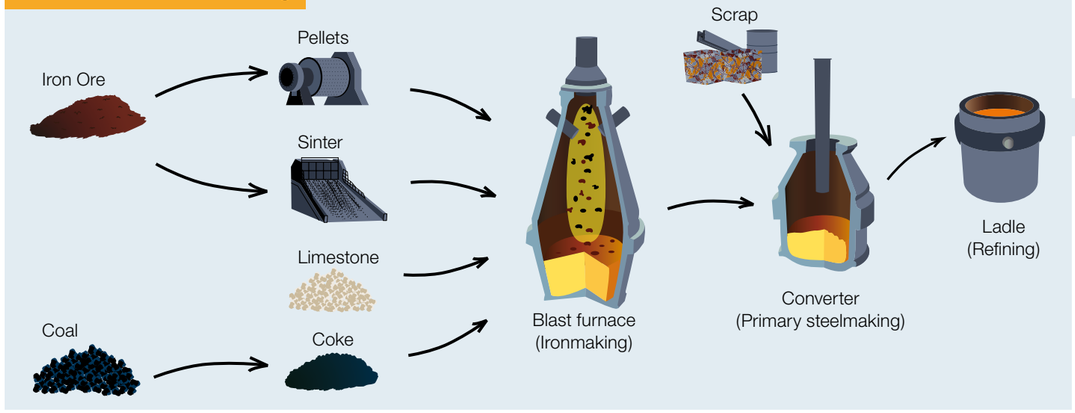
International Iron and Steel Institute

Steel and You

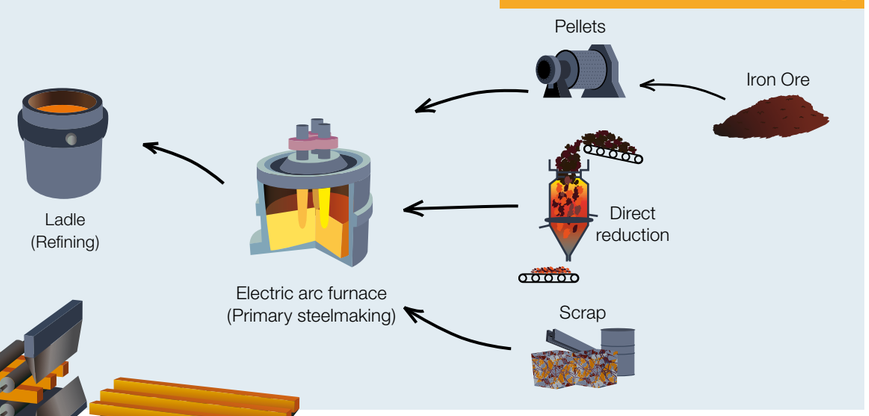
The Life of Steel

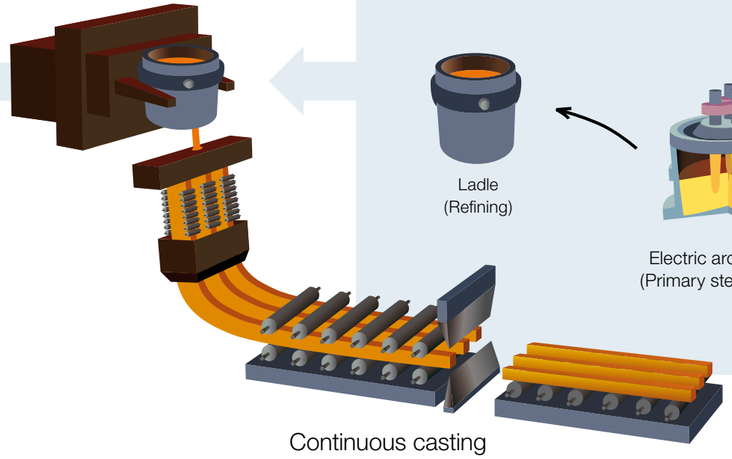
An overview of the steelmaking process

Blast Furnace Steelmaking



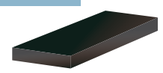
Electric Arc Furnace Steelmaking



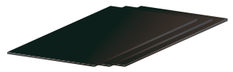


Continuous casting

Slab



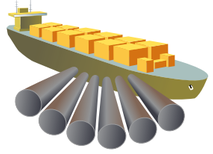
Hot and cold strip



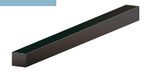
Cars - White goods

Coils

Ships - Welded pipes

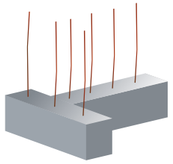


Billet



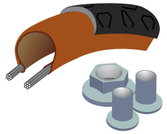
Hot rolled bars

Rebar



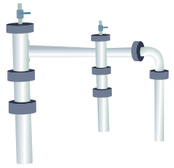
Rods

Tyre wire - Wire - Nuts and Bolts

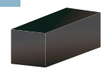


Tube rounds

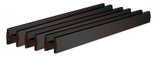
Pipelines



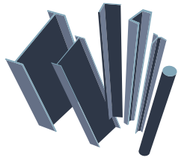
Bloom



Structural shapes



Structural profiles



Rails

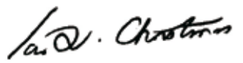
Train rails

The process shown above is illustrative only and is not designed to show the steelmaking process in detail.
Not all steelplants produce all of the products shown in this diagram.

Contents

Introduction

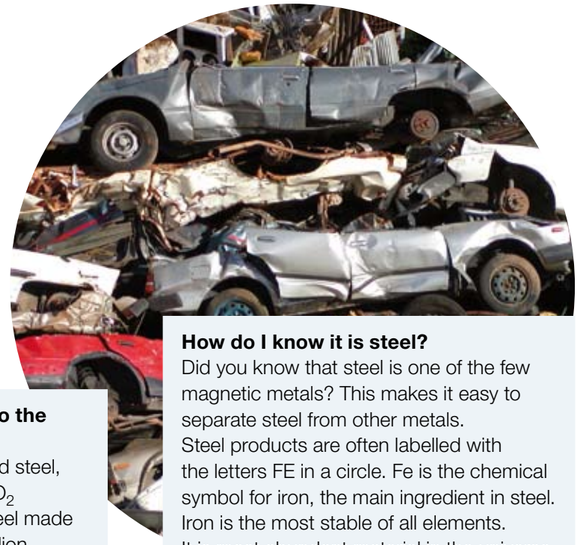
Steel fulfils a unique place in our lives and yet few of us fully realise just how important steel is to us. It is one of the most common materials that we come into contact with everyday.
The recyclability of steel is particularly amazing. There are few other materials that can be recycled over and over again without loss of properties. Even steel created 150 years ago can be recycled today and used in new products and applications. As we contemplate the legacy we will leave our children and grandchildren we must focus much harder on the sustainability of our world. The recyclability of steel is an invaluable asset.
Another very important focus of our attention is steel-related greenhouse gas emissions.
Over the past 25 years the steel industry has engineered a revolution in its performance through massive investment in new products, new plants and technology and in new methods of working. But there is still much more to be done.
In this brochure we seek to give you some insight into both how steel is made today and how its application is changing the face of the world in which we live.
As an insight into the life around us I hope you will find it interesting and perhaps even occasionally astonishing.



Ian Christmas
Secretary General
International Iron and Steel Institute (IISI)

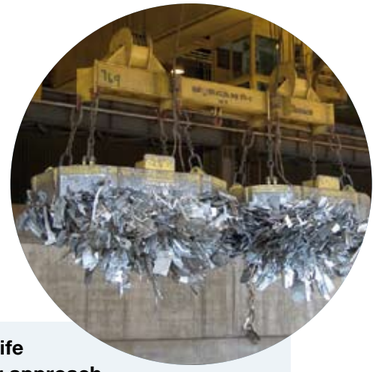
Recycling

Did you know that steel is the most recycled material in the world? According to IISI estimates, the 20 billionth tonne of steel was recycled in October 2007. Steel is 100% recyclable. It can be infinitely recycled without loss of quality. It is one of the few materials that does not lose its properties when it is recycled.



How do I know it is steel?
Did you know that steel is one of the few magnetic metals? This makes it easy to separate steel from other metals.
Steel products are often labelled with the letters FE in a circle. Fe is the chemical symbol for iron, the main ingredient in steel.
Iron is the most stable of all elements.
It is most abundant material in the universe, the fourth most abundant material in the Earth's crust and forms the core of our planet.

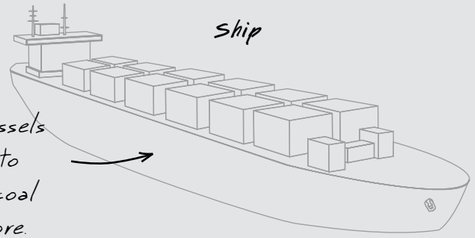
Why is recycling important to the steelmaking process?
Creating new steel from recycled steel, rather than iron ore, reduces CO_2 emissions. In 2006, recycled steel made up more than 40% (or 496 million metric tons) of the 1.240 billion metric tons of steel produced. This saved an estimated 894 million metric tons of CO_2. Recycled steel is as strong and durable as new steel made from iron ore. Unfortunately, there is not enough steel scrap available to meet the demand for new steel.

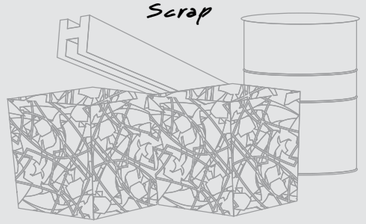


End-of- life recycling approach
The steel industry, along with many other metal industries, strongly supports the end-of-life recycling approach. It enables manufacturers, policymakers, designers, consumers and other decision-makers to ensure minimal waste and maximum recycling and reuse of materials.
By improving design, the need for new steel production can be reduced as steel components can be reused without reprocessing.

Steel cans are the most recycled food and beverage container in the world. Globally around 64% of steel packaging is recycled.

What percentage of steel is recycled?
Almost all available steel is recycled as it is an important input to the steelmaking process. In most sectors, including automotive and construction, steel recycling rates are between 80 and 100%.
Construction steel can also be reused without reprocessing. This saves greenhouse gas emissions, providing an added environmental advantage.
Steel and iron components make up around 65% of the average vehicle. Once all fluids have been drained and reusable parts removed from an automobile, scrap processors shred the vehicule. The average recycling rate for steel and iron in cars is close to 100%.





Transport

Trains, ships, cars, bicycles and many other forms of transport rely on the strength and versatility of steel. No other material has this range of properties. For many years, steel has been used to move people and goods around the world or just around the corner.

Trains
Often people prefer to travel by train rather than by plane, especially for short journeys. Today's high-speed trains can travel at up to 500 km/h and in temperatures ranging from scorching to well below freezing. The CO_2 emissions from train travel are very low.

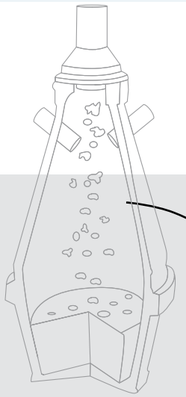
High-speed tracks use long and welded rails, which improve passenger comfort and load capacity. Even the railway sleepers are made of steel. Laser-guided precision technology is used to grind the steel wheels of trains, which minimises friction, noise and vibration.

Bicycles
Steel plays a key role in the bicycle's legendary robustness and longevity. For strength and stiffness of bicycle frames, steel is unbeatable as the material of choice. Cycling is one of the most environmentally-friendly mode of personal transport.

Aircraft
Aeroplane landing gear contain ultra high-strength steel because of its unique combination of strength and toughness. Modern ultra high-strength steels are stronger and lighter than the traditional grades they have replaced. This advanced steelmaking technology contributes to the safety of passengers.

The steel used in shipbuilding must have impact toughness, corrosion resistance in sea water, fatigue resistance (to withstand continual wave action) and weldability.

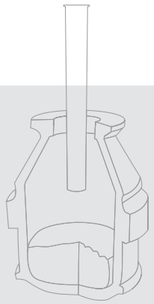
Ships
Capesize vessels are huge double-hulled bulk carriers that can hold more than 140,000 tonnes of cargo. The double-hull is made from a new generation of steel that is stronger and lighter. The use of such large vessels reduces the number of sea voyages needed. This lowers greenhouse gas emissions from shipping activities.



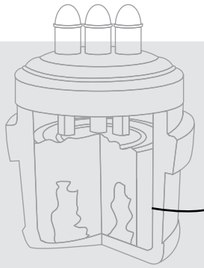
New, very large blast furnaces produce less CO_2.

Blast furnace

Waste gases can be recovered and reused.



Converter



Secondary processing refines the steel.

Ladle furnace

Energy

Deep cuts in fossil fuel usage cannot be achieved without large volumes of energy from renewable sources. Steel is an important component of the structures that make these renewable energy sources viable.

Special steel alloys were used in the construction of the PS10. The steel alloys are critical to the reliable operation of the hot molten-salt pumps that convert solar energy into electricity. Such steels are capable of withstanding the corrosive effects of salt-lubricated bearings, surrounded by nitrate salt at 565°C.

Planta Solar 10 (PS10)
The first commercial-scale concentrating solar power plant was inaugurated in early 2007, near the Spanish city of Seville. The Planta Solar 10 (PS10) relies on large numbers of mirrors that reflect and concentrate sunlight on a central collector point for conversion into electricity. With some 624 mirrors (or heliostats) already installed, thousands will be added to the present arrays to greatly increase the plant's capacity.

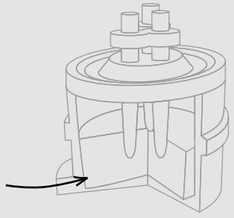
Steel is also an important element in the sandwich construction of the heliostats. The glass mirror is typically bonded to a steel sheet. Surface treatments, such as electro-galvanising, help to protect against corrosion and subsequent breakdown of the mirror surface. Bonding the entire mirror surface to the steel sheet also helps maintain the integrity of the mirror if it breaks, so that it can continue to function safely. Steel sheets are easily formed to the desired curvature for focusing the sunlight.

Tidal
Tides are normally regular and predictable, making them an excellent source of renewable energy. The power of the tide can be harvested in several ways.
A technique under development uses a structure that resembles a submerged windmill. This modern "tidal turbine" can be installed in areas with high tidal velocities or fast and continuous ocean currents.

The main component of the tidal turbine is a steel pile. With proper maintenance, the surface-protected steel has a proven lifespan of over 40 years in harsh marine environments.
Construction of a pre-commercial tidal turbine is planned for late 2007.
It will be installed in Strangford Lough, Northern Ireland. The turbine could generate up to 1.2 megawatts of energy and will be connected to the power grid.

Wind
During its lifetime, a wind turbine can deliver 80 times more energy than is used in its production, maintenance and recycling.
When installed on a good site, a 3.0 megawatt wind turbine will generate approximately 280,000 MWh (megawatt-hours) in 20 years.
This spares the environment approximately 230,000 tons of CO_2 compared to a coal-fired power station producing an equivalent amount of energy.

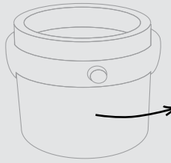
Steel is the main material used in wind turbines. The tower, gears, bearings, generator, shafts, casings and various other parts depend on steel.



The EAF uses an electric current to melt scrap and other steel. Less carbon-dependent than blast furnace method!

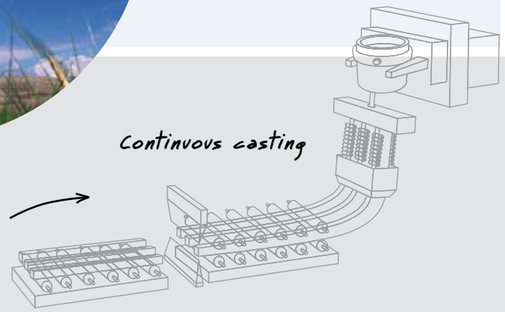
Electric arc furnace

Ladle



Holds around 100 tonnes of hot metal.

Continuous casting



Continuous casting is a more efficient method of casting.

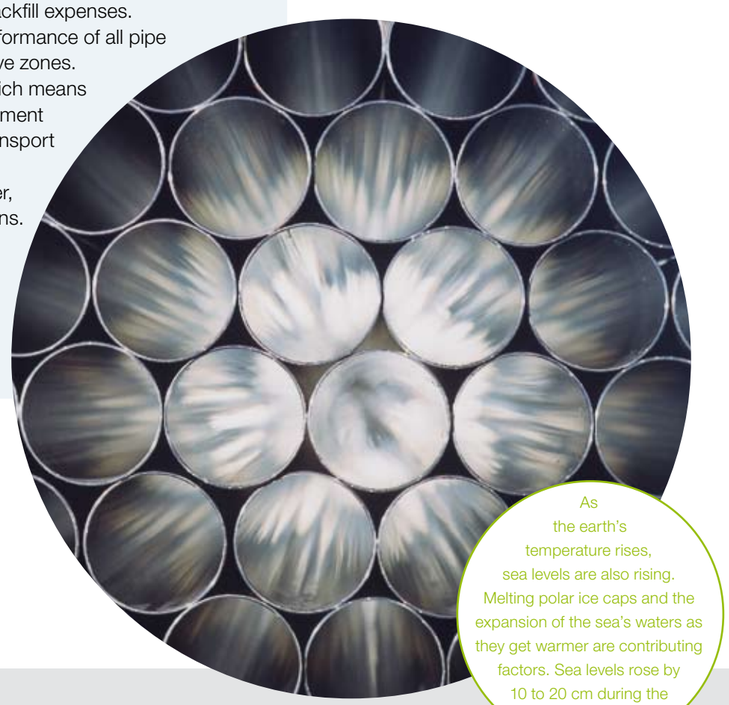
Water

Water is essential for all forms of life.
It covers over 70% of the earth's surface.
Yet less than 1% is available as freshwater.
Managing water resources is one of the critical challenges facing humanity.
Steel helps to protect this valuable resource all along the supply and delivery chain.

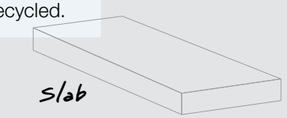
Rainwater tanks
A typical Australian household uses about 280,000 litres of water each year. Installing a rainwater tank has the potential to reduce residential fresh water requirements by 50%. A recent study by the University of Newcastle (Australia) compared the environmental impact of steel, concrete, and plastic tanks over their life cycle. The study found that rainwater tanks made from steel have the lowest overall environmental impact. At the end of its life, the steel tank can be completely recycled.

Barriers
Flood risk management has become a specialised task for governments and engineers. The Thames Barrier is a system of stainless-steel-plated hollow flood gates that stretch across the River Thames. The gates are left open for traffic in normal conditions and closed when there is a risk of flood. The total structure uses 36,000 tonnes of structural steel, and 10,000 tonnes of steel reinforcement. Use of steel allowed much of the barrier to be pre-fabricated. Making construction quick and easy.
With the barrier in place, the flood risk is reduced to 1 in 2,000, or 0.05%.

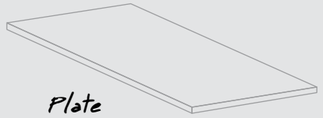
Pipes
The inherent strength of steel means that pipes can be made with thinner walls than other pipe materials. This maximises the capacity and working pressure of the pipe and means that smaller trenches are required, reducing excavation and backfill expenses.
Steel pipe has the best performance of all pipe materials in seismically active zones.
Steel pipe is lightweight which means that it is light on the environment during manufacture and transport to the installation location.
Longer lengths enable faster, more economical installations.
Coatings and corrosion protection lead to long life and low maintenance, further reducing the environmental impact of the pipe.



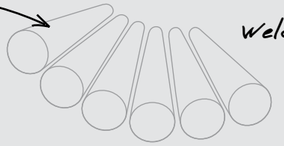
As the earth's temperature rises, sea levels are also rising. Melting polar ice caps and the expansion of the sea's waters as they get warmer are contributing factors. Sea levels rose by 10 to 20 cm during the 20th century.



Today external waste, such as plastics, can be added to a blast furnace, reducing the CO_2 emissions from coal.



High strength steels result in big reductions in CO_2 emissions in the use phase.



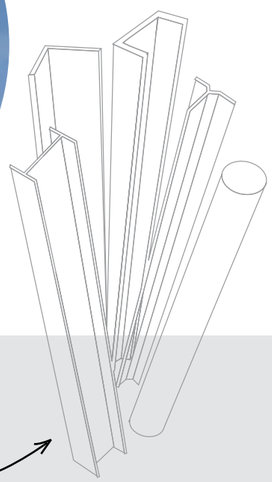
Housing and Construction

Building suitable housing for an ever-growing population is a major issue around the world. Today, housing solutions must be sustainable in both the building and use-phases of their life. They must also be easy to recycle and affordable.

The strength of building with steel
Ultra-high-strength steels (UHSS) reduce the need for heavy load-bearing beams. Beams can now be made thinner, increasing the usable space in a building. They can also be made longer, eliminating the need for some supporting pillars. Larger windows can be used, which increases light and ventilation inside.
UHSS also save energy and greenhouse gas emissions. Less material needs to be produced to make the building components, thereby saving on emissions during the material-creation phase. Lighter and fewer components also means lower emissions during transport to the building site.

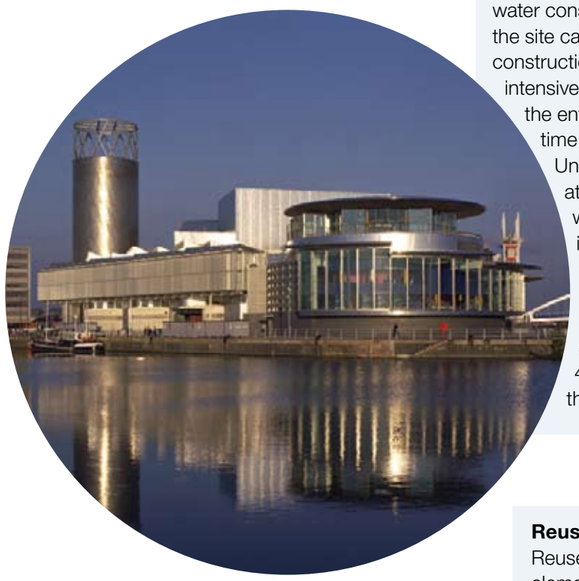
All new homes in the United Kingdom will have to be carbon neutral by 2016.

Energy saving
In the life of a building, most of the energy use goes to lighting and temperature control. Cooling a building normally requires more energy than heating or lighting. Good design can help to minimise energy use, and so can building with steel. Highly-efficient steel cladding systems help keep interiors cool in summer and warm in winter.



Combining steel and outer thermal insulation provides excellent airtightness and insulation which helps prevent corrosion.

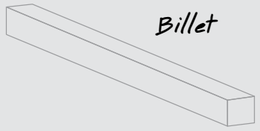
Structural shapes and profiles



Advantages over other materials
Analysis of steel-intensive buildings has shown that water consumption, waste, and trips to and from the site can all be reduced when using steel construction solutions. Compared to concrete, steel-intensive buildings have less impact on the environment during on-site work. Construction time is also quicker.
Unlike wood, steel is not prone to termite attacks and rot. Steel withstands severe weather and fire more easily. With the increase in severe weather events due to climate change, these are significant attributes for a construction material.
Steel also outlasts other materials. Most steel products are in use for between 40 and 100 years. With proper maintenance, this can be extended even further.

Reuse and recycle
Reuse of steel construction elements offers an even greater environmental advantage than recycling. Flexible design can allow for movable walls.
Or, the entire structure can be taken down and re-assembled elsewhere.
A steel building can be flexible enough to be put to alternative use, avoiding demolition.

Billet



Bloom

Productivity and yield from steelmaking have improved over the last 20 years.

Packaging

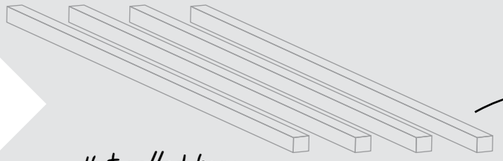
Modern packaging must do more than protect products and enable efficient and effective distribution. It must also serve as critical point-of-sale advertising. Steel is a versatile packaging solution, with unique properties that offer endless possibilities for shaping and embossing.

Flat pack system
The idea of ready-to-assemble or flat-pack furniture has been around for many years. The use of steel for flat pack furniture is relatively new. A system, developed by SuperRobot in Japan, uses a single piece of sheet steel to create items of domestic furniture such as chairs, stools, lamps, and shelving systems. Simplicity is key. The advantages are many. Items are easy to store and to transport in bulk. One truck can deliver many products, thereby saving energy. And the product is not easily damaged in transit.

Reusing steel packaging
Not all steel packaging ends up being made into other steel products. Some types of steel packaging are re-used, saving on further processing.
A leading vacuum-cleaner maker has recently started selling its products in steel containers that can be reused as a stool or storage solution.
The R4 concept house, developed by Spanish architect Luis De Garrido, takes old steel shipping containers and reuses them as housing modules. The modules can be tailored to the specific needs of a family using as many modules as required.

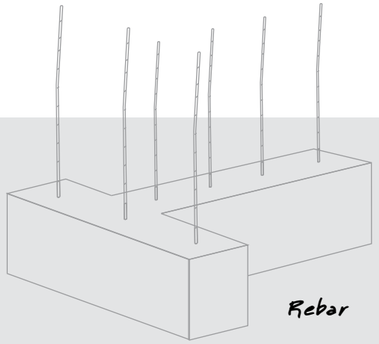
New developments in packaging technology
Steel companies are constantly looking at ways to improve their products. In the past, steel cans came in one shape of differing sizes and required a paper label so you knew what was inside. They were also difficult to open unless you had a can opener.
Today's steel cans enable manufacturers to print directly on to the surface of the steel in full colour. New drawing techniques make a wide range of shapes possible including conical and elliptical cans. Opening mechanisms have also been improved so that it is possible to open a can of food wherever you are.

Package design and printing
Consumers make 70% of their buying decisions at the retail shelf. Steel is a versatile packaging solution that offers endless possibilities for shaping and embossing in a wide variety of distinctive finishes.
Steel packaging, like all steel products, is 100% recyclable. Steel cans and packaging are easily extracted from the waste stream using industrial magnets. Sorting efficiency is almost 100%.
This means that nearly all the steel packaging we use is recycled.



Hot rolled bars

Used to make reinforcing bar (rebar). Rebar strengthens buildings, structures and roads.



Rebar

New high strength rebar makes flexible structures possible.

Agribusiness

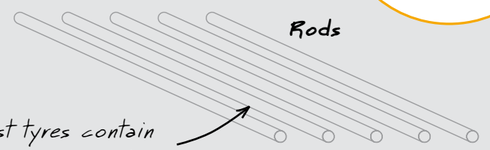
Less than 3% of the workforce in developed countries is employed in agriculture today. However, to sustain the population 100 years ago, over 75% of the workforce had to work in the agriculture industry. Steel has made the intensification of farming possible, and will continue to do so in the future.

Fish farming
Water mould is a problem in salmon fish farms because it inhibits the hatching of salmon eggs. To combat this problem, a leading wire steel manufacturer in Japan has developed a new antibacterial coating for use in hatching nets. The new antibacterial coating is applied to the wire before it is woven. This ensures that bacteria are unable to breed at the points where the wire crosses.

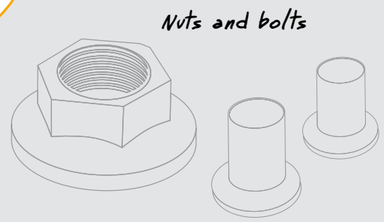
Reducing the need for expensive veterinary products and cleaning agents has resulted in cleaner waterways and healthier fish.

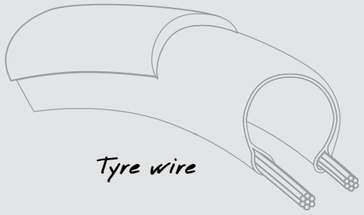
New fuel-efficient farm equipment
Lighter and stronger steels are improving the fuel-efficiency of mechanical farm equipment.

City farming
Transporting enough food to feed a city generates a lot of greenhouse gas emissions. One proposal to alleviate this problem is to build vertical farms in urban areas. The farm would look like a normal office building.
The difference is that edible plants could be grown indoors, in a controlled environment. Existing steel construction techniques, as used in skyscrapers around the world, could be used to build the farm. Once harvested, the produce would be distributed to local shops and restaurants with a minimum of transport and CO_2 emissions.



Most tyres contain kilometres of steel wire made from rods.





The steel in tyres can be recycled while the rubber is used to generate gas and electricity.

Automotive

The environmental impact of cars cannot be ignored. The key is to use materials that are safe and gentle on the environment, light and economical during use, and easy to recycle at the end of their life. Steel offers all of these advantages.

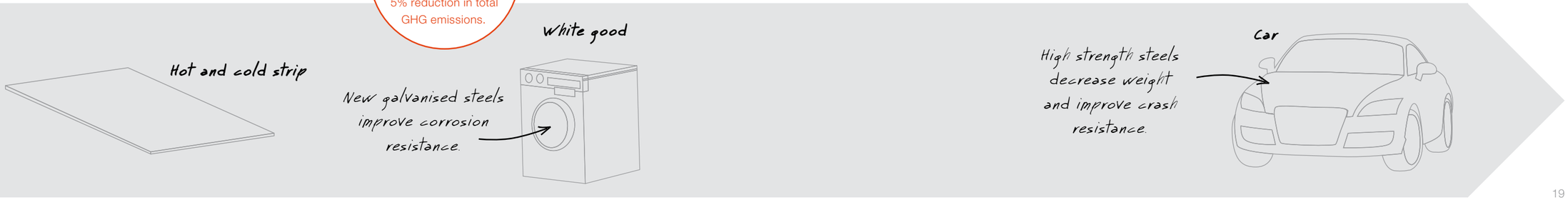
Reducing the life cycle impact of steel
To truly reduce a vehicle's footprint on the environment, consideration must also be given to factors beyond fuel efficiency. All phases of a vehicle's life, such as material production, vehicle production, use and end-of-life recycling, must be considered.

AHSS
Steel makes up a large percentage of today's vehicles. Advanced high-strength steels (AHSS) for body structures maintain good formability while providing high strength that helps reduce the weight of the body structure. Their use can improve both fuel economy and crashworthiness.

AHSS is predicted to be more than 50% of sheet steel in cars in 2010 contributing a 5% reduction in total GHG emissions.

A recent study commissioned by IISI's WorldAutoSteel group shows that using materials other than steel may create more GHG emissions during the material production phase than are saved in the use phase. The study compared conventional steel vehicles to AHSS- and aluminium-intensive vehicles over all phases of the vehicle's life cycle.

Steel in alternative powertrains
IISI's automotive group, WorldAutoSteel is embarking on a new research initiative that will develop a steel auto body concept that addresses alternative powertrains such as fuel cells, electric and hybrid systems. The goal of the research is the demonstration of light weight steel bodies for future vehicles that reduce GHG emissions over its entire life cycle.



Communication

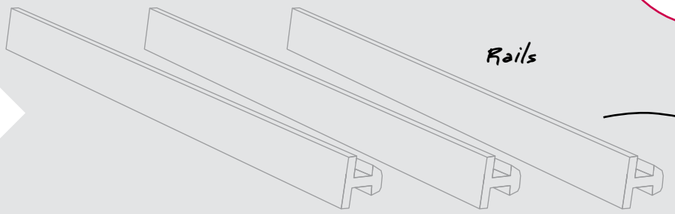
Steel is integral for many forms of human communication. It is found in all types of communication devices from the humble ballpoint pen to the most advanced communications satellite.

Mobile telephone
The hinge of this mobile telephone is made from injection-moulded stainless steel. Stainless steel is an ideal material for the body of the phone as it can be recycled over and over again without loss of properties. It is also hard wearing, giving the phone a long life.

Over 90% of the materials in mobile phones can be recovered and used as raw materials for new products.

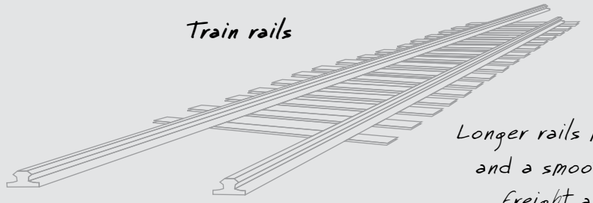
Telescopes
Steel is used extensively in radio telescopes. It is used to form the dish, stand (as reinforcing bar if the stand is made of concrete), and in the technical parts of the telescope such as the actuators that capture the signals from space. Steel makes it possible to prefabricate the elements of a telescope, minimising build time at the site and disturbance to local flora and fauna. The largest telescope array in the world is currently under construction in Chile. When complete, the Atacama Large Millimeter/ Submillimeter Array (ALMA) will contain 66 telescopes linked together.

Transmission towers
Radio, television, and mobile telephone transmission towers are usually built from steel. Steel provides the strength and flexibility that is required to support these structures. Steel also enables the tower to be constructed quickly and at minimum cost. The tallest transmission tower in the world is the KVLY-TV mast in North Dakota, USA. The tower is 628.8 metres tall and took 30 days to construct. The tower services a broadcast area of almost 80,000 square kilometers, an area similar in size to the entire Czech Republic.

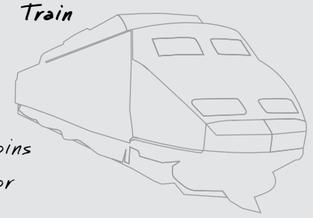


Rails

Improvements in casting enable longer, tougher rails.



Train rails

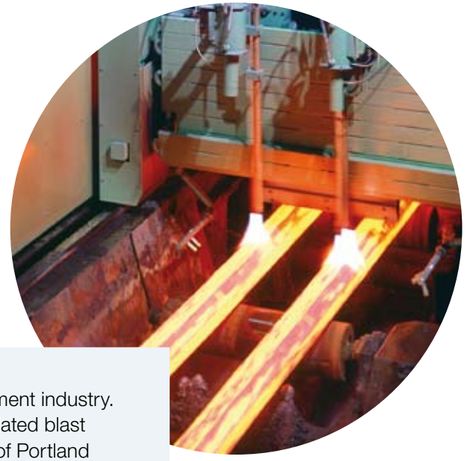


Train

Longer rails mean less joins and a smoother ride for freight and people.

By-product reuse

By-products from steelmaking are used in roads, cement and concrete, fertiliser and soil improvement agents, rock wool for insulation, glass, ceramics, pigments, magnets, plastics (such as polystyrene), electrodes for aluminium and steel plants, and cosmetics.



Slag
A key market for slag is the cement industry. It is estimated that using granulated blast furnace slag in the production of Portland cement (a type of cement which is the basic ingredient of concrete) reduces CO_2 emissions by 50%.
In some countries, up to 80% of cement contains granulated blast furnace slag.
Stones made from slag can be used in many applications. Homes built with slag-stones have often outlived the steelplants the slag came from. Another important application for these stones are in seawalls. The slag-stones are able to withstand the corrosive environment and provide protection against high tides and floods.

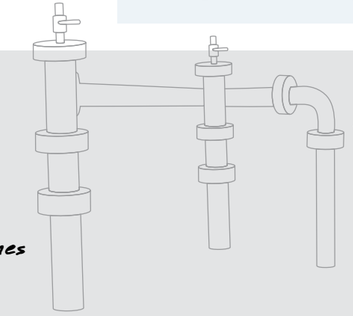
Gases
Gases produced during the steelmaking process can also be fully reused. They are used as a fuel source for heating steel furnaces or as an energy source in power generation plants within a steelworks. Electricity generated through this method contributes to the energy efficiency of the steelworks.

Roads
Aggregates such as rock and gravel are used to construct the base of roads. Slag can easily be substituted for more conventional aggregates. Slag has good environmental compatibility, bonds well to bitumen and has a micro-porous surface structure. This guarantees excellent tyre grip, even in extreme weather conditions and after long exposure to traffic.

Fertiliser
Slag from a blast furnace is rich in phosphate, silicate, magnesium, lime, manganese, and iron. The slag is ground very finely so that it can be spread on fields using conventional fertiliser-distribution machinery. Over time the slag decomposes, releasing nutrients to the plants.

Tube rounds

Steel tubes come in many sizes and transport all types of gases and liquids.



Pipelines

New steels resist corrosion from sour gases in harsh environments.

Summary

IISI has launched a new global steel sector approach for the collection and reporting of carbon dioxide emissions data by steelplants in all the major steel producing countries. The information collection will lead to benchmarking improvements based on actual performance data and then reporting and setting of commitments on a national or regional basis for implementation during the post-Kyoto period. The key advantage of the IISI approach is that it is supported by its members in both the developed and developing countries including China which accounts for approximately 50% of total steelmaking CO_2 emissions.

IISI uses an intensity-based approach to measurement of carbon dioxide emissions, taking into account the CO_2 produced per tonne of steel rather than the total carbon dioxide emissions within a country or region. This globally consistent calculation methodology will allow production-normalised CO_2 emission comparisons between regions that are not possible today.

IISI has put in place an expert group to oversee the collection of emissions data. This task force will develop a reporting methodology and specific approaches to reduce the steel industry's global CO_2 emissions.

Credits

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