

Alstom Transport commitment towards sustainable mobility

Worldwide demand for mobility is increasing. Demographic projections show that the global population is expected to reach 9 billion people before 2050, with 70% living in urban areas. Public authorities are concerned about the environmental impact of transportation – especially considering that around 23% (and rising) of all energy-related CO₂ emissions already come from it. A move towards electric transport and away from motorised¹ transport is vital for the optimisation of the transport sector's contribution to environmental sustainability. For the +2°C target for climate change² to be reached it will be imperative to move towards the modes with the lowest carbon footprints.

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¹ Using an on-board combustion engine

² Maximum rise target set by the UNFCCC for the century

Rail: the cleanest powered-transportation mode

More energy efficiency and less CO₂

Rail is already one of the **most energy efficient transport mode**. Globally, in 2011, the transport sector represented 27.6% of all energy used and was responsible for 22.7% of the total global energy-related CO₂ emissions. Worldwide transport sector CO₂ emissions increased by 53% between 1990 and 2011. In this context, **rail consumes only 2.2% of transport final energy and is responsible of 3.3% of CO₂ emissions in transport** (including indirect energy-related emissions) whilst carrying 9% of global passengers and freight³.

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CO₂ EMISSIONS per passenger per kilometre



This good performance reflects the **intrinsic efficiency of rail transport** and the benefits of **efficient electric traction** allowing braking energy recovery. Further development of clean and renewable energy sources will bring further environmental efficiency to the rail sector.

Air quality

Particles from diesel exhaust, as well as other air emissions from road transport, contribute significantly to poor air quality in large cities worldwide. In 2014, the World Health Organization (WHO) indicated that in most cities monitoring outdoor air quality, air pollution failed to meet WHO guidelines for safe levels.

A prioritisation of rail transportation would serve to reduce significantly the contribution made by the transport sector to air pollution in cities.

Reduced environmental footprint

Rail is **the most efficient transport mode in terms of space use**. Worldwide, road infrastructure uses 37 times more land than rail infrastructure while only carrying 3.5 times more transport units than rail.⁵ For example, on average, on a track smaller than a bus lane, a tram provides about up to two or three times higher transport capacity than a bus.

Safety

While more than three million people are killed in road traffic accidents every year, train incidents in the world are rare. **Railway systems are designed to meet the highest safety standards.**

³ Source: UIC

⁴ For France Sources : SNCF, RATP, MEDD – Guide méthodologique / Information CO₂ des prestations de Transport (oct 2012). "<4gr" data for urban and high speed trains

⁵ Source: UIC

Alstom, at the forefront of clean transportation

Alstom is convinced that transport systems should be **fluid, eco-friendly, safe, connected and accessible**. The company is constantly working on enhancing rail's reputation as the greenest public transport mode, striving to reduce the high cost of energy and committed to reducing transport's carbon footprint. In recent years, Alstom's technical innovations have allowed energy consumption reductions of up to 20%, depending on the train type.

Innovation as a driving force

Among the main innovations of the past few years, **permanent magnet motors** (PMM) have had a huge impact on the energy efficiency. Alstom decided to switch from asynchronous motors to PMMs because of their high power to weight ratio, which led to a 3% increase in output and a corresponding increase in energy efficiency. **High-temperature IGBT⁶** technology allowed a move from water cooling of the traction system to air cooling, or from forced to natural ventilation. We can also cite **electric braking down to 0 km/h**, which allows the recuperation of more energy, combined with **Hesop**, a power-supply substation designed for optimal energy efficiency and reduced infrastructure costs for urban and suburban rail transport networks. Hesop is the only all-in-one solution offering both traction and recuperation capabilities in the same piece of equipment.

Alstom also started to introduce **ecodesign** in engineering processes more than 10 years ago with the aim of reducing environmental footprint of its solutions. The results are environmental dashboards with targets on "hot spot" at the beginning of the development phase, a quantified environmental footprint (life-cycle assessments), and greener solutions. Today, over 100 experts (eco-designers, acoustics and material experts, energy engineers, etc.) are dedicated to guaranteeing the environmental performance of every solution.

Reducing the environmental footprint of trains, components and systems

Before tackling entire transport systems, Alstom reduced the environmental impact of its trains. Firstly, **weight** has been significantly reduced thanks to redesign of parts and the use of new materials such as composites. Alstom also develops components that have a **longer lifespan**; in the Citadis X05 for example, on new bogies, the wheel lifetime has been extended by up to 30% before requiring replacement.

Secondly, efforts have been made to improve **recyclability at end-of-life**. Progress made in this area has enabled Alstom to design trains that are up to 95% recyclable (c.f. 87% ten years ago) and 97% recoverable⁷ (c.f. 93% ten years ago).

Alstom is constantly looking to **upgrade its components** based upon the latest available technologies. Examples of this are the HVAC⁸ systems that now detect the presence of passengers in the train and adapt air flows to the occupancy⁹, and the lighting systems, which now use almost exclusively high-efficiency LEDs.

Alstom has also developed signalling solutions which **maximize energy efficiency**. The Urbalis Fluence for metros, which provides automatic control of train movement, delivers up to 20% energy savings thanks to **reduced intervals between trains** and a **reduction in maintenance** with a 20% cut in equipment.

⁶ Insulated gate bipolar transistor

⁷ Including energy recovery

⁸ Heating, ventilation and air-conditioning

⁹ Either through measuring the weight on the secondary bogie suspension or through CO2 captors

Automatic train operation (ATO) optimizes train movement and allows the **selection of an energy efficient mode of operation**. Furthermore, the fleet management system facilitates the optimisation of traffic to avoid the energy peaks.

In order to support its customers to improve energy efficiency of existing fleets, Alstom can also **modernise any train**, whether manufactured by Alstom or not, to upgrade traction chains or high energy-consuming equipment such as ventilation systems. For example, in 2014 the company was awarded a contract to upgrade the traction of 85 metro cars in Mexico. A previous metro modernisation contract in Mexico (MP82) demonstrated a 35% reduction in energy consumption.

Alstom has been designing systems, complete rail solutions supplied on a turnkey basis, for decades and in recent years has made efforts to optimise them by offering **solutions that include all the latest environmental innovations**.

Axonis is an elevated metro system able to carry from 10,000 to 45,000 passengers per hour per direction, which runs mainly on viaducts, but can also run at ground level and underground. It is a non-proprietary system, allowing cities to increase their fleets and develop line extensions through a competitive bidding process. The system can be up and running in three to four years from contract signature. Once the viaduct is elevated, railway tracks are installed using Alstom's Appitrack, which reduces the impact of infrastructure construction works, limiting noise, dust and waste. Energy consumption is limited as it is equipped with steel wheels, 100% motorised bogies and Hesop. The combination of these three elements reduces the traction energy required by up to 40% compared with metro trains running on rubber tyres.

Attractis, Alstom's integrated tramway system, brings together all of Alstom's expertise, enabling cities to develop, at a more affordable cost, a tramway system that is environmentally-friendly, interoperable, simpler to operate and offering large transport capacity ranging from 4,000 to 14,000 PPHPD¹⁰. Alstom is currently undertaking a carbon footprint analysis of its Attractis system.



¹⁰ Passengers per hour per direction

Examples of reduction of the environmental footprint of our solutions



The braking system of the **new type of metro for the Paris network (MP14)** is 100% electric, recovers energy and injects it back into the network in the form of electricity, thus avoiding the emission of fine particles from brake pads. This system reduces air pollution as well as the metro's energy consumption by up to 20%.



Despite its wide gauge, **the Metropolis train for Amsterdam** is low weight (12 tons per axle) thanks to its aluminium body and redesigned components. Its electric braking until the train comes to a complete stop enables full recovery of the braking energy and reduced dust and noise emissions. Its lighting is 100 percent LED. The Amsterdam metro is one of the quietest in the world (-8dB interior noise level).



Citadis trams now include permanent magnet motors, an optimisation of the traction system to reduce energy consumption and making the trams highly recyclable by using materials designed to protect the environment. Since it first entered service, more than 5 million tonnes of CO₂ emissions have been avoided by Citadis operations.



The Euroduplex is the only double-decker very high-speed train in the world. The consumption of energy per seat is 20% lower than in single-deckers and the trains can carry between 20% and 40% more passengers in high comfort.



The H3, a new-generation hybrid shunting locomotive that produces up to 50% less CO₂, and up to 70% less pollutant emissions overall. Noise emissions have also been significantly reduced (2dBA). The 350 kW diesel generator meets the highest exhaust gas standard requirements and has been designed with future exhaust gas standards in mind. Depending on its use, the shunting locomotive will spend between 50% and 75% of its service time in battery mode. This makes it possible to achieve zero-emission rail transport in urban areas or production halls.



The reduced weight, traction system, associated with an original design of **Coradia Polyvalent** enable a reduction in energy consumption of around 15% compared to previous generations. The lifecycle of the trains, from their conception to their recycling, represents an investment for the future due to their very long lifespan. Coradia Polyvalent is over 98% recoverable.

Alstom's new ambition for energy efficiency

Alstom has set its targets for the energy efficiency of its **solutions** and its **operations**. The company will commit to an energy consumption reduction of its transport solutions of **20%** by 2020 (compared to 2014 levels). Moreover, Alstom is committed to reducing the energy intensity of its operations by **10%** by 2020.

-20% of energy consumption for Alstom's solutions

Tracking energy performance of solutions

Alstom is the first manufacturer to have set a **key performance indicator** and a target on the energy performance of its solutions. This will allow the evolution of the energy performance to be tracked. The company is currently defining standard energy measurement methodologies to ensure consistency in data collection and deploying energy simulation for existing and future solutions.

Innovating for higher energy efficiency on all phases of the life-cycle

Alstom is currently developing entirely **new types of trains** equipped with a fuel cell drive, a device that converts the energy from a fuel into electricity through a chemical reaction. This technology has already been used in the automotive industry. The train will be completely emission-free and its noise level will be drastically reduced. Furthermore, through the use of energy storage, as well as intelligent energy management systems and a cost competitive fuel, the new train will be significantly more efficient to run than a conventional diesel multiple unit.

Alstom is also developing **a new generation of high-speed trains**, which will be able to carry up to 750 people and will consume 35% less energy than the previous generation.



In 2014, the company signed an LOI with five German Landers (regions) to develop a **new-generation emission-free train**

The -20% target is expected to be achieved through innovations on the trains themselves but also on the **infrastructure and the services** offered. Alstom will for instance further reduce the **weight** of the trains and the **resistance to motion**. Optimized **HVAC** systems will be implemented for the different market segments through the use of CO₂ sensors or similar and **heat pumps** will be proposed.

The company has been working on the integration of **Capillary pump loops** (CPL) - extremely high-performance calories evacuation systems - within their traction systems. CPLs can be installed on every type of train in order to replace classic cooling systems such as ventilators, pumps and radiators. This technology offers clients a solution that operates silently, does not consume energy, and requires very little maintenance.

Alstom has also developed **a new auxiliary convertor** that enables entirely natural cooling and leverages the technical performance of silicon carbide semi-conductors. This enables a reduction in conduction and switching losses. Natural cooling removes the need for bulky and less reliable cooling systems (pumps,

ventilators) and reduces maintenance costs and energy consumption, while simultaneously increasing passenger comfort thanks to its silent operation.

The company will further develop and deploy **Ecomode** - energy storage systems that will be used for future tramways wireless technologies, **Ecoregulation** - which is a smart software for on-time performance and energy saving and **Ecodriving** - which deploys advisory systems and training capacities for the drivers.

Lately, Alstom added SRS – an **innovative ground-based static charging system** – to its catenary-free range. SRS charges the tram in less than 20 seconds when it stops at stations. Equipped with super-capacitors, the tram is recharged via a ground-based conductive rail and through collector shoes mounted under the body allowing highly energy-efficient catenary-less operations.

Collaborating with customers and suppliers

Alstom has established collaborative programmes with its customers in many countries (France, Brazil, Ireland, Spain...) in order to improve energy efficiency of trains and railway systems and build the sustainable transport modes of tomorrow.

Alstom is also committed to the sustainable sourcing of its products. In March, the company joined **Railsponsible**, together with five other companies from the railway industry. Railsponsible is a collaborative procurement initiative focused on improving sustainability throughout the entire supply chain, by sharing best practices and processes, driving common understanding across the industry, and using common tools.

-10% of energy intensity for Alstom's factories and sites

Alstom has defined its priorities for environmental management which includes water, waste and energy management. Energy intensity of operations (per hour worked) is tracked. **Alstom has already succeeded in reducing the energy intensity of its operations by 18% since 2008.**

In Germany, Alstom's Salzgitter plant has deployed an extensive energy management plan involving overall computer-based energy management system, heat recovery from compressors, variable speed compressors, LED lighting. In Italy, Alstom has established an energy steering committee to track the energy consumption of its sites and deploy improvement programme.

In France, a new series of in-depth energy surveys is being deployed to identify further areas for improvement. **Alstom's sites in the UK and Belgium** are being supplied with green electricity guaranteed for zero-carbon emissions and **sites in France** are using certified electricity to ensure at least a minimum level of renewable content in the energy they use. This will be extended to other units in the future.

In the Netherlands, Alstom succeeded in getting certification level 5 (highest level) on the CO₂ performance ladder initiated by ProRail. This demonstrates the leading CO₂ performance of Alstom's operations in the country. It reflects the commitment of Alstom teams and its suppliers to reduce global



CO2 emissions, through a large number of initiatives and programmes such, one example of which is a renovation programme to reach the highest energy efficiency standard for the headquarters building in Rijswijk.

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