Aluminium for Future Generations

Progressing through dialogue

Progressing through dialogue

The route to full sustainability

Contents:

Introduction

Aluminium is the third most abundant element in the earth's crust. We may not always be aware of it, but aluminium is present in every aspect of our daily life – our mobility, nutrition, accommodation and leisure. Today, aluminium is the world's second most used metal and the aluminium industry is an important stakeholder in society.

So it should not be a surprise that, since 1900 when worldwide production was a mere 1,000 tonnes per annum, by the end of the twentieth century annual use of aluminium had reached 10 million tonnes in Western Europe alone.

With the growth in importance of aluminium and the aluminium industry have come increased responsibilities and the natural need to invest in continuous development. In other words, the profitable growth of companies has come hand in hand with a recognition of environmental and social obligations.

The *Aluminium for Future Generations* initiative was launched in 1998 as a pan-European consultation process, through which the aluminium industry was to enter into dialogue with legislators, academics and non-governmental organisations on sustainable development issues relating to aluminium, aluminium product applications and general industry operations in Europe.

On the basis of stakeholders' constructive critique of our operations, activities, products and performance in areas such as energy use, climate change, recycling, research, and market development, the European Aluminium Association (EAA) produced a response paper in which the industry committed itself to:

- further improve performance on sustainability,
- monitor and report on energy use and on reduction of greenhouse gas emissions,
- participate in voluntary agreements and joint initiatives designed to address global climate change,
- optimise recycling rates,
- dedicate ongoing resources to research and development.

Since this first consultation, the European aluminium industry has made significant effort and progress in its understanding and wider acceptance of the need to adopt a "triple bottom line" approach to its activities – namely embracing economic, environmental and social aspects.

This paper illustrates the initiatives and actions we have developed in accordance with our commitments. It is a snapshot of the current situation and does not mark the end of the process. On the contrary, *Aluminium for Future Generations* will continue to be the catalyst for progress through dialogue on our path towards full sustainability.

We invite the reader to look at what we have done and to consider whether we are addressing the main concerns appropriately. Furthermore, we ask all stakeholders in our industry to continue to provide us with the benefit of views and guidance and to take into consideration, wherever possible, our input.

Aluminium offers

intelligent solutions in modern day life

The appreciation of "Quality of Life" varies according to the needs and aspirations of individuals and the sort of society in which they live. As our basic needs are satisfied, we develop increasingly complex requirements that challenge the ingenuity of designers and manufacturers and put increasing demands on materials. Whereas a wooden wheel on a cart may meet the needs of some people, nothing but the latest alloy wheel can meet the performance and aesthetic aspirations of others.

Since aluminium was first commercially produced over 115 years ago, its unique combination of properties has enabled designers and manufacturers to develop products that enhance the quality of life. Many applications in transportation, medicine, food preservation and electricity distribution would not have been possible if a material with aluminium's high strength-to-weight characteristic, outstanding barrier properties, good conductivity and corrosion resistance had not been available.

Chapter 1 One

Mobility




Nowadays, for many, mobility has increasingly become a basic need – like eating, sleeping and shelter. Passenger transport and the movement of goods are of key importance if people are to reap the benefits of life. Goods are transported all over the globe. Workplaces are rarely within walking distance. Supermarkets are often found in out-of-town locations. Relatives and friends frequently live several hundred kilometres from each other. People want to live an active and eventful life. This can include holidays overseas, attending events and lots more. These activities would be inconceivable without efficient transport systems – and, whether it be car, lorry, bus, train, boat or airplane, they all contain aluminium.

As far back as 1865 - twenty years before the commercial production of aluminium - Jules Verne anticipated the bright future of aluminium in his book '*From the Earth to the Moon*'. He wrote: *"This valuable metal possesses the whiteness of silver, the indestructibility of gold, the tenacity of iron, the fusibility of copper, the lightness of glass. It is easily wrought, is very widely distributed, forming the base of most rocks, is three times lighter than iron, and seems to have been created for the express purpose of furnishing us with the material for our projectile"*.

The aviation industry would not have existed without aluminium. "Kittyhawk", the Wright brothers' first airplane that flew in 1903, had a 12 horsepower engine modified with a 30-pound aluminium block to reduce weight. Twenty-three years later, it was an aircraft made of aluminium, which took Charles Lindberg on his flight across the Atlantic, thus launching commercial aviation. Aluminium now comprises about 80% of large commercial aircraft.

The current emphasis on fuel efficiency and emission reduction has highlighted the opportunities for automotive manufacturers to utilise aluminium more intensively. Today, the nearly 4.5 million tonnes of aluminium used in worldwide car manufacturing alone have the potential, over the lifespan of the vehicles, to reduce greenhouse gas emissions by 90 million tonnes CO_2-equivalent and so to contribute to a cleaner environment. In today's commercial vehicles, aluminium reduces tare and increases capacity. For example, every tonne of aluminium replacing heavier materials in the production of articulated lorries has the potential to save, over the vehicles' life cycle, 12 tonnes of CO_2 through fuel economy or 52 tonnes of CO_2 through increased payload. In urban environments where inner-city pollution is an increasing problem, aluminium provides the opportunity for significant weight savings, enhances the safety characteristics of vehicles and improves their environmental performance.

Mobility means much more than just motorised transport: for example, walking aids or transport aids for disabled, infirm or elderly people. Aluminium is ideal for such applications … Thanks to its use in wheelchairs, walking frames and stair-lifts, people can enjoy their independence, without having to rely so much on others.

Aluminium offers intelligent solutions in modern day life

Health and well being

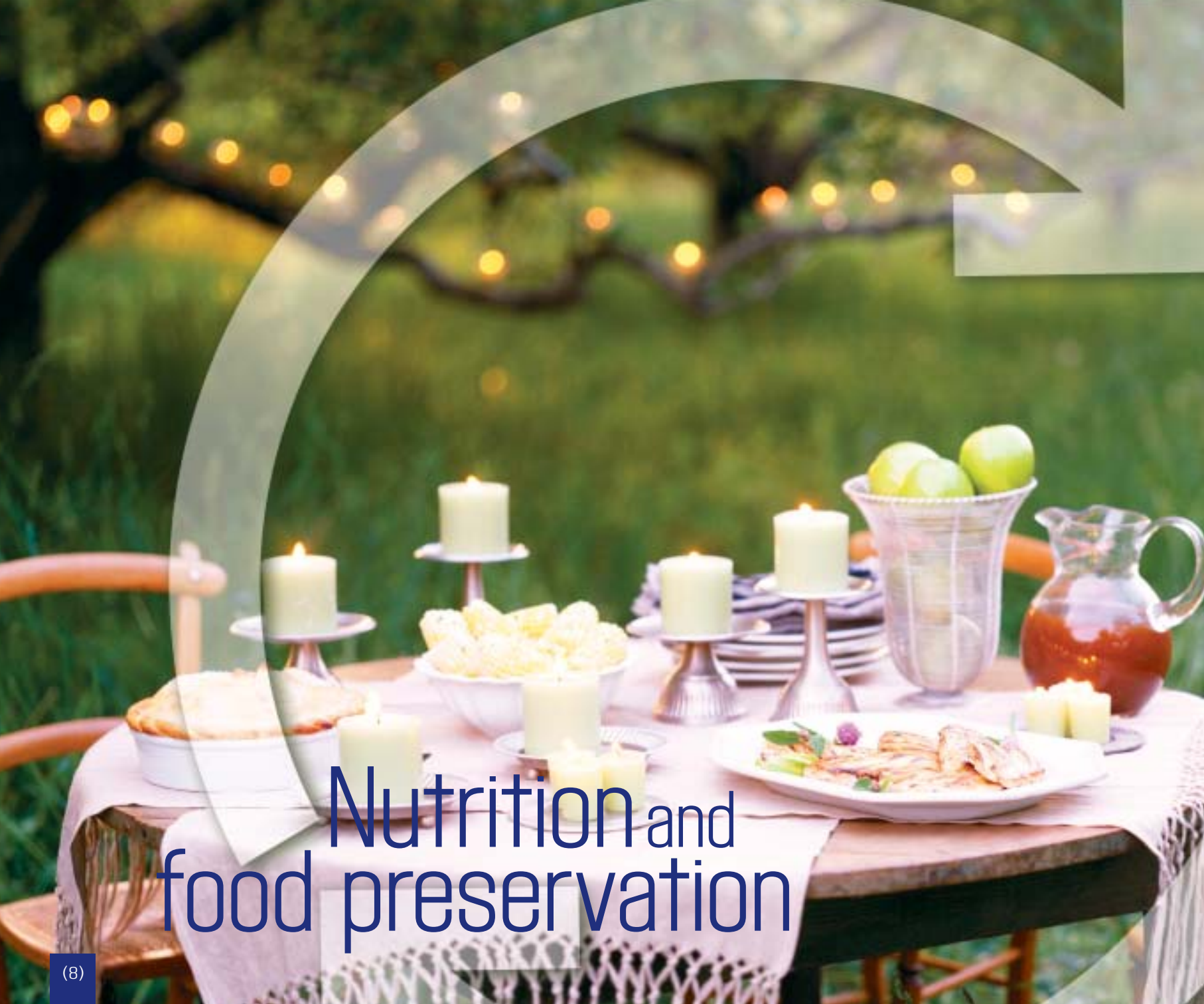
As stated in the introduction, aluminium is the third most abundant element in the earth's crust. It occurs in various chemical forms in most rocks and soils, in vegetation and is found naturally in most water supplies and as part of dust particles in the air. It is important to realise that life and human civilisation have developed in an aluminium-rich environment. It has been estimated that the average human body contains between 35 and 50 mg of aluminium, of which approximately 50% in the lungs, 25% in the soft tissue and 25% in the bones. Aluminium in the diet of an average adult usually ranges from about 3 mg to 12 mg per day.

Moreover, aluminium makes a valuable contribution to healthy living in facilitating the provision of clean and safe water supplies, in medicinal treatments and in emergency protection aids.

Most water authorities throughout the world use aluminium sulphate as a “flocculant” in purifying the public water supplies. When added to the water, the aluminium compound attracts small particles, unwanted chemicals and potentially harmful organisms and bacteria, thus allowing them to be filtered out. Aluminium sulphate is effective, safe to handle and has become the benchmark in water treatment.

In medicine, aluminium compounds are prescribed by doctors for the treatment of gastric ulcers. Even more widespread use is made of aluminium compounds in non-prescription drugs and toiletries such as antacids, antiperspirants, antiseptic solutions. Aluminium is not known to produce any adverse effects on health and is recognised for such uses by the World Health Organisation.

In the preservation and saving of life in extreme temperatures and conditions, the reflective and barrier properties of aluminium are put to use in a variety of ways. Protective fire “suits”, thermal recovery blankets and fire tents often have a metallic coating or foil layer which greatly enhances insulation.



Nutrition and food preservation

"Packaging plays an important role in preventing foodstuffs from being destroyed and thus in reducing the impact on the environment. Zero packaging means a distribution of loose goods; in which case the waste of perishable products would be considerable. Using packaging, it is possible to reduce waste of products".[1]

Aluminium packaging offers a wide range of properties to guarantee a high degree of protection for products and ensures that they retain their characteristics and value. It offers tailor-made solutions, which take into account the socio-demographic trend towards small households and changing eating habits. It conserves resources and is recyclable.

Aluminium is used in rigid as well as flexible packaging applications. Being odourless and tasteless, it will not taint flavours. Its light-weight provides scope for transport cost-savings and its good thermal conductivity means that aluminium-packed products can be heated or chilled quickly and economically.

Aluminium packaging is readily printed and many designs incorporate the natural attractiveness of the metal itself. Aluminium bottles, cans and pots can be used for particularly sensitive chemical products. Such seamless and odourless packaging is impermeable and can be used to protect flavourings, laboratory chemicals, agrochemical products, sealants and adhesives and can ensure product stability for long periods.

On the one hand, aluminium foil has the ability to protect its contents from damaging environmental influences such as oxygen, light, moisture, micro-organisms and unwanted aromas. On the other hand, the tasteless aluminium barrier will retain liquids and prevent the loss of aroma and other volatile components. Aluminium foil can be readily combined with materials such as paper and plastics to further enhance the properties of each material. As a result, a minimum of materials can provide a maximum of packaging performance.

For example, a barrier layer of 1.5 g of aluminium foil in a 1 litre UHT milk carton (total packaging material weight: 28 g) is sufficient to ensure that the milk can be stored for several months without refrigeration. This is essential in countries where the facility to distribute nutritious products like milk over great distances at minimum cost can be life-saving. Health is also of great significance in the case of pharmaceutical packaging where aluminium foil provides very long-term protection for sensitive products.

[1] The Swedish Institute for Packaging and Distribution, Report 194, June 2000

Aluminium offers intelligent solutions in modern day life

Shelter and comfort



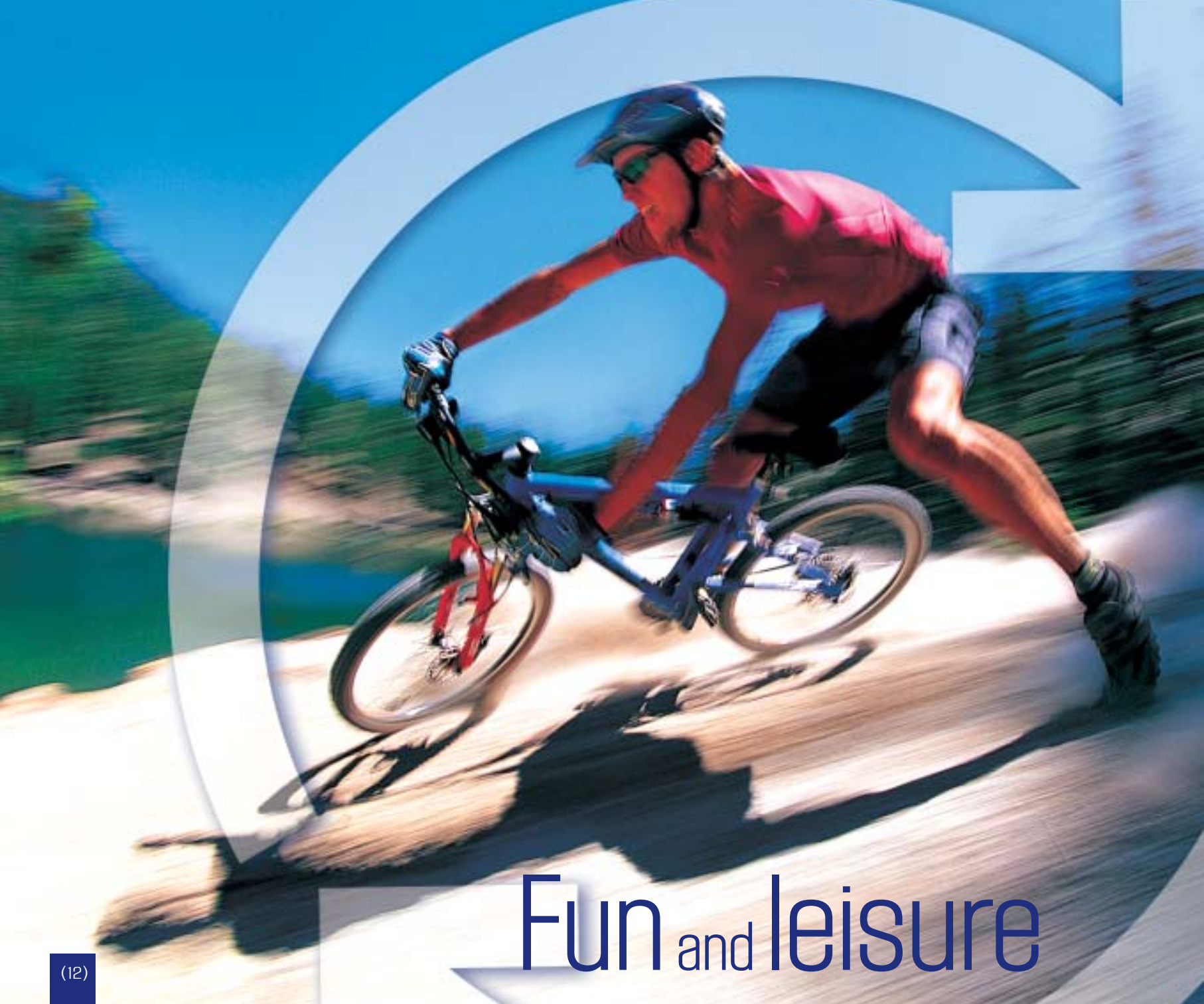

Buildings are part of our lives – at home, at work, when shopping or eating out. As prosperity increases, so do the demands on our buildings. The hierarchy of needs extends from shelter, warmth and security to more aesthetic needs such as décor and ambiance. Aluminium products can fulfil these requirements by providing efficient solutions from stylish curtain wall systems to ultra modern furniture and lighting.

Unlike some alternative building materials, aluminium offers an almost unlimited life expectancy and evidence of this is all around us. Some striking examples are the aluminium sheets installed more than a century ago to clad the dome of Rome's San Gioacchino church, the aluminium components installed in New York's Empire State Building (the first building to use anodised aluminium) and the statue of Eros (only recently cleaned and renovated) in London's Piccadilly Circus. Their excellent condition bears witness to the fact that aluminium does not age in the way that organic materials do and needs no protection from ultraviolet light. In addition, the cast and wrought aluminium alloys used in building combine properties of durability and high resistance to weathering or atmospheric attack, both in industrial and marine environments.

To meet the architect's decorative requirements, aluminium can be anodised or painted, which can further enhance the material's natural durability and corrosion resistance, and also provide easy-to-clean surfaces.

Aluminium offers intelligent solutions in modern day life

Chapter One



Fun and leisure

Aluminium's range of properties means that it is able to meet a wide variety of requirements in the field of leisure and sports.

It is used to make CDs and all high-performance mountain bikes, skis, roller blades, soccer goal posts, sailing boats, scooters...

The Olympic Games are the arena in which aluminium can shine. In Sydney 2000, the Olympic Torch survived the long journey from Greece to Australia thanks to the intensive use of aluminium. In Athens 2004, once again the Olympic Torch will be made of aluminium, this time in combination with wood, to reflect Man's relationship with Mother Nature.

The components of our "quality of life" are difficult to define or predict but one thing is certain – they will always be evolving.
There will always be a need for materials that are versatile and environmentally responsible. Aluminium is such a material.

Aluminium offers intelligent solutions in modern day life

Sustainability –

the strength of aluminium

The aluminium industry sees sustainable development as the framework within which to take forward its commitment to future generations. Since the beginning of the *Aluminium for Future Generations* programme, the European aluminium industry has put effort into understanding and implementing the "triple bottom line" approach through a number of research projects and studies.

SUSTAINABILITY INDICATORS

Since the meeting in Lisbon in 2000, various European Councils have underlined the need for indicators to reflect an appropriate balance between the three "legs" of sustainable development.

In this respect, the Wuppertal Institute for Climate, Environment and Energy (Germany) proposed a set of environmental, economical and social indicators for aluminium in a project entitled *'Towards a Sustainable Aluminium Industry'*[2].

To prepare this study, targeted interviews and workshops were conducted throughout Europe with a wide range of stakeholders including NGO's, academia, government institutions and politicians in order to understand their views and priorities. A similar study was carried out by Warwick University in the UK, with funding from the Department for Trade and Industry, on behalf of the Non-Ferrous Alliance.

A third study *'The Social Dimension of Sustainable Development in the Aluminium Industry'*, was undertaken by the 'Centre d'Economie et d'Ethique pour l'Environnement et le Développement' of Versailles University (France). The objective was to define opportunities and methods and propose appropriate indicators for corporate social responsibility within the aluminium industry, based on a "bottom-up" approach of meetings and interviews with stakeholders at local level. At the time of writing, the results of this study obtained from French case studies are being used as benchmarks in other locations throughout Europe.

The above-mentioned studies are the roots for an ongoing process of understanding the meaning of sustainable development for the European aluminium industry and identifying key fields of action to ensure continuous progress.

[2] See article 'Developing a System of Sectoral Sustainability Indicators for the European Aluminium Industry', published in the UNEP Journal 'Industry and Environment', July-December 2002 and available on the UNEP website (access via the EAA website: www.eaa.net/affg)

Chapter 2 Two

Economic aspects




In many ways aluminium and the aluminium industry contribute to the economic well-being of society. From production, through the use-phase to end-of-life recycling, aluminium offers economic incentives to do “more with less”. The characteristics of the production process are at the origin of the natural drive for resource efficiency (energy, recycling) whilst the utilisation of aluminium in its different applications offers direct economic benefits to its users.

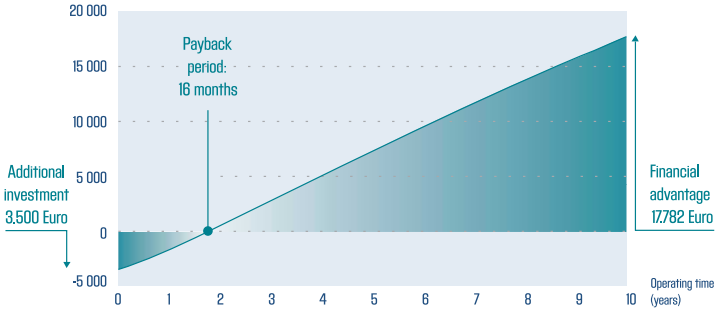
The most evident example is the economic significance of aviation. Aluminium has helped make it possible for man to fly.

The economic impact of this is unquantifiable. In order to identify factors, forces and mechanisms, which influence further growth of aluminium diffusion in the European transportation industry, the Bocconi University conducted research in 2001 and 2002. The results have been published as a book entitled: *‘Aluminium for the Transportation Industry in Europe – Innovation and Competitive Advantages. A System Dynamics approach’*. It clearly states that the spread of aluminium in transportation as a technological innovation gives competitive advantages to producers and customers, with evident social benefits.

The TGV duplex (French high speed train) is a highly innovative product because it integrates the concept of high speed with the concept of high transportation capacity. Because of the train’s double-decker structure, aluminium was needed to guarantee compatibility of the weight and the load-bearing capacity of the carriages. The use of the light metal made it possible to produce a train, which, despite its double transportation capacity, weighs 12% less than the traditional TGV. Similar arguments are applicable to high-speed ferries.

As shown in the graph on the left, in road freight applications there is a short payback period for aluminium intensive vehicles: additional income and cost savings from increased payload, the need for fewer trucks, reduced fuel consumption, reduced maintenance and higher residual value.

The financial advantage of lightweighting and higher residual value



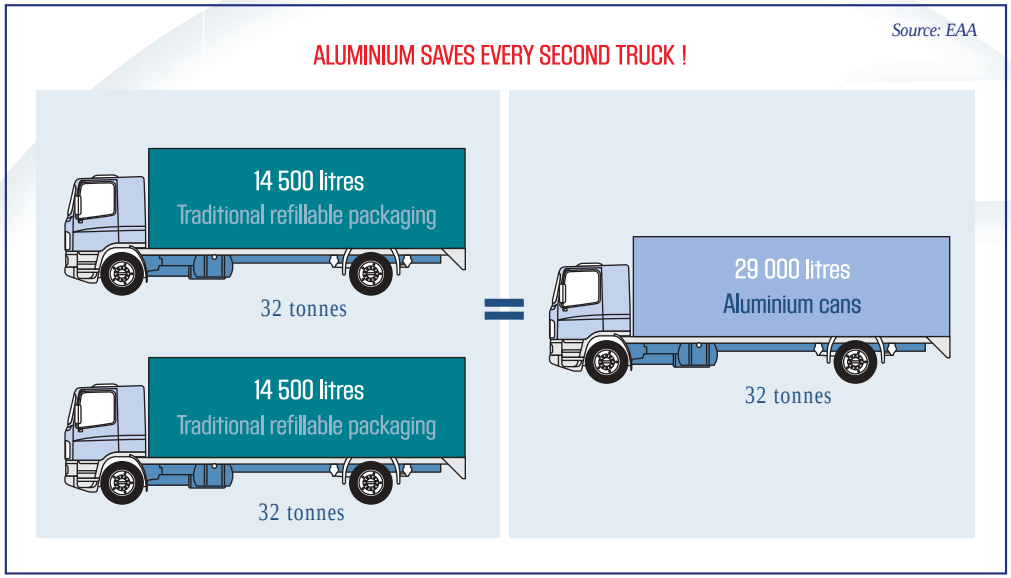
Source: EAA

Sustainability – the strength of aluminium

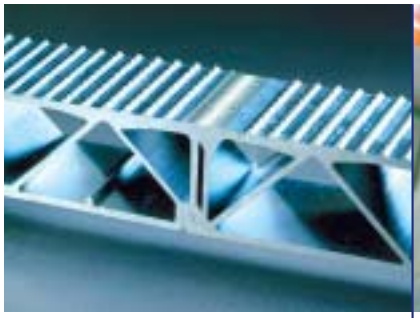
Reducing the weight of a car by 100kg allows fuel savings of up to 0.6 litres/100km. Intensive use of aluminium reduces the weight of an average car by 300 kg thus saving up to 3,000 litres of fuel over its lifetime - a major economic consideration.

In aluminium packaging applications, aluminium cans, which are lighter than many other traditional packaging materials, can ship up to 40% more liquid in the same truckload.

Aluminium: the leightweight packaging



Economic aspects




Reduced maintenance requirements in aluminium intensive buildings are an important reason for the increasing role of aluminium in this sector.

The intrinsic value of aluminium is the most effective driver for aluminium recycling. Recycling is essential from an environmental and social point of view but if, on top of that, it makes economic sense, success is guaranteed! In 2002 the total production of semi-fabricated aluminium comprises 6 million tonnes of primary metal and 4 million tonnes of recycled aluminium.

Through the increasing success of its material and its leading position in technology development, the aluminium industry has become an important economic player in Europe. It includes metal production in primary smelters as well as the remelting and recycling of aluminium, the manufacture of semi-fabricated products and castings, and subsequent processing to foil, tubes and cans.

As shown in the following table, about 800 plants produce or process aluminium. Although they include companies that are active globally, they are often small and medium-sized. Moreover, the economic activities of the aluminium industry spread intensively into other branches and suppliers.

Aluminium industry key facts and figures in Western Europe in 2002*

Source: EAA

Direct jobs	± 237 000	Number of companies	
Mining (bauxite)	± 2.3 mio tonnes	Mining	3 plants
Refining (alumina)	± 6.0 mio tonnes	Refining	8 plants
Metal production	± 3.9 mio tonnes	Metal production	31 smelters
Production of semis:		Extrusion plants	318 plants
• extrusions	± 2.4 mio tonnes	Rolling mills	55 mills
• wire	± 0.3 mio tonnes	Rollers/converters	100 plants
• rolled products	± 3.8 mio tonnes	Remelters	115** plants
• rollers/converters	± 0.8 mio tonnes	Refiners	174** plants
Recycling aluminium	± 3.6 mio tonnes		

*15 EU countries plus Norway, Switzerland and Turkey
** 2001 data

Environmental aspects




Sustainable use of resources

The EU 6th Environmental Action Programme addresses the issue of sustainable use of resources. It wants: *"to ensure that the consumption of renewable and non-renewable resources, and the associated impacts, do not exceed the carrying capacity of the environment, and to achieve a de-coupling of resource use from economic growth through significantly improved resource efficiency, dematerialisation of the economy and waste prevention"*.

The strength of aluminium is its life cycle. A major objective of the European aluminium industry is to continue to improve environmental performance through all stages of the life cycle of aluminium from production to use and subsequent recycling - through:

- efficient use of resources,
- reduction of emissions to air and water,
- maximizing the contribution of aluminium in the "use-phase", and
- reduction of manufacturing waste.

To measure progress, the EAA issued its first Environmental Profile Report in 1996 providing detailed information in a Life Cycle Inventory (LCI) on aluminium production recycling and scrap remelting processes. This document is reference material for Life Cycle Assessment (LCA) and, as such, serves as a benchmark. An updated version was published in 2000.

CE Delft, an independent research and consultancy organisation, issued a report on the complexity of life cycle assessment (LCA) related to aluminium, especially when used as basis for policy-making. Case studies from various European countries contribute to the discussions on how to use LCA appropriately.

Natural resource extraction: bauxite

At 8% of the earth's crust, aluminium is the third most abundant element in nature. The ore from which aluminium is produced is bauxite. Disregarding various quality grades, bauxite reserve estimates indicate adequate supply for at least 200 years.[3] More than 100 million tonnes of bauxite are mined each year, the major deposits being in the tropics and sub-tropics. Bauxite is currently being extracted in Australia, Central and South America (Jamaica, Brazil, Surinam, Venezuela and Guyana), Africa (Guinea), Asia (India, China), CIS and parts of Europe (Greece and Hungary). In many of these regions bauxite extraction is the only valuable natural resource.

[3] IAI Second Bauxite Mine Rehabilitation Survey, July 2000

Bauxite deposits are generally extracted by open cast mining from strata typically 4 to 6 metres thick, under a shallow covering of topsoil and vegetation (except in Europe where underground mining is used).
The aluminium industry is putting great effort into reducing the impact caused by mining and into restoring mined areas to their natural state or to other beneficial uses.
During the preparation of a site the surface soil is removed and is stored for use in site restoration.

Post-mining land-use shows 70% being returned to native forest, 17% to pasture and agriculture, 7% used for urban and industrial development, housing and recreational purposes and 3% for commercial forestry.

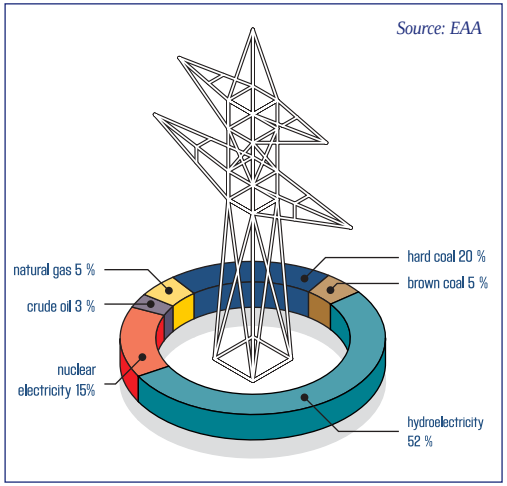
The International Aluminium Institute (IAI) conducts regular bauxite mine rehabilitation surveys. In 1998 the survey covered 72% of the world bauxite production proving that the industry is monitoring its performance and that continuous improvements are taking place. A very high proportion of mines have long-term plans for the mine areas that will leave a self-sustaining ecosystem in place when mining operations have been completed.

Energy

For primary aluminium production, the electrical energy in the electrolysis process is the major part of the total energy used.
The current energy supply situation, including the energy source, for each smelter is included in a European model developed by the EAA. This takes into account both the European aluminium supplies and imports from other regions. More than 50% of the energy used to produce the aluminium supplied to the European market comes from hydro-electricity, a clean and renewable source.

A recent study on climate change and energy supply systems for primary aluminium smelters carried out by ECOFYS, a leading company in the field of energy, shows that the EAA model is valid.[4]

[4] International Journal LCA, 'CO_2 Emissions related to the Electricity Consumption in the European Primary Aluminium Production', Matthias Koch and Jochen Harnisch, 2002



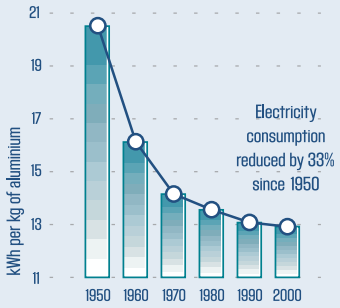
Environmental aspects




Reduction in energy use

The fact that energy represents a large part (about 25%) of the costs associated with primary aluminium production means that producers have always had a vested interest in minimizing electricity use. The global aluminium industry has recorded a consistent reduction in energy use per tonne of aluminium. Modern smelters use a third less electricity per tonne than the equivalent plants in the 1950s and are now close to the optimum allowed by existing technology. The aluminium industry encourages continuous improvements in energy efficiency by circulating benchmarking statistics.

Reduced electricity consumption at the electrolysis stage



Source: EAA

The present European average electricity requirement of 15kWh/kg of primary aluminium (ranging between 13kWh/kg – 17kWh/kg) has been continuously reduced by process technology improvements such as the widespread use of “point feeder” techniques, which save energy by enabling more consistent cell operation. Fossil fuel consumption during aluminium production throughout the process chain has also been reduced by 25% over the past 15 years and will decrease further as a consequence of new technology and plant upgrades.

Furthermore, energy from the production process can be used in other ways. In one German rolling mill, for example, the surplus heat from melting furnaces is used to provide heating for 6,500 people on a nearby housing estate, thus saving about 3.9 million cubic metres of natural gas each year.

A significant way to improve the energy efficiency of aluminium is to increase the proportion that is recycled. Recycling aluminium saves up to 95% of the energy required for primary production. Around 30% of the aluminium supplied to the European market originates from recycled metal. In an increasing number of applications such as building and transport the recycling rates are very high.

The use phase

The real impact on the environment of a product or material can only be judged from a life cycle perspective. The energy requirements of all aluminium production stages - from the mining of the raw material to the transport of the metal - must be considered in combination with the possible energy savings enabled during the lifetime of the finished aluminium product. Account must be taken of the energy-saving potential of recycling the aluminium after the product has been used.

Transport

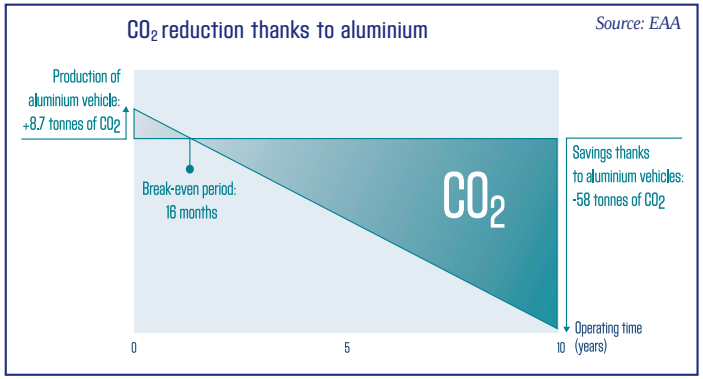
A recent study conducted by Amici della Terra (the Italian member of the Friends of the Earth network)[5] confirmed that the use of aluminium in transport applications leads to their weight decrease and therefore to reduced energy consumption. This, in the long term, brings an overall reduction in their environmental impact. Amici della Terra compared the increased use of aluminium to a more traditional material use scenario, taking into account the complete life-span of the vehicle as well as efficient recycling of aluminium back into the transport sector. An increased use of aluminium in transportation would reduce future growth in CO_2 emissions by 7% thus contributing to sustainability in the transport sector.

These energy savings in the use-phase of the life cycle of an aluminium product can more than offset the energy required to produce the primary aluminium.

An interesting example is the case of a road trailer where the increased payload achieved by light-weighting reduces the number of trips required to transport a given tonnage of goods. The fuel saved through reduced travelling translates into energy savings and reduction of CO_2 emissions. In this case a trailer in which 1,300 kg of aluminium replaced 2,800 kg of another material was able to carry 26.5 tonnes of payload compared to 25 tonnes. Energy saving and CO_2 due to the additional payload have been compared with the original energy requirements and CO_2 emissions linked to production.

Break-even point is reached when the environmental benefits provided by the increased payload match the additional aluminium production requirement. With a yearly mileage of 100,000km (75,000 fully loaded with heavy goods and 25,000 empty), break-even point is reached in 17 months for energy and 16 months for CO_2 emissions. Over a 10-year period the aluminium trailer saves 815 GJ of energy and reduces CO_2 emissions by 58 tonnes.

[5] Amici della Terra, 'The Environmental Compatibility of a Potential Increase in Aluminium Use in the Transportation Sector', 2001 - www.amicidellaterra.it



Environmental aspects

Packaging

Another illustration of resource efficiency is the down-gauging effort where a 33cl aluminium beverage can, which weighed 23 grams in 1980, today weighs less than 14 grams, a 40% reduction. Other examples of weight reduction in alufoil-based products over the past two decades are[6]:

- lidding for dairy products etc.: 15%
- flexible laminates: 28%
- drink cartons: 30%
- coffee packs: 42%

Such weight and material savings have been made without affecting the performance of the packaging materials. If packaging fails to fulfil its function of preserving and protecting, the contents will deteriorate. All the energy and resources used to produce and distribute the contents will then be wasted.

Thanks to technical advances, it is now routine to roll aluminium foil only 0.006 mm thick (six one-thousandths of a millimetre - a fraction of the diameter of an average human hair). At this gauge, the aluminium still possesses the ability to protect the pack contents from quality-reducing effects such as air, light, moisture, micro-organisms or unwanted aromas. Only 1.5 grams of aluminium foil in a pack weighing 28 grams enables 1 litre of UHT milk to be transported and stored for several months without refrigeration. Thus, 1 kg of aluminium enables about 650 litres of product to be preserved for a long time without the need for energy to keep it cool.

Additionally, lighter packaging means lower fuel consumption and reduced emissions from transport. An example is the use of aluminium foil-based pouches instead of returnable glass bottles for drinks products. A study by a European drink producer has shown that nearly twice as much product can be shipped per truck when aluminium foil pouches are used instead of glass bottles. The weight of the foil packaging represents a mere 6.1% of the total load.

[6] Source EAFA, www.alufoil.org

Building

In response to the requirements of the Kyoto protocol, the European Climate Change Programme has identified energy efficiency in buildings as one of the key areas of attention. It is estimated that 40% of energy consumption in the EU can be attributed to buildings. The study *'Sustainable use of aluminium in buildings'* developed by SINTEF, Civil and Environmental Engineering Institute in Trondheim (Norway), focuses on the use of aluminium for energy-saving or energy-supplying elements in the building sector. It finds that, although aluminium is a very efficient conductor of heat, this characteristic is modified, where necessary, by the introduction of thermal breaks. In this way, aluminium is extensively used for the manufacture of windows, doors and building facades.

Aluminium also provides significant environmental benefits thanks to its low maintenance needs and the fact that being strong yet light, less material is needed in the supporting building structure. The SINTEF project also confirms that the recycling of aluminium components greatly reduces their environmental footprint.

Recovery and recycling

Aluminium is an "energy bank" – the original energy input can be valorized through recycling or other recovery methods such as incineration with energy recovery.
The increasing use of recycled metal saves the energy, emissions and mineral resources involved in primary production - using only about 5% of the energy required for primary production and generating only 5% of the greenhouse gas emissions.

All separately collected aluminium can and will be recycled, not only cans but also containers, window frames and automotive components. Scrap aluminium has significant monetary value - which makes its recycling an economically viable activity. Therefore, the physical promotion and organisation of aluminium recycling is key to the industry. It is the reason why the recovery of aluminium packaging was intensified through the European network of national aluminium recycling organisations. This has resulted in increased recycling rates. The European recycling rate of the aluminium beverage can, for example, reached 45% in 2001 (see graph on right hand page).

As the packaging and automotive markets require obligatory reporting under the prescriptive European Directives a first priority for the aluminium industry has been to confirm the recycling rates of aluminium in the building sector. The Delft University of Technology investigated the collection of aluminium from buildings. The data gathered in 2001 and 2002 show that current collection rates are over 90%. Case studies in both residential and non-residential buildings in different European countries (Germany, Italy, France, Spain and UK) are being explored.

Within the framework of resource efficiency, the estimated 400 million tonnes of aluminium currently "in-use" in transport, building and other applications form a valuable resource available for future generations when the products have finished their present useful life. When compared to the worldwide annual production of primary aluminium of 24 million tonnes, the significance of this "metal-in-use" inventory can be appreciated. If aluminium is valorised in energy recovery systems 1 kg of aluminium releases as much energy as the combustion of 1kg of coal or 0.8 litres of fuel oil.

Environmental aspects




Aluminium Beverage Can usage and Recycling - 2001

Source: EAA

COUNTRY	TOTAL CAN USAGE (1)	ALU CAN USAGE (1)	ALU SHARE	RECYCLING RATE (%)
Austria	800	750	94%	50% (2)
Benelux	2060	490	24%	80% (3)
Denmark	-	-	-	-
Finland	110	110	100%	84%
France	2900	820	28%	29% (2)
Germany	7300	950	13%	80% (4)
Greece	1050	1050	100%	36%
Ireland	340	265	78%	26%
Italy	1900	1850	97%	46%
Norway/Iceland	225	224	100%	89%
Portugal	480	340	71%	21%
Spain	5880	2350	40%	20%
Sweden	916	916	100%	88%
Switzerland	185	185	100%	91%
Turkey	1030	835	81%	50%
UK	7120	5300	74%	42%
TOTAL WESTERN EUROPE	32296	16435	51%	45% (5)
Poland	1650	1600	97%	39%
Other Eastern+Central Europe and Unallocated	3454	3405	99%	n.a.
GRAND TOTAL	37400	21440	57%	n.a.

(1) in million units
(2) as cans are not recorded separately, the quoted recycling rates refer to the estimated results from the recycled aluminium packaging fraction
(3) in Belgium and Netherlands recycling is counted for metals together
(4) as cans are not recorded separately, last official results for the recycled aluminium packaging fraction
(5) taking into account uncertainties of some figures

Waste management and emissions

The management of waste and emissions is an integrated part of resource use. As with most industrial processes, aluminium production involves some waste material and emissions. The aluminium industry has a longstanding record of developing ways to reduce their impact.

The methodology used for the Environmental Profile Report for the European Aluminium Industry is consistent with that outlined in ISO 14040 and ISO 14041 on LCA.
The number of companies participating provides good coverage of the various processes, making the results representative of the industry as a whole for the production of primary aluminium and subsequent conversion processes.

This report allows the European Aluminium industry to measure environmental progress in areas like emissions and waste management.

After alumina has been extracted from bauxite by the Bayer process there is a residue, which largely consists of compounds of iron and silicon. The sludge is red (due to the iron compounds), and the product is commonly called "red mud". This bauxite residue poses storage problems. A number of applications have been found for this material thus reducing the quantities to be deposited, these include use as a pigment in roofing tiles, as a material in highway construction and as an ingredient in cement production.

However, such applications cannot absorb the total amount of the material and the surplus is treated so that the alkaline content can be recovered and returned to the Bayer process. This means that the remaining mud can be deposited in large sealed dykes where, having been supplemented with layers of earth and sand, re-vegetation becomes possible. Australia is one example of a country where large filled basins containing red mud have been restored with new surface vegetation of grass and trees. The aluminium industry believes that controlled deposition together with research into significant applications for the residue, will remain the best means of dealing with bauxite residues for some time.

In the past fluoride emissions were the single most important pollutant from aluminium smelters due to their impact on vegetation in the surrounding area. Starting in the 1970s, the aluminium industry developed the technology and invested heavily to reduce these emissions and to return fluoride to the production process. The table on the right hand page shows the worldwide development in fluoride reductions through three generations of aluminium smelters. Today, according to the latest EAA survey average fluoride emissions have been reduced to below 1 kg per tonne.

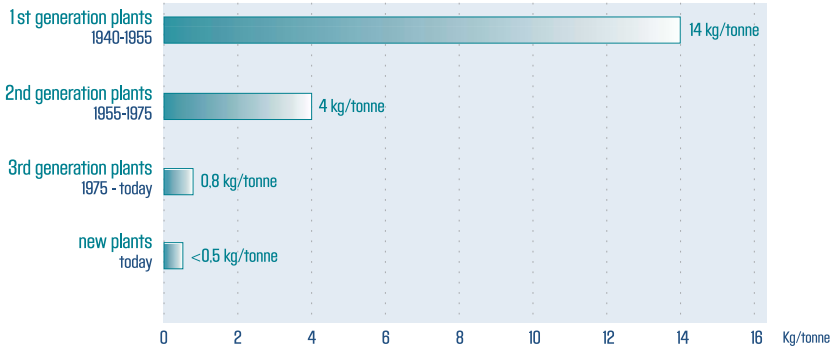
Polycyclic aromatic hydrocarbon (PAH) emissions occur during anode production (for "pre-bake" plants) and in the electrolysis emissions from Soederberg technology smelters. Latest anode production techniques incorporate dry scrubbing emission control systems, which limit PAH emissions to a level of approximately 0.05 kg per tonne (less than 0.01 kg for the more recent plants). Over the past 15 years Soederberg plants have been modified so that emissions have been significantly improved and are currently approximately 0.15 kg per tonne of aluminium.

The EAA monitors on a regular basis PFCs (perfluorocarbons) and other emissions from the industry. PFCs are greenhouse gases produced during "anode effects", brief process upsets in the electrolysis cells.

Environmental aspects




Evolution in average fluoride emissions from primary aluminium smelters



Source: EAA

PFC emissions from the European aluminium industry have been reduced from 16 million tonnes CO2-equivalent in 1990 to 4 million tonnes in 2000.

The aluminium industry continues in its proactive efforts to reduce the environmental impact of its emissions. Voluntary or negotiated agreements between government and industry have played a significant role in encouraging such reductions in emissions in many countries including France, Germany, Norway and UK. They have led to big improvements in fundamental understanding of the processes, and the implementation of modern technologies in smelting and emission control.

Social aspects




The European aluminium industry directly employs 237,000 people in the European Union, Norway, Switzerland and Turkey. In the EU countries alone the workforce numbers about 200,000.

According to a study in Greece on the aluminium cycle from the metal production to the final products used in buildings [7], the human factor plays a significant role in the value of an aluminium product. In fact, an installed window/door has eight times the value of the primary metal used, taking the same quantity as reference. The last aluminium transformation stage – doors and windows – employs 75 times more manpower in relation to the production of the same quantity of primary metal used.

Conscious of the contribution of aluminium and the aluminium industry to employment and social progress, the EAA has decided to build on the experience of its members.

Corporate Social Responsibility (CSR) is not a new concept for aluminium companies. On the contrary, it has been the driver for numerous voluntary actions, which have helped advancement and well being of communities.

In 2001 the EAA responded to a stakeholder consultation on CSR launched by the European Commission. This response positioned the industry in the debate and illustrated a series of good practices operated by aluminium companies. These good practices range from regional development, community relations and people development to health and safety [8].

In the process of benchmarking the aluminium industry's progress in the field of CSR the Versailles University study on social indicators is a reference. The empirical work of this study has been based on three site discussions in France and is now further developed in other European countries (Germany, Italy and UK). Results have so far revealed that "attempts to apply indicator procedures decided uniquely at head office level, or norms proposed by international agencies, may encounter difficulties". The European aluminium industry is now working on indicators that are "customised" to its operations and which reflect the stakeholders' views and concerns.

[7] Aluminium Association of Greece 'The Aluminium Cycle in Greece', 2002
[8] A more exhaustive view can be obtained by reading the document on Corporate Social Responsibility on the EAA website: www.eaa.net/affg

Community relations

Due to the nature of their operations, aluminium smelters are significant generators of economic wealth for the communities in which they are located. For example, Norwegian aluminium smelters are situated along the coast, in municipalities where they are the main employers and considered as cornerstone businesses.

Unlike primary aluminium production, aluminium extrusions and finishing product plants tend to be located in, or close to, urban centres. Whilst there is a range of stakeholder interests in these operations, they are typically unobtrusive, and their footprints are smaller than those of smelters.

In the areas where it operates, the aluminium industry strives to involve the community in an open and continuous dialogue.

As part of society, the aluminium industry and its employees are involved in a variety of community activities and offer their support in cash or kind to projects ranging from neighbourhood schemes to initiatives in developing countries. The contributions are used in sports, culture, environment, health and church projects, or to support aid organisations. As an example, the cash-for-cans programme in the UK saw £12 million paid back into the community in 2001 alone, in exchange for used aluminium beverage cans. Charities, schools and individual collectors benefit from this initiative in recycling aluminium packaging[9].

A qualified and motivated team of workers is an important prerequisite for companies to be successful in the marketplace. When recruiting for its operations, the aluminium industry tries to reach out to young people in the local communities, in schools and other educational institutions. This helps young people understand the industry - its products and applications, its place in society and its other contributions - and how they can be part of it for a sustainable future.

In the event of major changes to operations that have effects on the local community (for example, layoffs, downsizing or closures) the aluminium industry addresses local community concerns and helps find alternative employment and acquisition of new skills.

Stakeholder consultations in Scotland prior to decommissioning of one old smelter are often quoted as good examples of community relations. In October 2001, the programme to redevelop the local village took a major step forward with a groundbreaking agreement donating 80 acres of land to the community. This transfer was a catalyst that enabled the village to develop more fully as a tourist area, and is a good example of successful co-operation between industry and local authorities.

People development

The European aluminium industry considers respect for people and their development as a pre-requisite. Access to information, training, equal opportunities, respect for personal dignity in the workplace are given particular attention in member companies. Through a programme of co-operation with twenty-five universities in eleven European countries, the EAA, in partnership with several national aluminium associations, has developed the TALAT CD-ROM (Training in Aluminium Application Technologies)[10]. Aimed at engineering students and at engineers, TALAT consists of a compendium of lectures dealing with material science.

Within the framework of the Leonardo da Vinci Programme of the European Commission, the EAA is now developing the aluMATTER project in collaboration with major European aluminium producers, national aluminium associations and well-known technical training centres and universities. AluMATTER is developing modular interactive web-based courses on aluminium fabrication. These will complement the existing TALAT modules. AluMATTER will be particularly relevant to the many small and medium-sized companies making aluminium products.

[9] More information can be obtained on either www.alupro.org.uk or www.cashforcans.com.
[10] EAA, TALAT CD-ROM, version 2.0, 1999

Social aspects





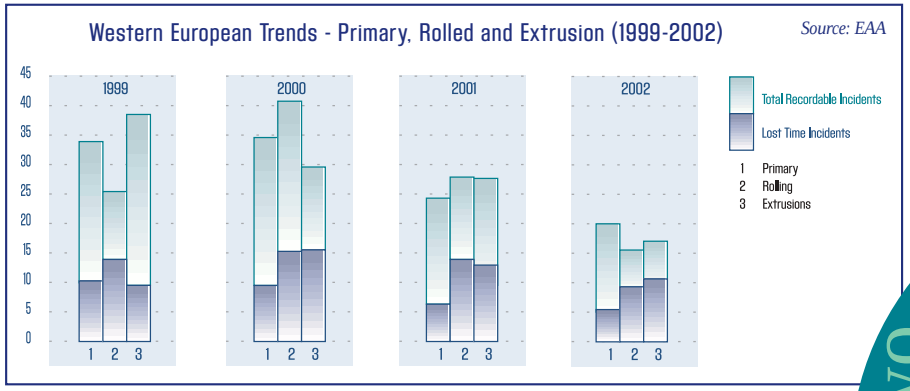
The aluminium industry provides opportunities for young people involved in apprenticeship and introduction to work schemes. In the UK the Aluminium Federation has been working closely with the Government for several years to develop training programmes particularly for small and medium-sized companies often unable to afford their own training department or training professionals. Consequently, National Vocational Qualifications (NVQs) have been established for sectors of the aluminium industry. An NVQ is a work-based vocational qualification that can range from shop floor skills to higher management.

A complementary training scheme for small and medium-sized companies set up in the UK between Government and employers is Investors in People (IIP), to which many aluminium companies of all sizes subscribe. Surveys have shown that the introduction of IIP has resulted in improved earnings, productivity and profitability, reduced costs and wastage, improved motivation and morale, customer satisfaction, public recognition and competitive advantage.

Progress towards specific policies concerning social values and objectives is reflected in the reporting of major aluminium companies. "Triple-bottom-line" reports, including corporate social responsibility, are increasingly being published and put on companies' websites.

Health and safety

Health and safety are top priorities for the aluminium industry, which compares favourably to other manufacturing industries. This is reflected in accident statistics, which have been declining at aluminium production plants, as shown in the following graph.



Investments in technical improvement, practice-oriented training, behavioural-based safety programmes and qualification measures aimed at identifying risks have all contributed to this positive development.

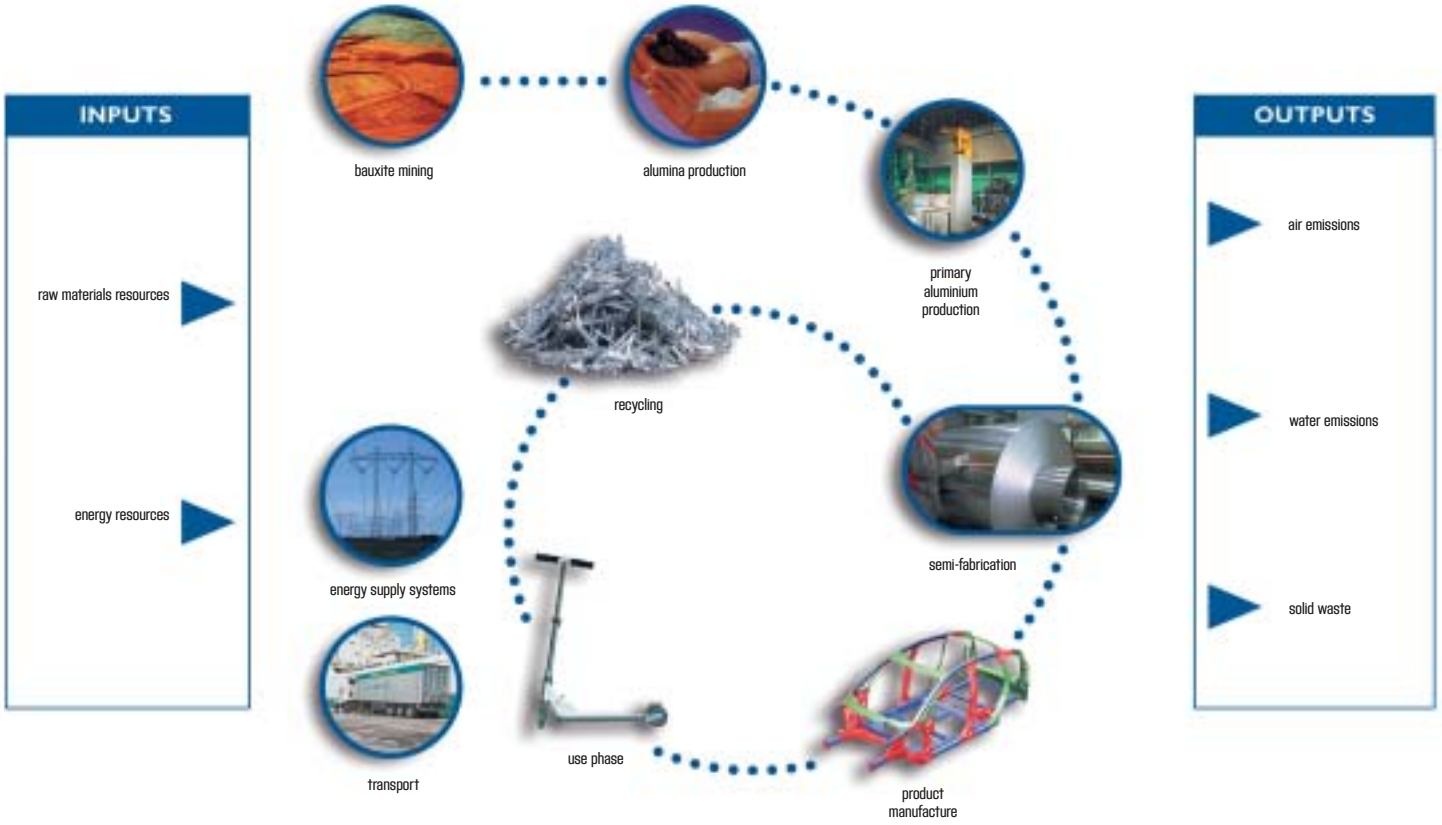
There is an increasing trend for aluminium businesses to adopt an integrated approach to management practices (and, often, certification) for health and safety, environment, and quality. Increasingly sites are going for single certification to cover ISO QS 9001:2000, EMAS / ISO 14001 and OHSAS 18001.

For the aluminium industry health and safety means: systematic approach, combining training and equipment solutions; behaviour based on safety standards normally higher than legal requirements; involvement of people, not only at work but also at home and in their communities.

In November 2002 the EAA organised the third annual safety workshop focussing on the topics of safety management and behaviour, molten metal safety and rolling and extrusion plant safety. A total of 23 presentations were made by experts from the industry to well over 100 participants. This framework not only provided a platform for “best experience” to be presented, but also provided space for discussions and questions from participants thus enabling a real sharing of invaluable knowledge and know-how. Topics discussed included, among others, root causes of accidents, protective equipment as well as changing people’s attitudes toward safety, behaviour based safety and EU safety legislation. The EAA shall continue to hold the safety workshop every year to measure progress and ensure continuous sharing.

Social aspects

Aluminium Life Cycle Inventory Analysis



Conclusions

& Appendices

Chapter 3 Three

Chapter Three

CONCLUSIONS




Conclusions

Developing and implementing a credible sustainable development strategy for an industry sector is easier said than done. Not only should the entire industry understand and support the fact that such a process is a cornerstone for continued profitability and development, but it should also be put in a position to identify, quantify and evaluate the different elements hereof in order to translate them into day-to-day business practice.

In 1998, the European aluminium industry made a commitment to continued progress. Since then, within the framework of the dialogue programme *Aluminium for Future Generations,* numerous events have been organized with stakeholders and a series of carefully identified research projects carried out. A full list of consultation events held in each country as well as a selection of studies are set out in Appendices One and Two, respectively.

This current "snapshot-report" aims to give to all those interested in following our efforts an overview of the latest developments in the ongoing process upon which we have embarked. At the same time it aims to be a basis for further discussion and therefore invites all readers to comment.

A FORM FOR THIS PURPOSE IS AVAILABLE ON THE EAA WEBSITE, WWW.EAA.NET/AFFG

It is clear that such a fundamental sustainable development process is not a one-way street. Interaction between management, workforce, local communities, regional authorities, government, NGO's and politicians is an integral part of the process. The voluntary nature of the process will guarantee a level playing field and broader acceptance of results.

Sustainable development stretches from general corporate policy to management attitude, product development, human resources, plant infrastructure and sales strategy. At the same time, it influences policy making at all levels down to rules and regulations that directly concern the competitive position of businesses like energy taxation, waste management, emission regulations, merger controls, fiscal policy and corporate social responsibility. There must be interaction and transparency at all levels in order to find the right balance.

The broad support for the *Aluminium for Future Generations* campaign in the European aluminium sector and the global character of the aluminium market will certainly be a catalyst for spin-off effects of this initiative into other parts of the world, starting with the accession countries to the European Union where the first priority is to effectively involve them in the process.

Aluminium is an irreplaceable metal backed by a valuable worldwide industry that takes its responsibilities seriously, an attitude that remains immutable.

COUNTRY	MAIN CONSULTATION EVENTS 2002 – 2003	DATES	CONTACTS
EU			
	• Conference 'Aluminium for Future Transportation – Innovation and Competitive Advantages' • Stakeholder dialogue events within 'Aluminium by Design' exhibition in Brussels • Plant visit with representatives of the European Commission (DG Environment and DG Enterprise) • Round table on sustainable development indicators, with representatives of EU Institutions, NGO's and research institutes	• 05 June 2002 • 18 February - 11 May 2003 • 20 March 2003 • 01 April 2003	European Aluminium Association Avenue de Broqueville 12 B-1150 Brussels Fax. +32- 2.779.05.31 berneri@eaa.be www.eaa.net
BELGIUM			
	• Flemish round table on aluminium, packaging and recycling • Walloon round table on aluminium, packaging and recycling	• 23 October 2002 • 26 November 2002	Aluminium Center Vlaanderen Vlamingstraat 4 B-8560 Wevelgem Fax. +32-56.41.76.36 els.aluminium.center@bckortrijk.be www.aluminiumcenter.be
DENMARK			
	• Plant visit and presentation of the aluminium life cycle from packaging to recycled material for journalists and researchers • Dialogue with municipalities on recycling schemes for aluminium • Projects supported by the Environmental Protection Agency on household waste, the use of new slag separation technology and treatment of fresh raw slag • Continuous dialogue with various stakeholders on the return of cans on the Danish market and related issues	• 11 January 2002 • throughout 2002 • 14 June 2002 - ongoing • 23 September 2002 – ongoing	Sekreteria for Aluminium & Miljø Thrigesgade 24, 3 DK-5000 Odense C Fax + 45- 66.14.53.79 alu-info@inet.uni2.dk www.alu-info.dk

Appendix I List of consultation events

COUNTRY	MAIN CONSULTATION EVENTS	DATES	CONTACTS
FRANCE			
	• Continuous dialogue on the contribution of aluminium in sustainable building (Fédération Française du Bâtiment trade fair on sustainable building, colloquium on climate change, High Environmental Quality label discussions)	• 2002 - ongoing	Communication and Institutions Boulevard Haussmann 105 F-75008 Paris Fax +33- 1.47.42.24.11 n.bouvier@cominst.com www.aluminium-info.com
	• CD-ROM 'Building in Aluminium for Future Generations', distributed to 13,000 building professionals	• March 2002	
	• Round Table on corporate social responsibility with company and stakeholder representatives	• 10 December 2002	
	• Visit of a HEQ high school and conference on the development of aluminium integrated photocells for the production of solar energy	• May-June 2003	
	• CD-ROM for academics and students on sustainable development through the use of aluminium	• June 2003	
GERMANY			
	• Dialogue with Ecofys to prepare the publication of the study entitled 'Emissions Related to the Electricity Consumption in the European Primary Aluminium Production'	• January-October 2002	GDA P.O. Box 10 54 63 D- 40045 Düsseldorf Fax: +49- 21.14.79.64.08 aluinfo@aluinfo.de www.aluinfo.de
	• Enhancing dialogue with NGO's, schools and universities	• throughout 2002	
	• Dialogue with Wuppertal Institute on sustainable development indicators	• throughout 2002	
	• Stakeholder workshops with Wuppertal Institute	• 2003	
	• Dialogue with churches and stand at the German 'Churches Days'	• 2003	
GREECE			
	• Exhibition 'Hellenic Aluminium 2002' inaugurated by the Ministry of Industry and Development	• 30 October - 3 November 2002	The Aluminium Association of Greece 115, Kifissias Avenue GR-115 24 Athens Fax +30- 210.69.85.366 alumi@netor.gr www.alunet.gr
	• Contacts with the organising committee of the Olympic Games 'Athens 2004' for the use of aluminium as a material in the Olympic Torch	• October 2002	
	• Study on 'Aluminium and Olympic Games' in collaboration with the Athens University of Economics and Business	• October 2002 - ongoing	

COUNTRY	MAIN CONSULTATION EVENTS	DATES	CONTACTS
ITALY			
	• Political round table – Aluminium and Transportation	• 07 November 2002	APCO Via dei Condotti 61/a I-00187 Roma Fax +39- 06.679.23.91 GCirieco@apco-italy.com Assomet/Centroal Via dei Missaglia 97 I-20142 Milano Fax. +39- 02.89.30.37.83 p.pizzuto@assomet.it www.assomet.it
	• Conference 'Aluminium, a New Culture of Mobility', focused on the role of aluminium in reducing the environmental impacts of transport	• 20 February 2003	
	• Dialogue with political stakeholders on energy and the definition of waste issues	• throughout 2002 – ongoing	
	• Aluminium Two Thousand	• 18/22 March 2003	
	• Aluminium Days 2003 (Alumotive)	• 06/08 November 2003	
THE NETHERLANDS			
	• Dialogue with NGO's, academia and press at the 'Aluminium Essen Fair'	• 20/22 September 2002	Aluminium Centrum P.O. Box 107 NL-3990 DC Houten Fax. +31- 30.638.55.67 ruyter@aluminiumcentrum.nl www.aluminiumcentrum.nl
	• Discussions with Feniks (bottom ash treatment) and VvAV (Association of Municipal solid waste incinerators) on increasing the recycling of aluminium from household waste	• Ongoing	
	• Dialogue with Christian Democrats in the Utrecht Province on Aluminium for Future Generations and sustainability	• 13 December 2002	
	• Round tables with politicians, policy makers, universities and NGO's	• 16 May and 19 May 2003	
NORWAY			
	• Conference and plant visit with delegates from the Ministries of Trade and Industry and Environment. Focus on competitiveness, aluminium in automotive applications, innovation and research	• 29 November 2002	Skanaluminium PB 7078 Oslo NO-0306 Oslo Fax. +47- 22.95.55.85 hd@aluminium.no www.aluminium.no
	• Official opening of the New Sunndal plant by the Prime Minister of Norway	• 03 December 2002	
	• Dinner meetings with Members of Parliament	• April and May 2003	

Appendix I List of consultation events

COUNTRY	MAIN CONSULTATION EVENTS	DATES	CONTACTS
SWEDEN			
	• Aluminium conference with industry stakeholders	• 24/25 September 2003	The Swedish Aluminium Association Box 22307 S-104 22 Stockholm Fax. +46- 8.508.938.01 johan.lidstrom@svensktaluminium.com www.svensktaluminium.com
	• Conference and plant visit to Stena Aluminium recycling plant with local parliament representatives and environmental organisations	• October 2003	
	• Conference and plant visit to Kubal primary smelter with parliament representatives and environmental organisations	• December 2003	
SWITZERLAND			
	• Aluminium Days with students and professors	• 11/12 January 2002	Aluminium-Verband Schweiz P.O. Box 71 CH-8024 Zürich Fax +41- 1.252.72.88 menet@alu.ch www.alu.ch
	• Dinner with Members of the Swiss Parliament	• 19 May 2002	
UNITED KINGDOM			
	• Dialogue with universities, research institutes, government, user industries and trade unions to update the Foresight report, which monitors any changes in the market outlook for aluminium products and reports on progress in the education and training sectors	• January 2002	ALFED Broadway House Calthorpe Road Five Ways GB-Birmingham B15 1 TN Fax. +44- 121.456.22.74 d_harris@alfed.org.uk www.alfed.org.uk
	• Dinner event with various stakeholders and launch of the ALFED's sustainability report	• 06 November 2002	
	• Annual meeting with UK Members of the European Parliament in Brussels Focus on climate change, trade, waste, competitiveness	• 19 February 2003	

INDUSTRY	
Aluminium - A Sustainable Material	German Aluminium Association - GDA
Aluminium for Future Generations - A Consultation Document, 1998	European Aluminium Association – EAA
Aluminium for Future Generations – Response of the European Aluminium Industry to the Consultation, 1999	European Aluminium Association - EAA
Aluminium in Advanced Car Design, 2003	European Aluminium Association – EAA
Aluminium - Social Aspects, 2001	German Aluminium Association – GDA
Aluminium Packaging – Tomorrow's Lifestyle Today, 2000	European Aluminium Association – EAA
Arte News – Aluminium by Design, February 2003	European Aluminium Association - EAA
Debate on Corporate Social Responsibility – A Contribution from the European Aluminium Industry, December 2001	European Aluminium Association - EAA
EAA Annual Report, 2001	European Aluminium Association - EAA
EAA Annual Report, 2002	European Aluminium Association - EAA
Environmental Profile Report for the European Aluminium Industry, April 2000	European Aluminium Association - EAA
Foresight – Aluminium Production and Use in UK in Building, Transport and Packaging 2010 and Beyond, November 2000	Aluminium Federation - ALFED
Foresight – An Update on Aluminium Production and Use in UK in Building, Transport and Packaging 2010 and Beyond, January 2002	Aluminium Federation - ALFED
Guidelines for Life Cycle Assessment of Aluminium Products	European Aluminium Association - EAA
Life Cycle Assessment and Aluminium - What you Need to Know, 2002	European Aluminium Association - EAA
Moving up to Aluminium – The Future of Road Transport, 2001	European Aluminium Association - EAA
Second Bauxite Mine Rehabilitation Survey, July 2000	International Aluminium Institute - IAI
TALAT CD-ROM, version 2.0, 1999	European Aluminium Association - EAA
The Aluminium Cycle in Greece, 2002	Aluminium Association of Greece
The Aluminium Industry Sustainable Development Report	International Aluminium Institute - IAI
The UK Aluminium Industry Progress on Sustainability, November 2002	Aluminium Federation - ALFED

Appendix II Further Reading

RESEARCH INSTITUTES	
Aluminium for the Transportation Industry in Europe, May 2002	*Egea – Univerità Bocconi*, Carmine Garzia and Edoardo Mollona www.egeaonline.it
CO_2 Emissions Related to the Electricity Consumption in the European Primary Aluminium Production, 2002	*International Journal LCA*, Matthias Koch and Jochen Harnisch (ECOFYS)
Developing a System of Sectoral Sustainability Indicators for the European Aluminium Industry, July – December 2002	*UNEP Journal "Industry and Environment"*, article by Michael Kuhndt and Christa Liedtke (Wuppertal Institute) and Jörg Schäfer (GDA)
Energy savings by lightweighting, January 2003	*IFEU Institute for Energy and Environmental Research*
Integration of the Social Dimension of Sustainable Development in Enterprise Strategies within the Aluminium Industry, 2002	*Centre d'Economie et d'Ethique pour l'Environnement et le Développement – Université de Versailles*, Sylvie Faucheux, Christelle Hue, Isabelle Nicolaï, Martin O'Connor – www.c3ed.uvsq.fr
Legislation using LCA concerning Aluminium, 2002	*CE Solutions for Environment, Ecology and Technology* – www.ce.nl
Sustainable Use of Aluminium in Buildings, December 2001	*SINTEF Civil and Environmental Engineering* – www.sintef.no
Recycling – Taking Aluminium as An Example, January 2002	*TU DELFT - Delft University of Technology*, Udo Boin
Report 194, June 2000	*The Swedish Institute for Packaging and Distribution*
The Environmental Compatibility of a Potential Increase in Aluminium Use in the Transportation Sector, 2001	*Amici della Terra*, Laura Cutaia, Giovanni Mastino, Isabella Buscema www.amicidellaterra.it
Towards a Sustainable Industry: Stakeholder Expectations and Core Indicators, March 2002	*Wuppertal Institute for Climate, Environment and Energy*, Michael Kuhndt, Justus von Geibler, Christa Liedtke www.eco-efficiency.de
Sustainability Performance Indicators for the UK Non-Ferrous Metals Industry, October 2001	*Warwick Business School*, Alyson Warhurst, Nick Dale, Magnus Macfarlane, Paul Mitchell, Deborah Webb

These lists are inclusive and not exhaustive. For any further information, please contact the EAA.

A FEW MORE WEBSITES	
www.eaa.net	(European Aluminium Association – EAA)
www.eaa.net/affg	(Aluminium for Future Generations page)
www.alufoil.org	(European Aluminium Foil Association - EAFA)
www.oea-alurecycling.org	(Organisation of European Remelters and Refiners - OEA)
www.world-aluminium.org	(International Aluminium Institute - IAI)
www.eurometaux.org	(European Association of Metals – Eurometaux)
www.euromines.org	(European Association of Mining Industries, Metal Ores and Industrial Minerals – Euromines)
www.alfed.org.uk	(Aluminium Federation – ALFED)
www.alu.ch	(The Swiss Aluminium Association – ALUMINIUM-VERBAND SCHWEIZ)
www.alu-info.dk	(Aluminium & Miljø)
www.aluinfo.de	(German Aluminium Association – GDA)
www.aluminium.no	(Skanaluminium)
www.aluminiumcenter.be	(Aluminium Center Vlaanderen)
www.aluminiumcentrum.nl	(Aluminium Centrum in the Netherlands)
www.aluminium-info.com	(Chambre Syndicale de l'Aluminium in France)
www.alunet.gr	(Aluminium Association of Greece)
www.assomet.it	(The Italian Aluminium Association – CENTROAL)
www.svensktaluminium.com	(The Swedish Aluminium Association)

Other useful links are available on the EAA website.

Appendix II Further Reading

Aluminium for Future Generations is an initiative based on consultation and dialogue.
We welcome your comments on www.eaa.net/affg

"The EAA would like to thank all associations and companies which provided photo material for this publication."

Designed by MORRIS & CHAPMAN

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