.

- As higher the recycling rate as better is the environmental performance of aluminium products.

- Besides the CF it is necessary to reflect other environmental indicators.

- In transport applications aluminium can score better due to its light weight.
Conclusions

- EPDs deliver environmental information. They are not tailored for evaluations.
- An environmental assessment should be done on base of a real building.
- A better understanding can be achieved if the food supply system is investigated.

The use of LCAs should be encouraged