aluminium & sustainability

The Council for Aluminium in Building

CAB

'new university library', university of oxford - windows installed in 1937 by james gibbons limited - a2n©

aluminium & sustainability

a 'cradle to cradle' approach

"a combination of long in-service life, low maintenance, maximum recyclability and minimum negative impact on the environment."

Justin Ratcliffe - CAB Chief Executive

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aluminium’s wide use in construction - a2n ©

past, present and future

The global aluminium industry has made great strides during the last century to reduce its environmental impact at all stages of the supply chain. This document summarises those advances and details the current facts about aluminium extraction, refining, supply and recycling – a full cradle-to-cradle overview.

“aluminium extraction and refining companies have reduced their energy requirements by almost 70% since 1900”

Much is said these days about carbon footprint, global warming potential (GWP), embodied energy and various other ‘sound bite’ phrases which are bandied around by people who often have very little understanding of the facts behind them. Then there are many agencies and schemes that purport to establish the relative environmental impact of each material and process to give an indication of their sustainability.

“the percentage of recycled aluminium globally is increasing”

Carbon footprint and GWP relate to the production of greenhouse gases, principally during the generation of electricity or burning of fossil fuels, of which CO_2 is the most common but the least toxic. The aluminium extraction and refining companies have reduced their energy requirements by almost 70% since 1900. They are using a growing percentage, now 50%, of hydro-electric energy and have virtually eliminated the release of the more damaging gases. It is particularly significant that currently more than a third of global aluminium production is from recycled metal, a figure that is growing. Recycling aluminium takes just 5% of the energy needed to produce primary metal with a consequent reduction of 95% in greenhouse gases production.

“75% of all aluminium produced since the 1880’s is still in use”

Embodied energy is a statement of the energy it takes to produce, transport and manufacture products. For aluminium by far the highest energy consuming processes are in the production phase and, as explained above, the industry continues to reduce these energy levels.

Moreover due to its complete recyclability the ‘bank’ of processed aluminium is getting larger with 75% of all aluminium produced since the 1880s still in use for future generations to exploit as a low energy resource.

“current global thinking encompasses the full cradle-to-cradle life cycle approach”

Methodologies for the assessment of environmental impact are becoming more sophisticated and current global thinking encompasses the full cradle-to-cradle life cycle approach. Environmental Product Declarations (EPD) that embrace this principle ensure that the merits of all materials are given due credence, while those methodologies that concentrate only on part of the life cycle place undue emphasis on the initial production processes.

“responsible sourcing”

The aluminium construction industry believes totally in the need for responsible sourcing, for continued development of energy efficient processes and in the preservation of the earth’s resources for future generations.

David Earle
CAB Technical Officer

Justin Ratcliffe
CAB Chief Executive

properties

Lightweight, strong and long-lasting

Aluminium is a very light metal with a specific weight of 27 g/cm^3, about a third that of steel. Its strength can be adapted to the application required by modifying the composition of its alloys.

Highly corrosion resistant

Aluminium naturally generates a protective oxide coating and is highly corrosion resistant. Different types of surface treatment can further improve this property. It is particularly useful for products where protection and conservation are required.

Excellent heat and electricity conductor

Aluminium is an excellent heat and electricity conductor and in relation to its weight is almost twice as good a conductor as copper.

Good reflective properties

Aluminium is a good reflector of visible light as well as heat and that, together with its low weight, makes it an ideal material for reflectors in, for example, light fittings or rescue blankets.

Very ductile

Aluminium is ductile and has a low melting point and density.

Completely impermeable and odourless

Aluminium, even when it is rolled to only 0.007 mm thickness, is still completely impermeable and lets neither light, aroma, nor taste substances transfer.

Recyclable

Aluminium can be recycled again and again without loss of quality. The re-melting of aluminium requires little energy; it saves up to 95% of the energy required for primary aluminium production.

Aesthetics

Versatile in its ability to accept different surface finishes, for example, anodising and powder coating.

aluminium, architecture and sustainability

This report by CAB sets out the credentials for aluminium as a sustainable material, useful in the construction of contemporary architecture. In its primary form aluminium is a high-energy product, it has a high embodied energy. However, designers and specifiers over the past 40 years have learnt to consider the selection of materials carefully, beyond fashion and first cost. Using a little of a high energy material wisely and purposefully is a more sustainable strategy than the ideological selection of materials. When preparing a specification it is essential to consider the responsible sourcing, effectiveness, durability, and the potential recycling of any material. BioRegional in its report on the Bedzed housing development, designed by Bill Dunster Architects, noted that:

"The embodied energy of a material needs to be considered over the lifespan of the material, for example aluminium is a highly durable material with a long lifespan of [over] 60 years and therefore is an appropriate solution … despite its high embodied energy."

Over 25 years ago I drew my first aluminium extrusion, the trial section was on my desk within three weeks. The drawing had precisely been transformed into a component that provided an interface between a preparatory louvre system and a composite cladding system I had designed. The aluminium extrusion produced a fine detail that performed mechanically and environmentally, the total opposite of an ugly, 'gunked up' on-site detail, which is far too common and often accepted in everyday construction. Aluminium is a route to building better buildings which are beautiful and perform well. All participants in construction should minimise risks whilst delivering a high quality built environment for the end users, a group to which we all belong. Design excellence is therefore a vital part of sustainability.

The aluminium industry is one of the pioneers of modern methods of construction and an example of successful prefabrication. Jean Prouvé, the inventive 'metalworker' designed and specified unitised aluminium curtain walling for a school in France in 1949. Aluminium can provide 'mass customised' components for individual projects with zero waste and predetermined performance characteristics.

"Only 5% of original energy to recycle aluminium - a step change like a car going from 35 miles per gallon to 700 miles per gallon"

Recycled aluminium only takes 5% of the energy to produce when compared to winning aluminium from bauxite. This is like a car that averages 35 miles to the gallon being able to travel for 700 miles per gallon, significantly further than the distance between London and Berlin. This is the type of step change that is needed as we face the risk of global warming. Aluminium can be recycled over and over again without loss of performance and it can be up-cycled if necessary. Aluminium is not like a fossil fuel – once used it is consumed – about 75% of the aluminium produced since 1888 is still in use. This represents the sequestration of 47800 Petajoules of energy – the same as the top 5 countries across the globe producing hydro electricity for over 8 years. Are we becoming a post-consumer society where the everyday recycling of packaging enhances the cultural perception of aluminium as a sustainable material? Recycling rate of aluminium packaging in Britain is only about 30% whereas the Delft Report, cited in this document, shows recycling rates from buildings of 92 to 98%.

In the design of Ballingdon Bridge, working with Arup, I realised that purpose-made aluminium extrusions could form part of the visually open balustrade of this new trunk road bridge in Suffolk. To the general public this looks like 'an ordinary' guarding system, yet it is strong enough to stop a 42 tonne truck from crashing into the river Stour. English Heritage supported the planning application, set in the context of listed buildings, for this modern bridge 'because of the depth of the sustainability embodied in the design'. It has since won an award from the Campaign for the Preservation of Rural England. There have been bridges on this site since the tenth century – the current bridge has a minimum design life of 120 years and aluminium forms a key part of this project. Aluminium is a vital material in the creation of high quality architecture and infrastructure; it can form a key component in the creation of a sustainable future.

Professor Michael Stacey
Michael Stacey Architects

most plentiful metal in the earth's crust

Aluminium is the third most abundant element and the most plentiful metal in the Earth's crust. It is most commonly present as 'bauxite', the ore from which primary aluminium metal is produced.

Bauxite is a reddish mineral that is normally found about half a metre under the topsoil in a layer between three and five metres deep. The presence of bauxite so close to the Earth's surface allows the ore to be extracted by a process known as open-cast strip mining. This method involves heavy earth moving equipment extracting the bauxite from shallow, low area, open pits. Mined bauxite resembles small red pebbles, called pisolites, averaging about five millimetres in diameter.

"only 5 km^2 is being mined at any one time"

Plentiful, rich supplies of bauxite are available in Australia, West Africa and the West Indies along with other tropical and sub-tropical regions around the globe. Only around 10% of bauxite mining takes place in rainforests and it is estimated that out of 14,000,000 km^2 of tropical rainforest less than 5 km^2 is disturbed at any one time.

Known reserves of high quality bauxite are sufficient to provide over 300 years supply at current consumption levels and, with increasing levels of recycling, there is little possibility of exhausting the supply of this valuable ore.

Bauxite miners work very closely with local communities to ensure that the environmental impact of mining is minimised while supporting various social programmes, such as community health initiatives and developing infrastructure and supporting industries that will benefit the communities into the future. Bauxite mines in current operation have an average life expectancy of around thirty years, so miners are committed to the sustainable development of the areas and communities in which they operate.

"97% of all bauxite mines in the world today have formal, written rehabilitation procedures in place"

The International Aluminium Institute (IAI) has been collecting and reporting industry performance data on the rehabilitation of these bauxite mines globally since 1991. The latest report from 2005 includes results from 23 operations which together supply 70% of the world's demand for bauxite. It reports that over 97% of all bauxite mines in the world today have formal written mine rehabilitation procedures in place. The IAI plans to publish an update on mine rehabilitation in 2008.

Prior to extraction of the bauxite from the strip mine much of the topsoil and some of the original flora is gathered for safe keeping in nurseries. In some instances endangered species of animals and reptiles are also gathered. Once the bauxite has been removed the site is quickly restored using the original materials thereby minimising the environmental impact. This process is known as the 'rehabilitation process' and it forms a major part of any mining undertaken in all parts of the globe.

"mining companies monitor the rehabilitated sites"

Some mining companies actively grow local native species in nurseries during the mining operation in order to minimise the time for the rehabilitation process. Many

bauxite processing - norsk hydro ©

of the mining companies monitor the rehabilitated sites for several years after they have been returned to their native state to ensure that replaced planting and landscapes are performing well.

Identifying the possible environmental impacts of mining and establishing procedures to mitigate these impacts is a key element of sustainable development. Erosion, for example, is a major issue for the mining operation as many mines are in, or near, areas of rainforest. When the vegetation is removed there can be a significant amount of erosion with surface water run-off. Careful design of

bauxite storage - norsk hydro ©

the mining operation with provision for catchment pools for any possible run-off ensures both site stability and minimal impact on the surrounding area.

Dust can also be problematic and strategies are in place at mines where this is deemed to be an issue. Strategies include the use of water to keep dust from entering the air on unmade roads, covers for vehicles transporting the bauxite ore and mechanical methods of extracting dust from air when there are ore crushing facilities at the mining operation.

"two thirds of all employees are from the local community"

The vast majority of global mining operations have strategies in place for minimising noise, the spread of weeds, possible emergencies involving spillages, floods and earthquakes.

The local communities are encouraged by the mining companies to become involved in the operation. Two thirds of all employees in the major mines currently operating around the globe are from the local community. Most mines also report paying salaries above the national average and also invest heavily in local facilities for their workers in the local community.

The mining companies are rightly proud of what they are achieving in the sustainable production of bauxite and alumina for our aluminium industry and many reports and documentaries, company and independently produced, are freely available. Mines conduct tours of their operations for education and tourism in order to communicate the wider benefits of the use of aluminium and the minimal impact the material has on our planet's precious resources.

alumina

Through the 'Bayer' chemical refining process bauxite is transformed into aluminium oxide (Al_2O_3) or 'alumina', the feedstock for the aluminium smelting process. Refining can be carried out close to the bauxite supply mine thus reducing transport costs and increasing efficiency; alternatively some mines ship their ore in bulk to major refineries.

The Bayer process uses caustic soda at high temperatures to extract alumina from the bauxite ore. The resulting solution is then left to settle so that the alumina can crystallise and be drawn off, filtered then kiln dried at 1100C. The resulting product has a similar appearance to flour. The caustic soda is recycled for efficiency.

The extractable alumina content of bauxite varies between 31% and 59% by weight with an average of 41%. In general four to five tonnes of bauxite yields two tonnes of alumina, which in turn produces one tonne of aluminium.

Not all alumina is converted into aluminium and some of it, for example, goes to the pharmaceutical and chemical industries for medical applications. The vast majority, however, is reduced to aluminium, primarily using the Hall-Héroult electrolytic process invented in 1886.

"Hall-Héroult Process"

Alumina is dissolved into molten cryolite (sodium aluminium fluoride) within a large carbon lined container known as a 'pot'. A carbon anode (positive) is lowered into the cryolites and, with the pot lining acting as a cathode, (negative) a direct current with very high amperage and low wattage is passed through the electrolyte. The electrolytic process strips the alumina of its oxygen atoms, reacting with the anode to produce carbon dioxide and depositing molten aluminium at the bottom of the pot. The aluminium is regularly drawn off into a holding furnace for further processing.

The aluminium at this stage can be alloyed for various end uses or it can also be sent to be cast as 99.7% pure aluminium. Aluminium is cast into ingots, rolling slabs or extrusion billets (log shaped). Aluminium can then be shipped to production plants which convert the aluminium into sheet, castings or extrusion products.

New primary aluminium smelting plants use higher currents and several 'potlines' which typically consist of 300 pots. Production from some of the largest smelters can be as high as one million tonnes per year.

"energy to produce prime aluminium has reduced"

The use of electrical energy to produce primary aluminium has been reduced since the 1880's by 70%; it now takes just over 15 kWh to produce one kilogram of aluminium from alumina and this figure continues to drop. This conversion takes place at 900C but the melting point of aluminium is 660C so in some smelters this excess heat is used to blend in some recycled material. With the recycled aluminium process using only 5% of the energy to melt compared to primary aluminium production it is an efficient process to use as much recycled material as possible. The resulting recycled aluminium has the same properties as the primary metal.

cell room - norsk hydro ©

cell room - norsk hydro ©

"50% hydro-electric power"

The energy used in the production of primary aluminium is extensive and up to 50% of all the energy required globally is now being provided from renewable sources such as hydro-electric power stations.

"5% of the original energy to recycle aluminium"

As it takes only 5% of the original energy to recycle aluminium it makes sense to recycle where we can. One of aluminium's greatest strengths is that it can be recycled repeatedly without any loss of its original qualities.

Two main forms of scrap can be identified, 'new' or 'process scrap' which occurs during manufacture of products and 'old' or 'recycled scrap' which occurs at the end of the product life.

Process scrap is already in the blended alloy form being used by that company so is easy to melt and reuse. Recycled scrap is a little more complicated as it is often associated with impurities such as thermal breaks, finishes, and hardware fixings. Recycled scrap is normally separated into a range of categories where there are similar impurities prior to being melted in a 'rotary-tilting furnace'.

"rotary-tilting furnace"

The rotary-tilting furnace traditionally melts the aluminium with salt flux which is used to separate the metal from its oxides known as 'slag'. As the contents rotate in a sealed cylinder the impurities collect in the salt flux to form a slag. The 'molten' aluminium and the slag can be tapped off separately. The salt flux can be recovered from the slag leaving only a residue of oxides. To further reduce costs and improve efficiency the expensive salts are now being replaced with a new salt free system known as 'phase separation' which is more economic.

The molten aluminium is then tested using spectroscopy on a sample of the material. This will determine what refinements will need to take place to ensure the aluminium is brought back to a recognisable alloy. In the case of aluminium for windows and curtain walling this alloy is normally 6060 or 6063 finished in either T5 or T6 heat-treated conditions to give enhanced properties.

"Aluminium for Future Generations"

The 'Aluminium for Future Generations' initiative, developed by the International Aluminium Institute, monitors the flows of aluminium globally. In 2006 production comprised 34 million tonnes of primary aluminium and 16 million tonnes of recycled aluminium from used products, which together met the increasing worldwide demand for aluminium.

from metal to product

Aluminium is used in construction in three basic forms, each of which have their own unique benefits; extrusion, rolled and cast. Extrusions can be provided in various lengths up to a maximum of about 7.5 metres and can be intricate in shape. Rolled or sheet aluminium can be pressed into various shapes for all types of uses from wall panels to flashings. Aluminium can be cast into very complex shapes whilst maintaining light weight and high corrosion resistance. Each form of aluminium can be used by itself or in combination to provide unique building solutions.

One very important factor over other materials and metals is the saving in energy during transportation. As aluminium is so light, energy used in shipment is lower for the same 'mass'. Taking this further into the lifting on site, the design of lighter weight aluminium structures needing less support, the advantages of using aluminium in today's competitive construction market become clear.

Extrusion

After the alloy formulation the molten aluminium is cast into cylindrical 'billets' or 'logs' which are designed to fit specific extrusion presses.

Presses vary in size and are usually categorised by their capacity, which is determined in tonnes pressure. The size of profile that can be produced is directly related to the press rating.

Once extruded the profiles are 'work hardened' by being stretched and are then cut to length and placed in stillages for the final stage of age hardening, usually in an oven, to further strengthen the aluminium alloy. The 'ageing' process is added to the alloy reference in the form of a 'T' code: T4 is naturally aged ideal for bending extrusions, T5 is aged after extrusion at about 170C and T6 is a more complex combination of solution and ageing treatments.

Rolling

Aluminium alloys can be rolled into sheet products used in cladding, roofing and roofline products and, since the arrival of CNC machines, many complex products can be made at competitive prices.

Aluminium is cast into large rolling slabs which are fed into rolling mills which turn the aluminium into sheets of various thickness. Normally the process starts with a hot rolling method taking the block back and forth through a reducing roller. Final rolling is through a cold roll process and the sheet can be taken down to 0.15 mm thickness.

The thicker sheet can be cut to form solid objects which can be further machined to form complex shapes. Thin sheet can be formed into structural sections and thinner sheets still can be profiled or pressed into shapes for use as cladding panels.

The sheet can undergo further reduction in thickness down to foil of 0.007 mm thickness where it can be used as an applied surface to another sheet material, offering an impermeable barrier to water whilst also reflecting heat energy with very low weight penalty.

Casting

Aluminium is one of the few metals which can be cast in all the metal casting processes thereby offering the widest use of the metal in construction. The most common methods include die casting, permanent mould casting and sand casting. Castings can also be made to virtually any size and for the architect this offers a flexible material to work with offering few restrictions in design.

Castings are often further modified by machining and, where appropriate, other materials can be added to form bearing surfaces for fixings and moving parts.

One of the most well known cast uses, and one of the oldest uses of aluminium, is the statue of Eros in London which was designed by Sir Alfred Gilbert and cast in 1893. In 1990 aluminium specialist Henshaws in Edinburgh removed the statue for repair and maintenance after vandals damaged the outstretched leg; otherwise it has withstood the atmosphere for over 100 years in pristine condition.

extrusion process - a2n ©

Finishing

Aluminium is one of only a few metals which can be left in its natural state without finishing. The front inside cover of this report shows the facade of the ‘New University Library’ in Oxford which still looks good despite the 70 year old aluminium windows not having any protective finish.

For today’s market advanced finishes are now available which take either of two basic forms; anodising which is an even oxidation of the surface of the aluminium and powder paint coatings which are available in all colours.

Aluminium will naturally oxidise when exposed to air and this thin film of oxide then fully protects the aluminium from further oxidation. Should the surface be damaged the aluminium simply oxidises again to protect itself. Anodising is an electrolytic process which accelerates the oxidation process and leaves the aluminium with a thin clear film of oxide many times harder than the aluminium and very resistant to wear. Metallic dyes can be sealed into the anodising which give colour due to reflectance and will never fade.

Powder coatings are applied in various forms using carefully controlled processes, making the coating of aluminium safe for the environment. Powder coating offers a wide range of colours and textures and gives aluminium a lifetime of protection.

Thermal Barriers

Whilst aluminium has a very high strength to weight ratio and has excellent corrosion resistance its insulation properties are quite low. Where aluminium frames and profiles are in contact with the outside and inside of the building as in a window, door or curtain wall they are designed with high performance thermal breaks.

The majority of new products are insulated using strips of polyamide, a glass-reinforced nylon. Basically two separate profiles are joined together usually using two strips of polyamide as an insulation medium. Two benefits of using polyamide are that profiles can still be powder coated up to 200C when joined and, if joined after powder coating, the profiles can offer differing inside and outside colours.

Becoming less widely used is the ‘resin fill and de-bridge’ technique which has been very popular in the last three decades. With the increased demand for thermal efficiency of windows resin fill has struggled to keep up with the requirement for higher insulation levels. This could change however, as resin formulations have recently improved significantly.

Composite Materials

Aluminium composite systems and aluminium clad systems are a combination of aluminium and other materials put together to form a full range of door, window and curtain wall products. The benefits of using modern manufacturing techniques combined with the excellent weathering capability of aluminium forms a traditional looking product with a high life expectancy.

sustainable

The largest use of aluminium, primary and recycled, is in transport which takes up 36% of the total produced per year in Europe. Following closely at 25% is building and construction. The importance of aluminium in the construction industry cannot be denied and the material is being used in ever more innovative ways by designers and specifiers.

Buildings constructed primarily of aluminium are lighter and require less groundwork in the form of foundations. Because they are light they need less energy to transport and less energy to erect on site. One of the earliest forms of off-site construction was the humble post war 'pre-fab' which was needed in thousands to re-house families after the second world war bombing destroyed many UK homes. These prefabs were built on a commercial scale and many still survive. Some were built from aluminium recycled from WW2 aircraft and are still lived in today. Homes which were intended for a 3 to 5 years life have survived over 60 years, a testament to aluminium's long service life. Many have been awarded 'listed building' status in recognition of their vital contribution to the development of building materials.

Whilst the 'all aluminium' buildings are products for the future, aluminium in component form is on the increase in our building structures and will continue so with its unique properties and plentiful, recyclable supply.

In commercial buildings aluminium is often visible as the structure used for carrying glazing in windows, doors and curtain walling. It is also very noticeable when it is used in cladding and roofing applications. This may not be as evident to everyone as finishes vary a great deal to meet the specifier's design. Quite common today is the use of

aluminium prefab in redditch - kalzip ©

new castle house - nottingham - a2n ©

grey powder coated aluminium in fenestration products, there is even a terracotta 'look-alike' aluminium cladding system.

Internally aluminium is being used in partitions, ducting, light fittings, suspended ceilings, hardware, to name a few. In fact it is difficult to think of a modern building where aluminium does not play its part in the construction process. Even during the building phase we now have aluminium scaffolding.

New Castle House

Built in 1935 by Sir Owen Williams, New Castle House was an early concrete structure which was pioneered by this famous architect and engineer. Designed on a 'post and slab' structure in reinforced concrete and then clad in ornate stone and glass, New Castle House was one of the original Boots office buildings in Nottingham. Originally the ribbon windows were designed in steel, but 21 years ago, in 1987, the building was fully refurbished as a listed building leaving the main facades in place and using a slim aluminium curtain wall system to replace the single glazed, non-insulated steel fenestration.

Around the back of the structure new modern access requirements were formed and clad with aluminium. As you would expect the structure looks no different today than it did when it was refurbished. The aluminium and its powder coated finish show no signs of weathering and are set to perform for many years yet.

The design of the curtain walling ensures that the external weatherseals are well protected from UV degradation by the aluminium capping on the curtain wall pressure plate which covers most of the exposed gasket. The very slim 50 mm lines of the 'new' curtain wall closely match that of the original steel structure but require virtually no maintenance apart from a regular cleaning programme.

Aluminium was the perfect choice for this refurbishment as it provided a low maintenance solution which closely matched the existing steel system whilst offering improved thermal and sound insulating properties.

New University Library

Aluminium windows were installed in the 'New University Library' at Oxford University nearly 70 years ago, further highlighting aluminium's extraordinarily long service life. The building, designed by Giles Gilbert Scott and built between 1937 and 1939, was a much needed addition to the Bodleian Library whose collections are used by scholars from around the world.

window at the new university library - oxford - a2n ©

Toby Kirtley, Estates Projects Officer for the Oxford University Library Services, commented that they were amazed at the quality of the windows which had been in the building for almost 70 years. These windows were installed with no anodising or powder coating, leaving the surface to naturally oxidise to form a protective finish.

The Estates Department undertook cleaning twice a year and only serviced any of the windows if a piece of glass broke and needed replacing. The hardware was all original and had been designed with brass bushes for a good life expectancy. The aluminium casement windows and window furniture were supplied by James Gibbons Limited of Wolverhampton.

The New University Library was commandeered by Navy Intelligence shortly after completion and much of the D-Day photography was processed and reviewed in the building. The building also became a repository for all of the work being carried out at the time in WW2 code-breaking. In 1946 the building was eventually handed back to the University and was opened by H.M. King George VI, on October 24th. Giles Gilbert Scott, the architect, is also remembered for his design of the Battersea Power Station and the famous British red K2 telephone box, amongst many other British landmarks.

Off-site Construction at BAA

Aluminium was extensively used at Heathrow Airport in a large project to form additional pier corridors for passengers. Aluminium was chosen for its light weight and long life expectancy and these features enabled the project to be completed with virtually no disruption to the 20 hours a day, 7 days a week operational status of the airport.

The concept was to build each of the new corridors in transportable modules which consisted of a steel pan and aluminium frame for structural rigidity, complete with all services, aluminium external envelope and all internal finishes and fittings which were to be installed on site.

Modules were constructed in a specially designed production facility off-site at Gatwick. As units were completed they were transported by road to Heathrow. Each of the completed modules was then stored just off the landing apron ready to be moved to the pier and lifted into place.

Whilst the modules were under construction, the roofs of the existing passenger piers were prepared and set out to accept the new pieces of the corridor which were to be lifted into place. This process of construction minimised disruption to the busy routine of the airport.

During the daily closure of the airport, early in the morning hours for routine maintenance and cleaning, the corridor modules were carefully taken to the pier where they were lifted into place to be located with prepared access and services.

The finished project is not recognisable as being prefabricated. The use of light, high quality materials and the attention to detail has created a structure which will have a life expectancy similar to that of the building to which it is fitted.

Aluminium was the perfect choice for a project of this nature offering a lightweight structure with high load bearing capacity and needing the minimum operational maintenance regime.

Unitised Construction

Modern construction methods harness the strengths of aluminium and this is most visible in facade installation. Once the preserve of high rise multi-storey offices, unitised facade technology is now finding its way into much smaller projects.

Systems companies are now designing and providing high performance glazed facade systems from stock. A growing number of UK fabricators have installed equipment to handle large interlocking pre-glazed panels which are taken to site for immediate installation. This results in much quicker installation times over other methods of construction, vital in the crucial phase of the programme to watertight the property before the second fix services can begin.

Aluminium is extensively used in the outer fabric of buildings, either in the form of interlocking panels or rainscreen systems which can be very simple or quite complex. As with all unitised forms of construction the benefit is in the quality of construction which is achieved on site at a reduced cost over alternative more traditional materials and methods.

The use of off-site construction, including lightweight aluminium materials, has significantly increased in recent years and has helped to replace old building stock with modern higher efficiency structures. Aluminium is now playing its part in the renovation of existing buildings offering sustainable solutions.

pier corridor - heathrow airport - a2n ©

valuable

The high intrinsic value of aluminium building scrap has always been the main impetus for recycling, independent of any legislative or political initiatives.

A Delft University study showed that the end-of-life collection rates for aluminium in the building sector were found to vary between 92% and 98%, demonstrating aluminium's pivotal role in the pursuit of sustainability in construction. The old Wembley stadium was one of the projects monitored by the Delft team and it attained a 96% recovery rate. Typically the 4% loss was due to handles, hinges and similar small items being lost in the deconstruction process. As more sophisticated recovery procedures are introduced even these items are now being captured.

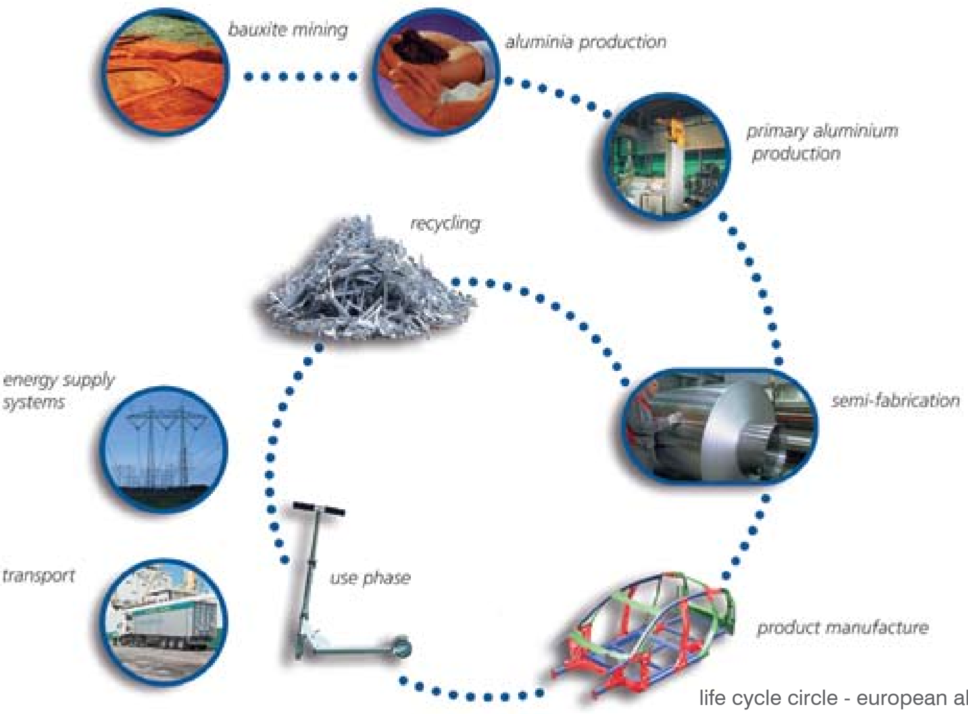
Aluminium scrap has high value due to the high embodied energy stored within it, resulting in a 95% saving on energy costs over those incurred in primary metal production. Furthermore, since its atomic structure is unaltered during the refining process, aluminium can be recycled again and again without loss of physical properties or value.

"96% aluminium recovery from the old Wembley"

Aluminium enjoys a 'cyclic' economy as most aluminium products are not consumed, merely used. Hence it is renowned for its 'cradle-to-cradle' life cycle where, for instance, the material from an aluminium can could end up in a curtain walling extrusion or vice versa. Neither does the age of the material have any adverse effect on its recyclability and, equally important, new and recycled aluminium have virtually the same value.

As aluminium is such a recyclable material we are beginning to build up a 'bank' of aluminium in use and the aluminium industry has set up an initiative to help communicate this in the industrial sector. The Aluminium for Future Generations programme monitors this bank of aluminium, looking at the inputs, the bank in use, and any losses. By analysing this data we can maximise our use of the material in all walks of life. Of products in use, building takes the largest share at 31% of the total.

Primary aluminium entering the 'bank' will be recycled many times over in the coming centuries at only 5% of the initial energy used to produce the aluminium from bauxite.



life cycle circle - european aluminium association ©

Remelting

Since 2003 the European Standard EN 13920 (parts 1 – 16) on aluminium scrap, which covers all scrap types, has been considered the norm for aluminium scrap classification.

Unlike some other materials aluminium can be of any age, from off-cuts during fabrication to scrapped windows which are decades old. Before being loaded into the furnace it is standard practice to separate alloy-specific batches to help achieve a precise alloy composition in the final product. This highly economic computer controlled process maximises the financial benefits while minimising the environmental impact of the aluminium refining and remelting processes. Once the aluminium is melted down the 'mix' can be adjusted by adding further alloys to bring the resulting aluminium up to a predetermined quality. The final product may be the same as the original (window frame – window frame) or a completely different one (cylinder head – gearbox).

Finishes to the aluminium are simply burnt away in the melting process and any noxious gas emissions are collected in efficient fume capture equipment. Non-metallic components end up in the salt slag, an inert substance skimmed from the molten aluminium. After mechanically extracting any aluminium the remaining dross is used in the cement industry. Thermal breaks of plastic or resin are either mechanically separated or simply burnt away in the process, the heat being captured and used in the refining process. Whilst the aluminium scrap value per tonne is slightly less for coated and thermal break aluminium, 100% recovery of the aluminium is possible.

In many instances aluminium is combined with other materials during manufacture such as stainless steel screws and fixing plates. These are either separated mechanically or manually from the aluminium or the scrap is fed into a special furnace that separates the iron thermally. These items melt at a higher temperature than aluminium and are also much heavier and as a result they fall to the base of the furnace, ensuring 100% aluminium can be tapped for recycling.

If all aluminium applications were grouped together the average global recycled content (excluding internal scrap) would stand at around one third overall. In reality recycled content varies substantially from one product to another. With the continued growth of the aluminium market and because most aluminium products have a long lifetime – in the case of buildings potentially more than 100 years – it is not possible to achieve high recycled content in all new aluminium products, simply due to the shortfall in the availability of recyclable material against total demand.

Furthermore, recycled aluminium is used where it is deemed most efficient in economic and ecological terms.

Directing the scrap flow towards specific products in order to achieve a high recycled content in those products, would inevitably mean a lower recycled content in other goods. It would certainly result in significant inefficiencies in the global optimisation of the scrap market as well as wasting transport energy with increased greenhouse gas production.

Calls to increase recycled content in specific product categories thus make no ecological sense whatsoever.

Life Cycle Analysis

The only way to assess the true sustainability of aluminium is to consider the complete life cycle and, where appropriate, how the recycled material can be best used. Many materials are recyclable to a limited extent, but few have such high recyclability credentials as aluminium. The methodology used in the BRE Green Guide limits the results by its simplistic concentration on cradle-to-factory gate values whereas the Environmental Product Declaration developed by the EAA takes into account the full life cycle thus meeting the definition in EN ISO 14040:


aluminium poured into ingot moulds - a2n ©

"quantified environmental data for a product with preset categories of parameters based on the ISO 14040 series of standards, but not excluding additional environmental information".

This method of overall analysis seems to be the most logical and is set to become the standard worldwide.

An important aspect of EPD's is to provide the basis of a fair comparison of products and services by their environmental performance. EPD's can reflect the continuous environmental improvement of products and services over time and are able to communicate and add up relevant environmental information along a product's supply chain.

Responsible Sourcing

The UK Government continues to promote the requirement that all products should be responsibly sourced. This includes such items as sustainable product manufacture throughout the supply chain with regard to the environment, health and safety issues, local infrastructure and the treatment of supply chain workers.

Aluminium has an enviable track record in this respect with a number of international bodies monitoring environmental and personnel issues. CAB is currently working with the International Aluminium Institute and other organisations to develop a sector scheme for aluminium both in the UK and globally.

Using aluminium, the specifier can be safe in the knowledge that the material can be easily and safely recovered from the building, is readily transported in bulk due to its light weight and has an extremely high recyclability.

"Indeed, considerations of sustainability must include the environmental, economic and social aspects and in all of these areas aluminium production, fabrication, end-use and recycling has a formidable record."

aluminium ingots - a2n ©

associations

ALFED - Aluminium Federation
http://www.alfed.org.uk

CPA - Construction Products Association
http://www.constructionproducts.org.uk

CWCT - Centre for Window and Cladding Technology
http://www.cwct.co.uk

EAA - European Aluminium Association
http://www.eaa.net

FAECF - Federation of European Window and Curtain Wall Manufacturers' Associations
http://www.faecf.org

IAI - International Aluminium Institute
http://www.world-aluminium.org

ICMM - International Council for Mining and Metals
http://www.icmm.com

OEA - Organisation of European Aluminium Refiners and Remelters
http://www.oea-alurecycling.org/indexen.php

EPD's - The International EPD System
http://www.environdec.com

government departments

DEFRA - Department for Environment, Food & Rural Affairs
http://www.defra.gov.uk

DBERR - Department for Business, Enterprise and Regulatory Reform (was DTI)
http://www.berr.gov.uk

DCLG - Department for Communities and Local Government
http://www.communities.gov.uk

DFPNI - Department of Finance and Personnel Northern Ireland
http://www.dfpni.gov.uk

The Scottish Building Standards
http://www.sbsa.gov.uk

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