worldsteel ASSOCIATION

FACT SHEET

Advanced steel applications

Across a broad range of industries and applications, the development and use of high-performance steels help to reduce greenhouse gas (GHG) emissions.

Steel is one of the most efficient modern construction materials. It offers the highest strength-to-weight ratio of any commonly-used material and is exceptionally durable. Around 20 billion tonnes of steel remain in use[1] today in a variety of products. Steel is 100% recyclable and can be infinitely recycled, allowing the creation of new products out of old products without any loss of strength, formability, or any other important measure of performance. This is why steel remains the material of choice for construction and manufacturing around the world. Steel can also be designed for the purpose of the end-use application and the specific strength, durability and end-of-life recycling requirements.

New formulations of high-performance steels enable carmakers to produce stronger and lighter vehicles that are more energy efficient. Steel offers considerable advantages for the construction of wind turbine towers due to its strength and durability. Environmental impacts are minimised as steel can be infinitely recycled. The strength of steel also enables building designers to use less material without compromising structural performance. Steel is also part of innovative technologies that reduce energy use in buildings.

Development of new steels

New steel applications have replaced conventional materials. This has contributed to the reduction of greenhouse gas emissions when the total life cycle of the application is taken into account. We give here just a few examples of the many ways in which advanced steels are used in our everyday lives and how they can contribute to reducing CO_2 emissions over the whole life cycle of a product.

Steel in transport

- Rail transport requires steel in the trains and for the rails and infrastructure. For short or medium haul journeys, rail reduces travel times and CO_2 emissions per passenger km compared to nearly all other forms of transport.[2]
- In 2015, around 90 million vehicles were produced worldwide[3]. Steel used per vehicle is 900kg on average. Advanced High-Strength Steels (AHSS) are now used for nearly every new vehicle design. Steel makes up more than 50% of today's vehicles and using AHSS makes possible lighter, optimised vehicle designs that enhance safety and improve fuel economy.[4]
- New grades of Advanced High-Strength Steels (AHSS) enable carmakers to reduce vehicle weight by 25-39% compared to conventional steel. When applied to a typical five-passenger family car, the overall weight of the vehicle is reduced by 170 to 270 kg, which corresponds to a lifetime saving of 3 to 4.5 tonnes of greenhouse gases over the vehicle's total life cycle. This saving in emissions represents more than the total amount of CO_2 emitted during the production of all the steel in the vehicle.[12]
- Many worldsteel members have recently developed new grades of innovative high-strength steels allowing auto components to be made thinner and lighter without sacrificing safety.[5]
- WorldAutoSteel, the automotive group of the World Steel Association, in 2013 completed a three-year programme that delivers fully engineered, steel intensive designs for electric vehicles. Known as the FutureSteelVehicle (FSV), the project features steel body structure designs that reduce the mass of the body-in-white to 188 kg and reduce total life cycle GHG emissions by almost 70%. The FSV study commenced in 2007 and concentrates on solutions for cars that will be produced in 2015-2020 [5]. Today we are seeing the material portfolio developed through the FSV programme progressively being introduced into new products.

Steel in energy

Whether energy is produced from fossil fuels, nuclear or renewables,

the production process and distribution routes rely on steel. Steel is used in electricity pylons, to make offshore oil platforms and it reinforces concrete structures in hydroelectric power stations. No generator, transformer or electric motor could be operated without electrical steels needed to transform electrical power into usable energy. Steel also plays a key role in converting solar energy into electricity or hot water. It is used as a base for solar thermal-panels and in pumps, tanks and heat exchangers. Steel is also used to fabricate wave energy devices.[6]

Steel is such a well-used material in modern structures that we are often unaware of the design efficiencies they embody. A prime example is the tubular steel towers used for the wind turbines now being installed around the world. Generally, taller towers offer greater energy generating efficiency, since wind speeds increase at higher altitudes. The new steels used in the construction of such towers offer much higher strength-per-unit weight ratios than other materials, so taller towers can be erected with much less stress on the structure. Lower weight also enables these towers to be manufactured in sections of up to 30 m, then assembled and installed on site. Ongoing research continues to produce new steels that are even stronger than their predecessors, and thus will minimise the mass of future towers. As a result, tower weights (per installed power in kW) have declined by about 50% during the past 10 years.[7] A typical modern tower in the Horns Rev wind farm in Denmark is 70 m high and weighs only 140 tonnes.[8] This represents a 50% reduction in weight and a saving of more than 200 tonnes of CO_2 for each tower compared to its predecessors of just 10 years ago.[9]

Steel in buildings and infrastructures

The possibilities for using steel in buildings and infrastructure are limitless. Steel is used in reinforcing bars and structural sections, roofing and insulating panels but also in heating or cooling equipment, internal fittings such as rails, shelving and stairs, and much more.[6]

New steels are also applied in modern solar heating systems for large buildings and warehouses. For example, the Canadian SolarWall® air heating system recently installed in a military base in the US is designed to save over 1,800 tonnes of CO_2 a year.[10] It is also projected to realise fuel savings of 46,000 GJ a year.

Another advanced steel application for buildings is the Arsolar solar panel roofing system, developed by ArcelorMittal. Arsolar roofing converts solar energy to electricity. Each Arsolar roof module consists of photovoltaic sandwich panels assembled onto galvanised steel roofing panels. The system saves 30 tonnes of CO_2 a year for every 45m^2 of installation.[11]

The advanced steels used in steel-plate applications also find uses in a number of related industries. Offshore oil rigs, bridges, civil engineering and construction machines, rail carriages, tanks and pressure vessels, nuclear, thermal and hydroelectric plants – all these applications benefit from the attributes of modern steels.

Steel in shipbuilding

Shipbuilding traditionally uses structural steel plate to fabricate ship hulls. Modern steel plates have much higher tensile strengths than their predecessors, making them much better suited to the efficient construction of large container ships. Steel ships transport 90% of the world's cargo. An estimated number of 17 million containers of varying types made up the worldwide container fleet and the majority are made of steel.

A particular type of plate is available with a designed-in resistance to corrosion, ideal for building oil tankers. Such steels make possible much lighter vessels than before, or larger-capacity vessels for the same weight, offering significant opportunities to save on fuel consumption and hence CO2.

The importance of life cycle assessment (LCA)

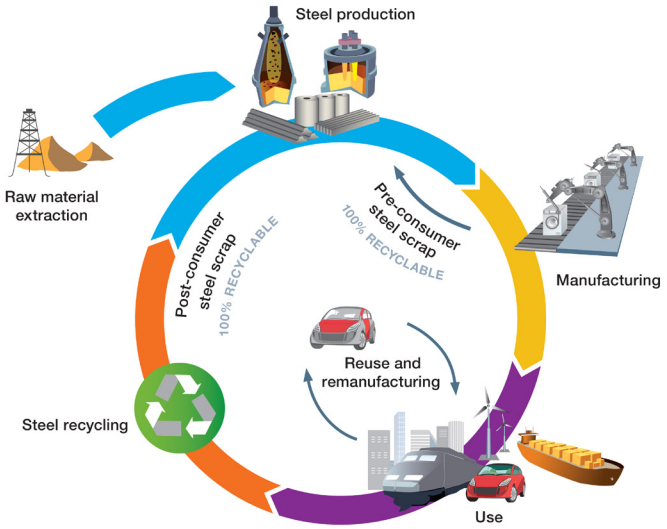
The above are just a few examples of the many ways in which advanced steels are used in our everyday environment. There are many more. The common factor is that they are based on modern designed-for-the-purpose steels, which offer features and benefits specifically tailored to each application.

At first glance, materials that weigh less than steel, such as aluminium, magnesium and plastics, may appear to be interesting alternatives.

> When considering GHG emissions, a key factor in understanding the real environmental impact of a material is its LCA. This approach considers the total greenhouse gas emissions generated by the production, use and end-of-life (recycling or disposal) phases of a product.

However, when the total life cycle of a material is taken into account, steel is very competitive, owing to its strength, durability, recyclability and versatility.

Figure 1: Steel's endless life cycle



Some facts about steel

- Steel is 100% recyclable at the end of its life. Alternatively, steel can be reused or remanufactured prior to being recycled.
- Between 3 to 4.5 tonnes less greenhouse gases are produced over the total life cycle of a typical five passenger car when the vehicle's body is manufactured using AHSS, compared to when using conventional steel.[12]
- Today, steel is the most recycled material in the world. Over 650 Mt of steel is recycled annually, including pre- and post-consumer scrap.[13]
- Steel is valuable and easily recoverable with magnets. Where collection and handling systems are in place, recycling rates are very high. For example, more than 85% of vehicles are recovered globally and nearly 100% of the steel in these recovered automobiles is recycled.[14]

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Footnotes

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14. Steel in the circular economy - A life cycle perspective, worldsteel, 2015.