Touching the earth lightly...

Australian steel's role in a sustainable world.

AUSTRALIAN STEEL INSTITUTE

Contents

COVER IMAGE: The winning project in the Architectural Steel Design category of the ASI Steel Awards – Queensland 2007. Located on a ridge beside Mount Cooroy on the verge of the Sunshine Coast hinterland, the building was designed by John Mainwaring (Design Architect) and Paolo Denti (Project Architect) of JMA Architects to seemingly float on the side of the hilltop like a box kite and to be completely self sufficient in terms of water, electricity and sewage. Photographed by Peter Hyatt.

Australian steel's role in a sustainable world

"Steel's high strength to weight ratio makes it the ideal material for adding extensions to existing buildings. Sophisticated design and modeling of steelwork often enables refurbishing and upgrading without the need to recast foundations or substantially reinforce the existing structure. Getting greater use and efficiency from an existing building is good environmental practice."

TRISTRAM CARFRAE, Principal, Arup

"Modern steel affords builders the flexibility to plan and build-in provisions to allow for cost-effective extensions and expansion of services later on, in effect 'future-proofing' buildings. For example the Brisbane Airport car park was designed to allow additional stories to be added when the need arose without disruption to the existing site. This design for future needs is great environmental practice."

GRAEME SMITH, Principal, Rice Daubney Architects

"With increasing onus on building sites to minimise waste, steel has the advantage of pre-fabrication off-site. Pre-fabrication of steel off-site eases waste removal issues on building sites, a real boon in today's environmentally aware times. The minimisation of material waste at the source is good environmental practice."

ALISON MIRAMS, Regional Construction Director, Brookfield Multiplex

The discovery of iron and its later refinement to steel was a key milestone in civilisation's advance. Its toughness and strength enabled Iron Age man to control his surroundings, develop agriculture and build better buildings. Centuries later the steam-driven machines which ushered in the Industrial Revolution also demanded those qualities and a great deal more. The iron of the Iron Age was to become steel, tougher and stronger than iron and available in abundance through the invention of large scale Bessemer and open hearth steelmaking processes.

Today steel is the everywhere material used for ships, railways, cars, appliances, machines, tools and implements, drums and cans and in every conceivable form in the construction industry. Life without steel would be hard to imagine in our modern society.

Fortunately steel has solid credentials that can uniquely contribute towards sustainable life on our planet for a long time to come.

The Australian Steel Institute (ASI) representing Australian steel manufacturers, steel distributors, steel fabricators and engineers, designers and architects working in steel has published this brochure to tell the steel sustainability story.

The everywhere material

Much in today's world involves steel in its manufacture or is itself made of steel. Its versatility allows it to be used in a wide range of products and applications so we see it in motor car bodies where it is malleable to allow it to be pressed into the intricate shapes sought after by the stylists and we also see it in excavation equipment where it is tough enough and hard enough to move Earth.

Worldwide a little over 1.3 billion tonnes[1] of steel are produced and consumed annually and this figure is growing year on year as developing economies expand, especially in China and India. There is strong global competition in steel with about one-third of all steel produced being traded across international borders.

The Australian steel industry produces about eight million tonnes of steel a year[2] and including all of its steelmaking, manufacturing and distribution activities has a turnover of $29 billion and employs 91,000 people earning $4.6 billion in wages (ABS data 2005/06).

Image courtesy of BlueScope Water

Image courtesy of BlueScope Steel

steel

Our many automotive, packaging and other industrial and manufacturing companies consume significant quantities of Australian steel, but the largest proportion goes into buildings of all descriptions and construction associated with resource and energy development, transport and other infrastructure.

Steel in building and construction bolsters Australia's continuing development, whether it is structural beams for buildings and bridges, pipework for water supply or the iconic 'corrugated iron' nowadays transformed into the sophisticated COLORBOND® steel and ZINCALUME® steel claddings which we see everywhere.

So steel plays a vital role in our world of today and tomorrow. Its unique material qualities can greatly contribute to Australia's sustainable development.

There is very little in today's world which does not involve steel in its manufacture.

From abundant ingredients

The primary source of steel is iron ore which is one of the most abundant minerals in nature with known global reserves of 800 billion tonnes or about 400 years' supply at current usage rates of 1.8 billion tonnes a year (according to the latest International Iron and Steel Institute (IISI) figures on ore consumption).

Ore bodies are found in many parts of the world but their iron content varies considerably, ranging from less than 30 percent in parts of Europe and China to more than 60 percent in Australia and Brazil. Higher iron content ores require less energy per iron unit to transport and generate lower volumes of slag in the smelting process and consequently are in high demand. Australia produced 275 million tonnes of iron ore in 2007.[1]

There is also a significant secondary source of steel which is steel scrap.

The IISI's *World Steel in Figures* reported that in 2007 the world steel industry consumed 482 million tonnes of scrap to make 1.342 billion tonnes of steel, meaning that 36 percent of world steel production is from recycled material.

Unlike many other materials, steel can be recycled again and again with reprocessing techniques maintaining its properties and qualities.

36 percent of world steel production is from recycled material.

OneSteel's recycling business in Australia employs 600 people across 37 locations collecting and trading nearly two million tonnes of scrap metal a year. The number of cars it recycles each month would be equivalent in length to a traffic jam over 60 kilometres long.

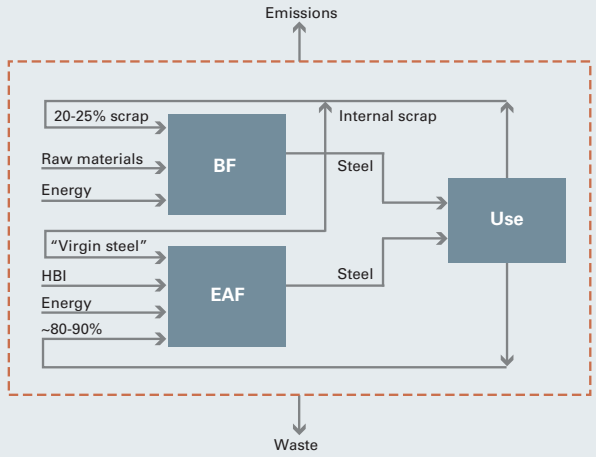
Image courtesy of OneSteel

Towards less GHG

Steel made from raw materials involves chemical reactions and high energy processes. Carbon, in the form of metallurgical coke, reacts with iron oxide from iron ore in a blast furnace (BF) to produce iron. The molten iron is then refined into steel in a Basic Oxygen Steelmaking (BOS) furnace. Steel scrap and other essential elements are added and oxygen is blown in to reduce the carbon to the level required by the steel's specification generating carbon dioxide (CO_2) as part of the high energy reaction.

Steel made from scrap uses less than half the amount of energy per tonne of steel produced and essentially involves melting scrap steel in an Electric Arc Furnace (EAF). However it is reliant on steel being made from iron ore in the first instance to service world steel demand and thereby ultimately increases the world scrap pool. EAF steelmaking takes advantage of the energy already spent by the BF/BOS steelmaking route from iron ore in achieving its energy and greenhouse profile. The EAF steelmaking process is complementary to the BF/BOS steelmaking process so favouring a higher percentage of recycled steel content in any sustainability rating system does not achieve an overall reduction in GHG.

Integrated steel production and recycling



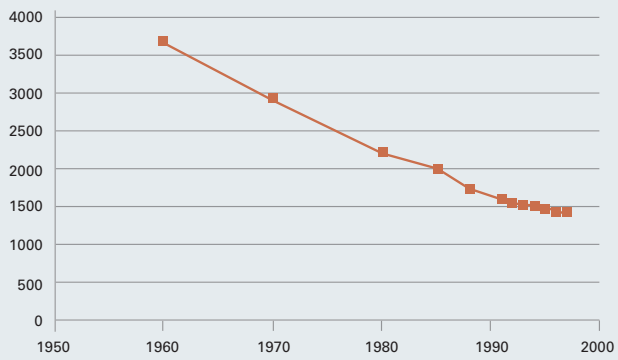
Reducing energy and greenhouse gas (GHG) emissions is a major steel industry endeavour worldwide.

Plants are meant to be 'green'

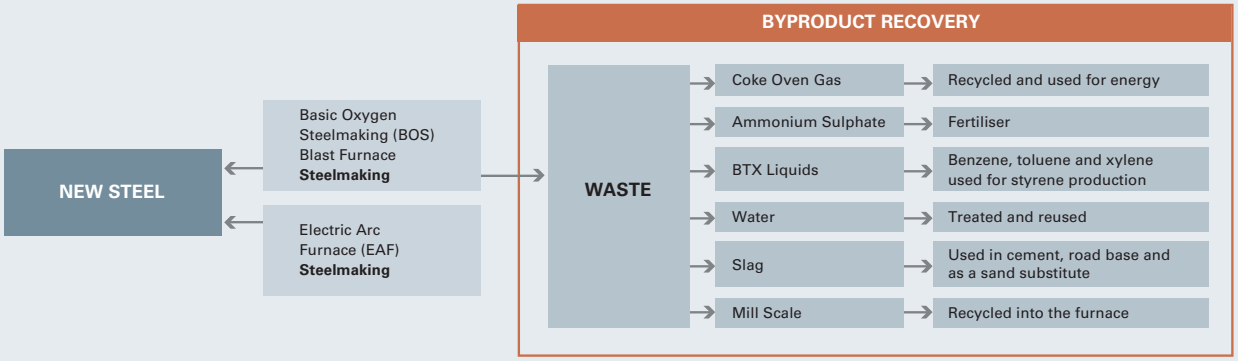
At BlueScope Steel's Western Sydney sheet steel paint-line plant, new Regenerative Thermal Oxidising technology is reducing energy consumption and greenhouse gas emissions by reusing heat from the product drying and baking processes to preheat ovens and heat water. Only a handful of paint lines in the world use this technology and it is already reducing gas consumption. Six rainwater tanks with a total capacity of 2.28 mega litres have been installed onsite to harvest rainwater from a substantial proportion of the plant's roof area. Water recycling, stormwater retention, planting of indigenous plants and utilisation of natural light have all been incorporated into the design of the plant.

Image courtesy of BlueScope Steel

Emissions of CO_2 (kg per tonne of liquid steel)



Australian Steel Waste Recovery



Reducing energy and GHG emissions is a major steel industry endeavour worldwide, both to reduce costs and improve environmental performance. In the past 40 years the industry worldwide has developed energy saving technologies such as continuous casting, the basic oxygen steelmaking process and by adapting electric arc steelmaking to produce flat rolled steel - which all contributed to halving the average energy needed to make steel over that time.

Most of these technologies have been adopted in Australia where energy and emission reduction has also been a prime concern. One of the emerging energy saving technologies is the direct casting of steel strip which eliminates the energy intensive hot strip mill. This innovation came from Australian research and although not yet applied here is already successful in the US. Another is the Hismelt process for making iron being developed by Rio Tinto at Kwinana in Western Australia.

Today the incentive to reduce GHG emissions on a worldwide basis is stronger than ever and the world steel industry is responding accordingly. Reflecting this leading steel companies from around the world, including both OneSteel and BlueScope Steel, are actively participating in a number of IISI GHG reduction related initiatives.

Tightening tap on freshwater

Since the early 1990s, BlueScope Steel has halved the amount of freshwater used to make a tonne of steel at Port Kembla Steelworks to about 2500 litres per tonne today. In September 2006 a major water conservation initiative between Sydney Water and BlueScope Steel began with the steelworks taking 20 million litres of recycled water each day replacing that previously drawn from the Avon Dam. This project has further cut the steelworks' freshwater consumption by over 50 percent. Already more than 10 billion litres of freshwater has been saved through this initiative. Today, 96 percent of the water used at Port Kembla Steelworks is either recycled water or salt water.

Image courtesy of BlueScope Water

Greenhouse research

Long-term cooperative research known as the *IISI CO_2 Breakthrough* program includes the Ultra Low CO_2 Steelmaking (ULCOS) program with companies, universities and research institutes to research and develop new and improved steelmaking technologies aimed at significantly reducing GHG emissions. OneSteel and BlueScope Steel with researcher CSIRO are participating in this R&D program with the Australian projects currently examining biomass (charcoal) and dry slag granulation with heat recovery.

Valuable byproducts

Higher strength steels reduce the amount of steel (and hence energy and GHG) needed in the product and often contribute to reducing its lifetime energy requirement. High strength autobody steels are a good example.

A significant reduction in GHG is also being achieved through the turning of what were once waste products into valuable byproducts. About 80 percent of Australia's 1.6 million tonnes of blast furnace slag is now used as cement substitute in concrete making and about 60 percent of the one million tonnes of steelmaking slag is now used as road base to replace quarried material.[3]

Spent acid from sheet and coil galvanising and pickling processes are also being used in fertiliser production and coal seam methane gas (which is 20 times more potent than CO_2 as a greenhouse gas) is being captured in collieries supplying the steelworks at Port Kembla and turned into electricity.

Plastic fantastic for steelmaking

OneSteel's polymer injection technology has attracted significant international attention as a win for the environment and a win for steelmakers. The technology's development follows three years of close collaboration between OneSteel and the University of New South Wales (UNSW) to replace some of the coke used as a slag foaming agent in EAF steelmaking with polymers, including recycled rubber and plastic. When injected, the coke/polymer blend improves slag foaming properties for more efficient use of electrical energy and to potentially reduce carbon consumption produced by coal-fired power stations. Polymers that are often diverted to landfill are recycled into value-added steel products. OneSteel has the exclusive right to take this technology to the world market through a new business arrangement with UNSW's commercialisation arm, New South Innovations (NSi).

A significant reduction in GHG is also being achieved through the turning of what were once waste products into valuable byproducts.

Image courtesy of OneSteel

Touching the Earth lightly

Steel's lightness, strength and durability make it a material of choice for construction and many other applications. These qualities improve the environmental performance of buildings, structures, automobiles and many other applications.

Steel has a number of green virtues for construction too.

The decision to use steel has benefits right from the initial stages of a project. Its great strength to weight ratio produces a lighter structure that minimises foundation work and the excavation and earthworks involved.

As building proceeds, steel can be fabricated off-site in a factory and delivered to site as required. This means that the components can be fabricated with great accuracy and be assembled onsite with minimum labour and truck movements. Moreover there is virtually no waste to be disposed of, solving a major logistic and environmental problem on most sites.

Using steel in the design of a building allows larger column-free areas to be created, making better use of natural light to save energy.

As buildings age they often have to undergo radical modification to meet changing circumstances and in this event a steel structure is much easier and quicker to modify and get back in use, using much less energy and creating much less waste as any redundant steel has immediate scrap value for recycling.

Using steel in the design of a building allows larger column-free areas to be created making better use of natural light to save energy.

At the end a building's life some of the structural elements can potentially be recovered for reuse, especially if the building has been designed for this from the outset. Recovered steel not able to be reused can be recycled (re-melted) into new prime quality steel products. The value of the steel recovered for both reuse and recycling can usefully contribute to reducing demolition costs rather than increasing costs by sending waste to landfill.

Free and flexible design

Adopting steel as the construction medium allows great freedom to designers and architects to produce an individuality which can stay fresh and modern. Along with the capacity of steel buildings to accommodate change and modification, the useful life of steel constructions is prolonged and saves energy and waste over that life.

An emerging discipline of smart design is designing for deconstruction. Steel is the ideal material for this concept since many steel components like structural beams can be reused especially if the initial design retains the original identity and certification. Steel not reused can be recycled. Steel retains its value in both instances.

Currently in Australia it is estimated that 82 percent of all steel products are recovered from building demolition ranging from 95 percent for structural steel to 70 to 80 percent for reinforcing steel.[3]

A steel-supported building can also be relocated at a fraction of the energy and GHG emission cost of demolition and new construction. Steel is the ideal material for this type of design and there are many examples of its use in this way.

The Sydney Olympic Aquatic Centre had an extra stand added for the Games and it was designed specifically to be moved to Wollongong as stadium seating afterwards. This principle is being adopted for whole stadiums being built for the 2012 London Olympics.

At the other end of the scale there is also a thriving secondhand shed market in Australia which likewise depends on steel's ability to be precision engineered and tough enough to withstand dismantling, transport and re-erection.

Image courtesy of BlueScope Steel

The stories continue...

An established CBD building at 77 King Street, Sydney received a new lease of life with a lighter weight composite steel frame solution providing five new levels (four floors and steel roof) that allows more advanced, roomier and environmentally friendly facilities. The 34 year old, 19-storey tower was transformed into an A Grade building in line with Property Council of Australia guidelines. A comparatively lightweight composite steel frame was selected so that in strengthening the existing foundations, columns and core elements were kept to a minimum. The two existing basement levels were originally designed to be a loading dock and basement parking. Significant opportunity was realised by repositioning the basement levels through demolishing the existing low ceiling floors, excavating and re-pouring new floors so the area could be reused as higher clearance retail floor space.

* Story courtesy of Arup and OneSteel.

The many lives of steel

< 1 YEAR

7 – 15 YEARS

5 – 15 YEARS

One material, many lives

The ability of steel to be reused and recycled again and again into new steel products more or less regardless of condition or age is one of its main virtually unrivalled sustainability virtues.

Measured in tonnes, it is by a large margin the most recycled material in the world. Around 482 million tonnes were recycled in 2007 and in Australia about 2.7 million tonnes are recycled annually[1], a substantial part of our eight million tonnes produced.

EAF steelmaking depends largely on scrap and typically post-consumer scrap content is 85 percent or higher. Major technology developments have enabled it to produce virtually the whole range of steel products which has greatly added to the value and demand for scrap and has for purely economic reasons created a highly efficient recovery and recycling system.

BF/BOS steelmaking also requires scrap as part of its process and content is typically around 20 percent including both internally arising process scrap and bought-in post consumer scrap.

Of the steel made in Australia, about 20 percent is EAF and 80 percent BF/BOS produced.

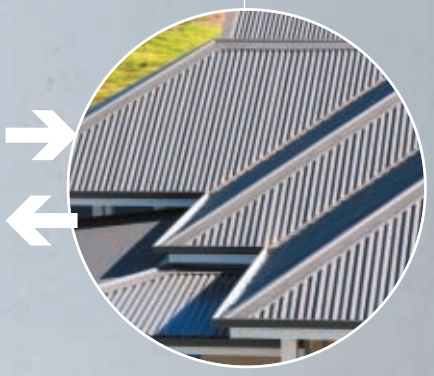


Image courtesy of BlueScope Steel

20 – 60 YEARS >

From the Earth, for the Earth

A recently constructed local resource at Mount Annan Botanic Garden in Western Sydney embodies recycled and reused materials. The Macarthur Centre for Sustainable Living provides education and practical advice on all things sustainable and is itself mainly comprised of renewable and recyclable building materials, including extensive use of recycled steel. Steel plays an important part in ensuring long-term durability, not just on the roof collecting the rainwater, but as gutters and downpipes that take the runoff to the steel water tank, donated by BlueScope Water. The Centre has been designed for deconstruction, incorporating whole sheets of steel for the roofing and much of the walling to maximise the likelihood of those sheets being used again. So even when the sheets have reached the end of their use and reuse they can be recycled into yet other steel products.

The fundamental sustainability attribute of the steel recycling process is that once a tonne of steel is created it can virtually exist in that state forever by simply being recovered and recycled. There is of course a small yield loss in each cycle and while not all steel is recovered, rates are very high. It is estimated that about 80 percent of potential scrap from all sources is recovered in Australia[3], and this figure is rising as the value of scrap increases and the barriers to higher collection rates are addressed – eg; the viable availability of concrete crushing to allow demolished concrete to have the steel reinforcement separated out.

And the unique magnetic properties of steel make it relatively easy to recover from general waste.

In Australia it is estimated that about 80% of potential scrap is recovered.

Measuring the life cycle

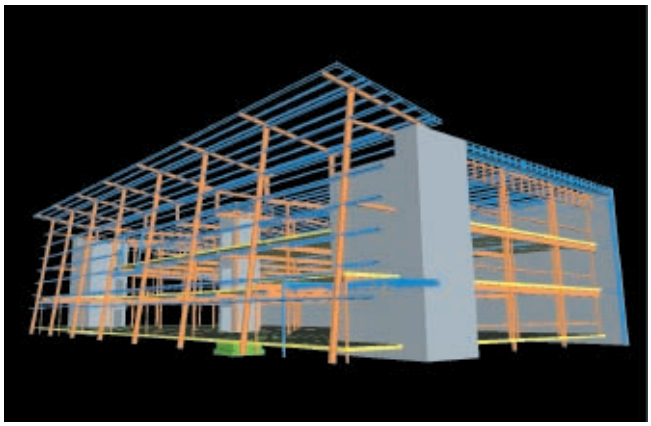
Developing measuring systems based on scientific methodology which take into account the 'whole life cycle' of a structure is essential for evaluating the real sustainability of competing solutions for particular situations.

Measuring systems in the past have often concentrated on the material content of buildings and have used simple 'embodied energy' content per unit of weight to determine the best environmental performers.

This can be quite misleading. A tonne of steel has high embodied energy content but because of its strength, a little goes a long way and it can do the job of several tonnes of other materials or could extend the life of a building in certain designs. While many materials have one life in the building and then become costly demolition waste, steel can have many lives and so retains a high value either as components for reuse or as recyclable scrap. Throughout the life of a building, steel's capacity to accommodate radical modification with minimum fuss, dust and waste is a strong environmental plus.

Measuring systems taking account of this 'whole of life' life cycle assessment (LCA) concept are either in use or being developed around the world and the ASI strongly supports their development here in Australia as does the IISI internationally. Both organisations believe that basing evaluation on an LCA mindset will allow a genuinely fair assessment of materials and building systems.

This latter factor will become increasingly important as construction planning and control becomes more sophisticated and Building Information Management (BIM) systems seek to include environmental performance data as well as cost and logistical data.



MBA Building Newcastle (images courtesy of Lindsay & Dynan Consulting Engineers)

Image courtesy of OneSteel

Image courtesy of OneSteel

For the future

The steel industry recognises that if steel is to play the role expected of it across the globe in developing a sustainable future then the industry itself must be sustainable. It must embrace a sustainability mindset in all aspects of its business to achieve this.

Working together through the IISI the steel industry established a policy on sustainable development in 2002. This policy lists the commitments made by IISI's member companies, including BlueScope Steel and OneSteel, to address the economic, environmental and social sustainability of their businesses and to engage in constructive and open dialogue with their stakeholders to honour these commitments.

Eleven indicators have been developed to measure economic, environmental and social performance to systematically evaluate the progress of steel manufacturers' sustainable development.

These measurements now form the basis of *The Sustainability Report of the World Steel Industry – Steel: the Foundation of a Sustainable Future* and are acting as benchmarks in the drive for world steel industry improvement (www.worldsteel.org).

References

1 IISI World Steel in Figures 2008

2 ABARE

3 *A Life Cycle Perspective on Steel Building Materials*, The Crucible Group, 2006

Australian Steel Institute

The Australian Steel Institute (ASI) is Australia's peak steel industry association promoting the use of Australian steel in manufacturing and construction. Its membership covers the full spectrum of the steel industry from the steel mills to the education sector.

ASI is a not for profit organisation with three sustaining members, BlueScope Steel, OneSteel and Fletcher Building as well as a tiered membership structure covering all steel industry-related sectors.

The ASI Sustainability Group comprises experts from the major Australian steel producers who meet regularly on initiatives supporting steel's improving environmental performance and to promote adoption of the latest sustainability advances to members.

The ASI's website contains a dedicated Sustainability section that provides information on Sustainable Construction Issues, Structural Efficiency, Embodied Energy, Suitability for Manufacture, Future Adaptability, Steel Industry Responsibility and a range of case studies on steel's sustainable use.

[September 2008]

AUSTRALIAN STEEL INSTITUTE

HEAD OFFICE
Level 13, 99 Mount Street
North Sydney NSW 2060

PO Box 6366
North Sydney NSW 2059

Tel 02 9931 6666
Fax 02 9931 6633
Email enquiries@steel.org.au

Web www.steel.org.au

ACN (94) 000 973 839