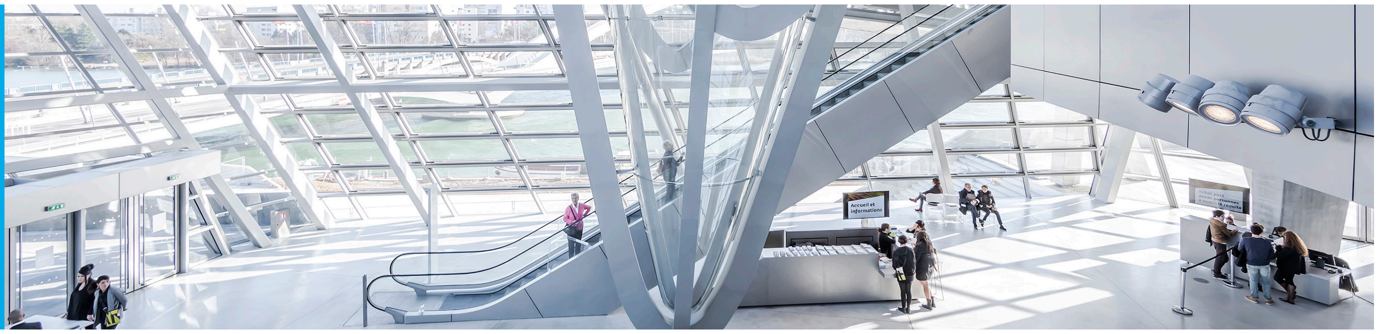
Fact sheet

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 25 billion tonnes of steel remain in use today in a variety of products.[1] 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 a key material 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. The strength of steel also enables building designers to use less material without compromising structural performance. Steel is part of innovative technologies that reduce energy use in buildings.

Today, steel is the most recycled material in the world. On average, around 650 Mt of steel is recycled annually, including pre- and post-consumer scrap.[2] Steel is valuable and easily recoverable with magnets. Where collection and handling systems are in place, recycling rates are very high. For example, around 90% of vehicles are recovered globally and nearly 100% of the steel in these recovered automobiles is recycled.[3]

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.[4]
- In 2019, around 91.8 million vehicles were produced worldwide[5]. Steel used per vehicle is 900 kg 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 enables lighter, optimised vehicle designs that enhance safety and improve fuel economy.[4]
- When taking a life cycle approach to compare functionally equivalent automotive components, Advanced High-Strength Steels consistently outperform lower density competing materials, emitting 5 times less CO_2 in the production phase than aluminium or carbon fibre, and 7 times less CO_2 than magnesium.[6]
- 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.[7]
- Many worldsteel members have been developing new grades of innovative high-strength steels of up to 1,500 Megapascals (MPa) allowing auto components to be made thinner and lighter without compromising on safety.

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 used to transform electrical power into usable energy.

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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 make wave energy devices.

Steel is such a well-used material in modern structures that we are often unaware of the design efficiencies they embody. A prime example are 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.

Steel in buildings and infrastructures[7]

Buildings with a steel structure offer the prospect of significant environmental savings at all stages of their lives: from the production of components to dismantling and reuse. For example:

- With steel structures, there is little or no construction waste. Co-products such as blast furnace slag cement and gas can be reused. The increasing use of used steel (scrap) in the production of new steel creates less and less need for the raw materials iron ore and coal. For example, over 80% of all steel beams are currently made from scrap. It is possible to make all standard steel grades from scrap steel. There is no 'downcycling'. Continuous innovation in production techniques and methods has provided a permanent reduction in energy used and emissions.
- Building with steel involves low use of raw materials. The use of stronger steels (up to 485 Megapascals) enables a further reduction in the quantity of material needed per structural element.
- A steel building has a long service life. Several environmentally friendly system types are available for protecting steel, including a series of coating system types, duplex systems (galvanizing + coating) and hot sprayed aluminium. The protection is applied in the factory under controlled conditions.
- A building can have a prolonged service life, e.g. by 'topping-up'. One or more new floors can be added with a light steel structure, thus minimising the extra loading on the existing structure and foundations and saving expensive reinforcement. Steel also lends itself to other forms of intensive use of space, by providing ample freedom in the arrangement and rearrangement of the building.
- At the end of the service life the steel structure is just as easy to dismantle as it was to construct. After dismantling, following some adaptation, the original parts are suitable for reuse as building components in new construction projects. For example, at present 50% of all structural steel is reused as building components. The remaining proportion is used as scrap in the production of new steel.

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 17 million containers of varying types make up the worldwide container fleet and the majority are made of steel.[8]

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 CO_2.

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, lower density materials, such as aluminium, magnesium and plastics, may appear to be interesting alternatives from a use phase perspective. However, these materials are often more energy and CO_2 intensive to produce than steel, thus increasing the production phase impacts. Therefore, when the total life cycle of a material is taken into account, steel is very competitive.

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

Steel's sustainability is also improved due to its strength, durability, recyclability and versatility.

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1. worldsteel calculation
2. worldsteel calculation
3. worldsteel calculation
4. UIC, High Speed Rail, Fast Track to Sustainable Mobility, 2012
5. Organisation Internationale des Constructeurs d'Automobiles (oica.net).
6. WorldAutoSteel, UCSB Model
7. WorldAutoSteel calculation
8. https://www.statista.com/statistics/253987/international-seaborne-trade-carried-by-containers/