AGV
FULL SPEED AHEAD INTO THE 21ST CENTURY

ALSTOM

In the 21st century, very high speed rail is emerging as a leading means of travel for distances of up to 1000km.

The AGV in final assembly in our La Rochelle facility: placing the lead car on bogies

ALSTOM'S 21ST CENTURY RESPONSE

With responsible energy consumption a key consideration in transportation, very high speed rail is emerging as a serious contender for market-leading positions in the competition between rail, road and air over distances ranging from 100 to 1000 km.

INTERNATIONAL OPPORTUNITY KNOCKS

Clean-running very high speed rail offers clear economic and environmental advantages over fossil-fuel powered transportation. It also guarantees much greater safety and security along with high operational flexibility: a high speed fleet can be easily configured and reconfigured in its operator's service image, whether it is being acquired to create a new rail service or to complement or compete with rail and airline operations.

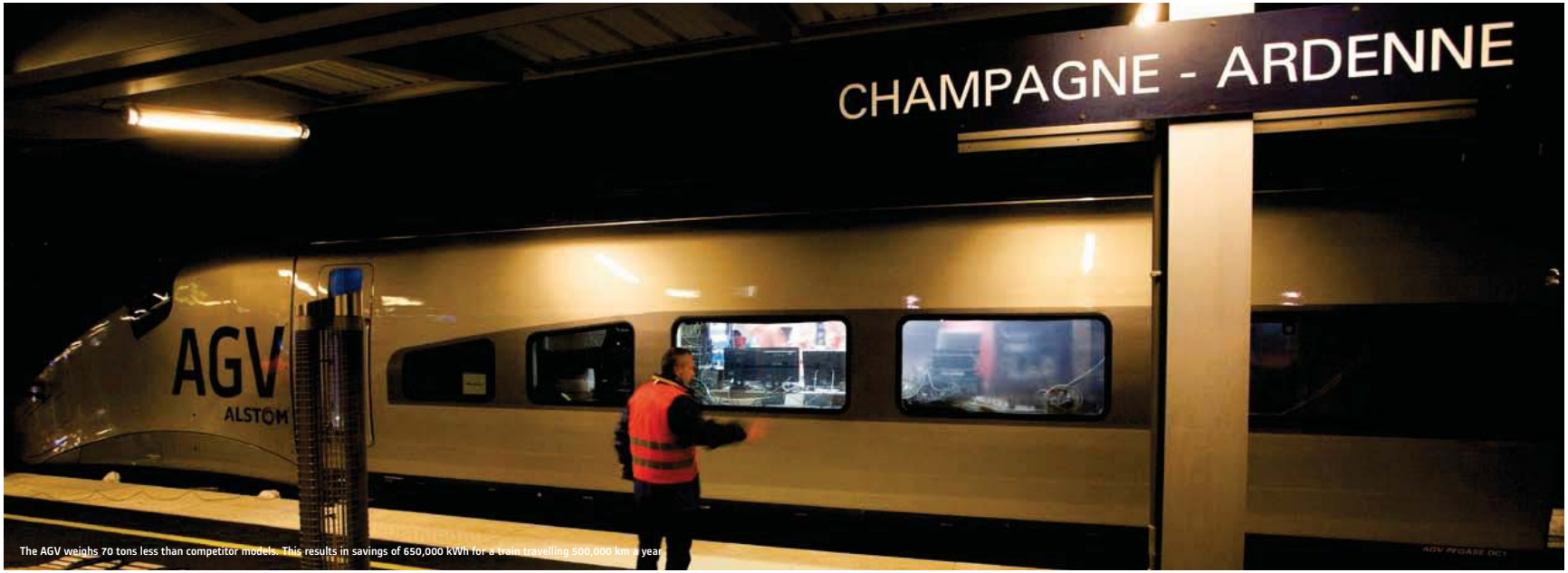
Major technological advances in rail are helping to open these new business prospects. As new national and international opportunities arise, such advances will enable you to define the best direction for your company in this next generation of higher speeds, higher expectations and higher potential rewards.

AGV, INNOVATION WITH A CLEAR PURPOSE

The AGV is designed for the world's expanding market in very high speed rail. It allows you to carry out daily operations at 360 km/h in total safety, while providing passengers with a broad new range of onboard amenities.

The single-deck AGV, along with the double-deck TGV Duplex, bring operators flexibility and capacity on their national or international itineraries. Solidly dependable, the AGV delivers life-long superior performance (15% lower energy consumption over competition) while assuring lower train ownership costs from initial investment through operating and maintenance.

The AGV combines the well-established design philosophy of the TGV and 30 years of technological expertise in very high speed rail with ground-breaking innovation. Over 560 Alstom Very High Speed Trains (VHSTs) currently operate at speeds above 300 km/h - that's over 60% of all VHSTs worldwide. Together they have transported over 1.7 billion passengers.



The AGV weighs 70 tons less than competitor models. This results in savings of 650,000 kWh for a train travelling 500,000 km a year.

AGV, PROVEN INNOVATION FOR A NEW RAIL ERA

The AGV is the very first VHST to be designed from the outset as an internationally interoperable train that meets the needs of all involved: operators, passengers (including those with reduced mobility), train drivers, train fleet maintainers and railway infrastructure managers.

YOUR OPERATIONAL NEEDS, YOUR HIGH SPEED CHOICE

Safe, economical and versatile, our very high speed range is at once environmentally-friendly and built for comfort. Operators can order either the single-deck AGV or the TGV Duplex to build the interoperable VHST fleets that best serve their needs.

The double-deck train is for dense traffic. It offers the highest train capacity on this market as well as a very high level of comfort. It will also comply with the latest TSI* requirements and be fitted with best-in-class comfort features including a passenger information system.

Complementing our high density carrier, the AGV offers flexible composition in single-deck architecture. Developed for seamless international operations at 360 km/h, AGV has been designed from the start for full compliance with TSI. It can be used for service with multiple stops, bifurcations and international routes.

* Europe's Technical Standards for Interoperability

New world speed record in rail

On April 3, 2007, the Alstom V150 train tested in partnership with SNCF and RFF reached a speed of 574.8 km/h on the new East European high speed line in France. The V150 trainset consisted of 2 TGV power cars, 3 TGV Duplex coaches and 2 AGV motorized bogies and traction units. The new AGV bogie design demonstrated excellent stability in extreme performance conditions. The AGV Permanent Magnet Motors (PMMs), pantographs, traction units and transformer were also fully validated. The world record was the culmination of thousands of hours of testing involving over 300 engineers and technicians.


The Alstom V150 at 574.8 km/h, a new world speed record in rail

DESIGNED FOR SAFETY & SECURITY

The AGV's front end is designed to absorb impact to assure driver and passenger safety

Safety & security are essential attributes of the AGV's pedigree and have been perfected by Alstom over 30 years of accumulated VHST know-how.

ARTICULATED TRAINSET ARCHITECTURE

The AGV is not just equipped for safety. Safety is integral to its basic design. Take the proven articulated trainset architecture: each car shares a bogie with the adjacent car, creating a semi-rigid link between cars. In addition to providing superior dynamic comfort, this full-train architecture minimises the risk that the trainset will break up and cars will pile up, in the event of a derailment. This, in turn, limits the risk of a derailment becoming a very serious accident.

A NOSE FOR SAFETY

Thanks to its uniquely designed nose, the AGV meets TSI crashworthiness requirements in full, as defined in terms of a set of specific crash scenarios. The kinetic energy absorption unit installed in the AGV nose provides the highest levels of protection to both driver and passengers in the first coach in the event of a collision. It consists of a 3-stage crumple device that absorbs 4.6 MJ (equivalent to the impact of a heavy truck at 110km/h).

THE AGV DRIVER, SAFE AND SECURE

Beyond ergonomics and comfort, the driver's cab has been the subject of studies to assure a maximum level of driver safety. The cab area's structure has been specially studied to remain integral in case of collision. The driver's desk and surrounding areas have been designed with rounded forms to avoid injury in case of impact; simulations have been carried out with crash test dummies to verify that the environment is truly non-aggressive. To heighten security, the driver has a dedicated entry door and all cabinets containing critical equipment are located in the secure driver zone, completely inaccessible to unauthorized parties.

THE FLEXIBILITY TO MEET YOUR SERVICE NEEDS

The AGV's "hollow tube" interior gives operators great design flexibility

The AGV is designed to give operators the flexibility they want in terms of train composition and interiors.

THE IMPORTANCE OF BEING FLEXIBLE

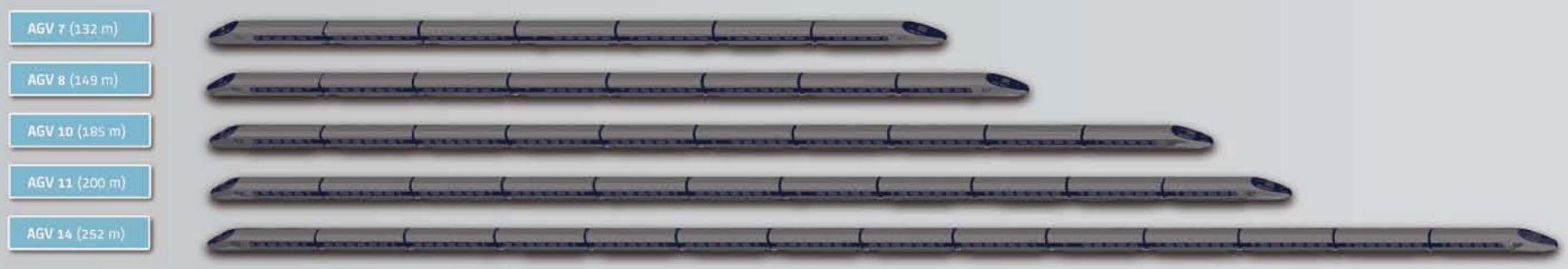
The AGV is offered in trainset configurations of 7, 8, 10, 11 and 14 cars. Up to three 7-car AGV trainsets may be operated in multiple units (within the standard TSI length limit of 400 m) on an initial itinerary and then separated for different final destinations. This flexibility brings operators significant benefits in terms of yield management. The AGV's flexibility-by-design also allows each operator to guide the configuration of train interiors according to their own marketing strategy and their ideal balanced between high comfort and high capacity.

TUBE DESIGN LEAVES OPTIONS OPEN

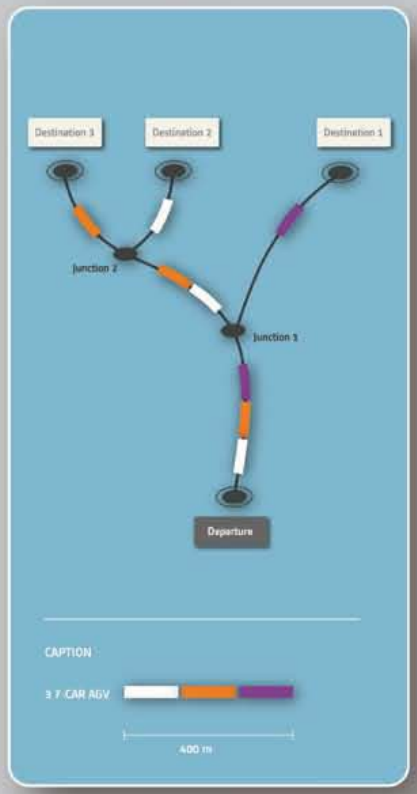
The AGV is designed basically as a hollow tube that operators can fit out as they see best fitting their business model. With such flexibility, operators can choose to install different areas for leisure, work, meetings, reading and rest. In each of these areas, lighting can be customized to enhance the ambiance desired. Textures, paint colours and new lightweight textiles co-developed by Alstom and our partners are also part of the palette available to operators to lend character to different travel areas. Thanks to the AGV's "tube" design, operators can easily re-configure interiors and seat pitches during the train's lifetime.

THE FLEXIBILITY TO MEET YOUR SERVICE NEEDS

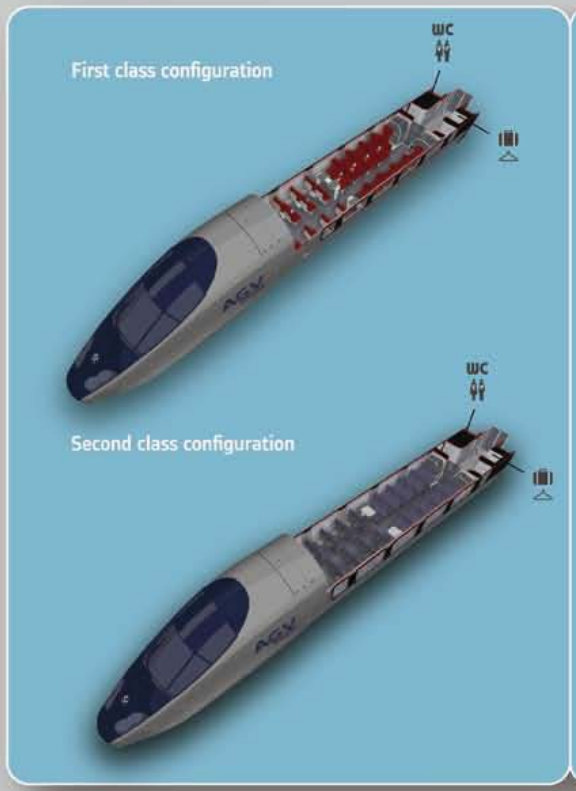
AGV CONFIGURATIONS



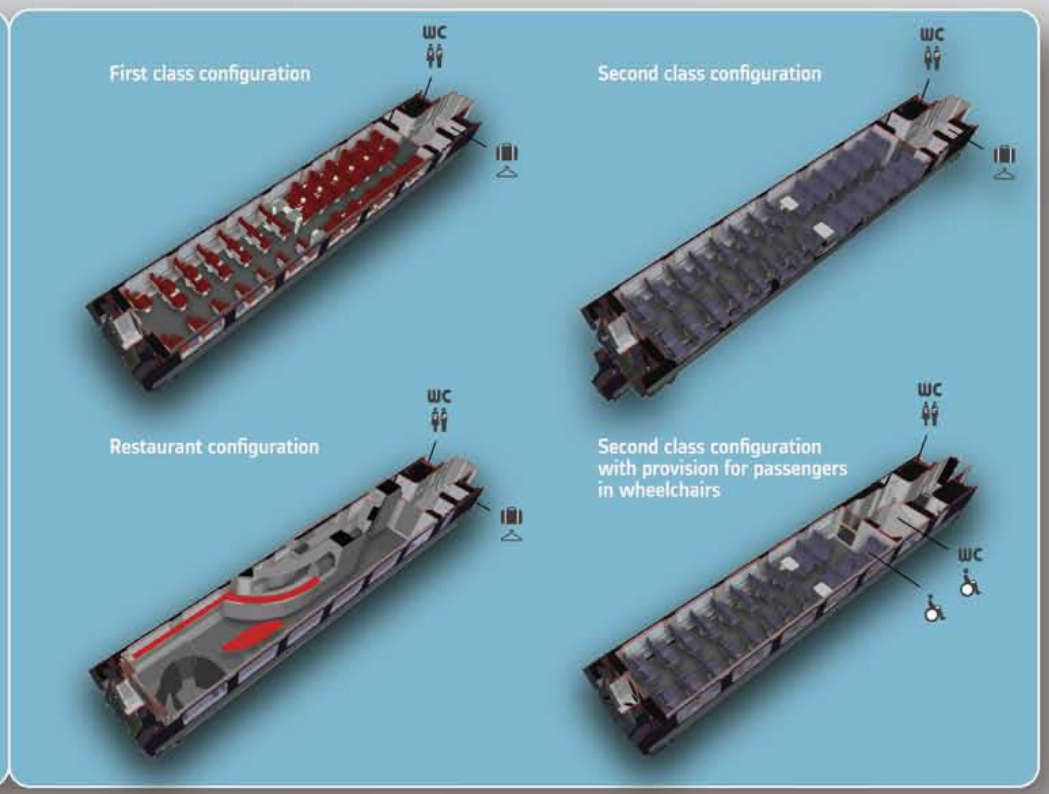
FLEXIBILITY FOR MULTIPLE DESTINATIONS



DRIVER CAR



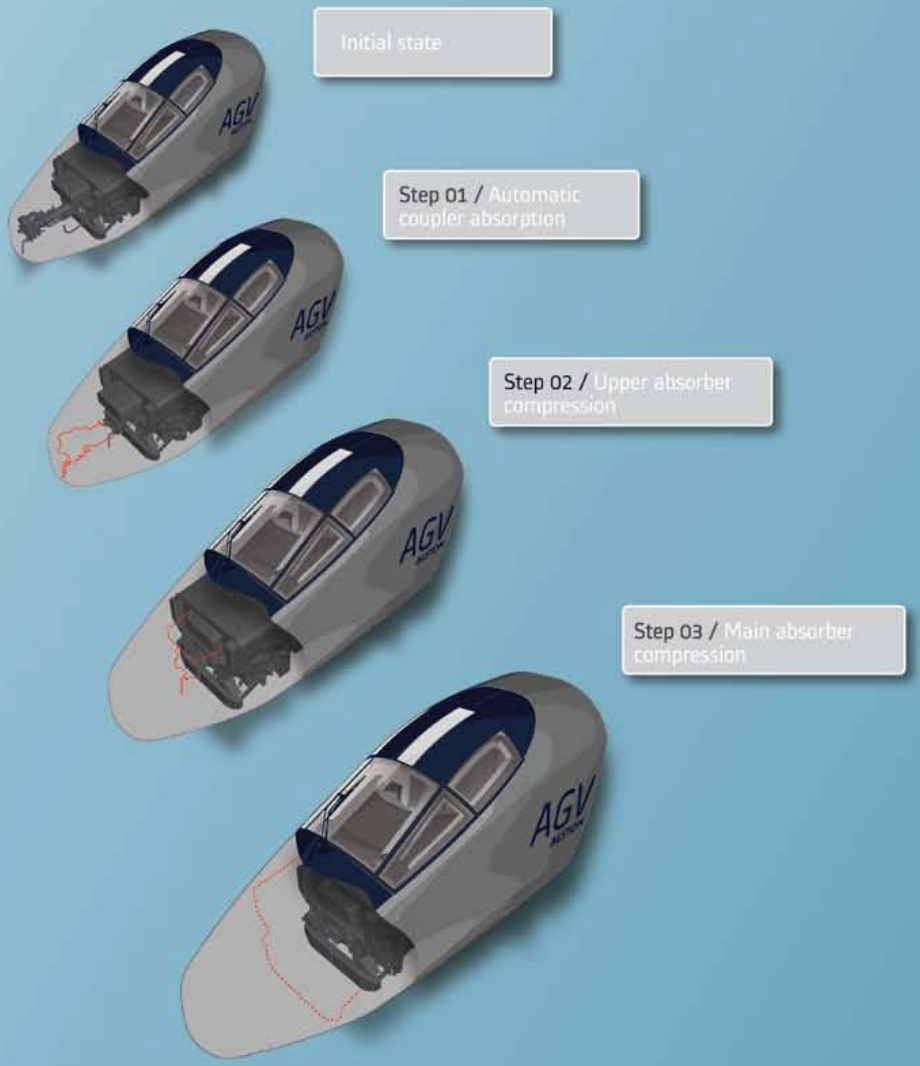
TRAILER CAR



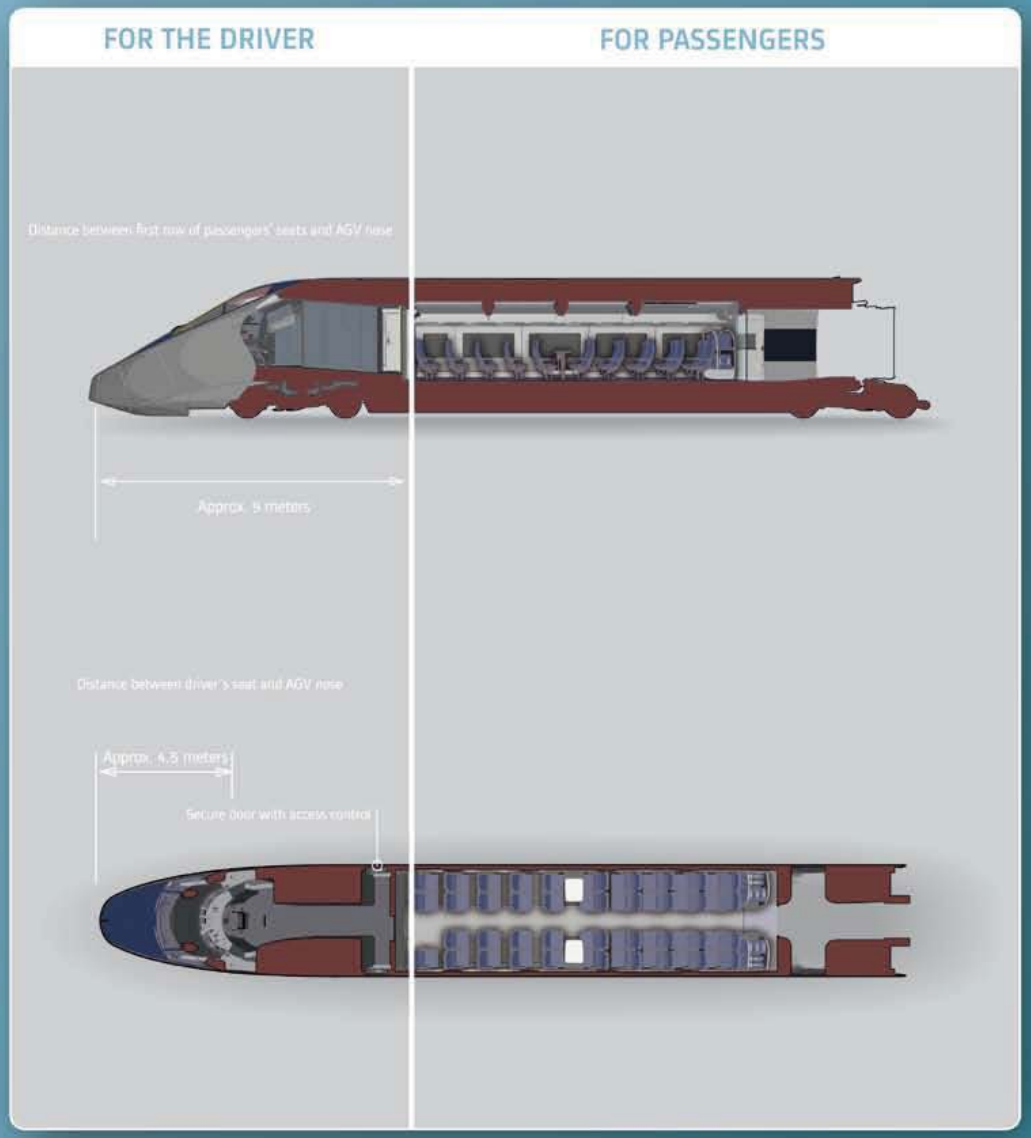
FLEXIBILITY OF INTERIORS

DESIGNED FOR SAFETY & SECURITY

ENERGY ABSORPTION DEVICE



DRIVER AND PASSENGERS SAFE & SECURE



The driver's desk has been designed ergonomically for comfort, optimum performance and safety

e-capabilities:
Infotainment and security

The AGV is equipped with a standard Ethernet backbone dimensioned to deliver the multimedia and connectivity services your passengers expect in the 21st century. A wide range of optional equipment for passenger information and entertainment services is offered including Wifi and onboard Internet. Designed for modularity, our IT technology can be tailored to meet your specific needs, either as an integrated system or as separate modules. Our IP-based system solutions allow us to easily integrate equipment of any make. All meet new European and US standards for visual and audio communications for passengers with disabilities.

DRIVER CONSIDERATIONS

The cab is TSI-compliant in terms of crash protection and interoperability. It has also undergone rigorous reviews by ergonomics and aesthetic design teams to ensure pleasant working conditions, including intensive acoustic studies to minimise noise levels inside the cab, which are limited to 78db at 330 km/h. The cab is fitted with a redundant HVAC system and an individual access door, and all electrical cabinets are directly accessible from inside the dedicated driver zone.

The driver's desk

The AGV driver position and controls are located centrally. The cab has a generously dimensioned conical front bay, affording the driver an excellent view and natural light. The desk can be manned by a single driver and a seat is provided for a co-driver. An ergonomic study was done using digital modelling to minimise driver fatigue and to make user-friendly screens for the modern TCMS (Train Control and Monitoring System).

IMPROVED ON BOARD COMFORT

Quality time to spend as you choose aboard the AGV

The AGV is designed to offer all travellers new levels of comfort: spacious interior compartments and wide gangways, large window surfaces, a smooth ride, lower levels of interior noise and multimedia amenities.

PUTTING PASSENGERS FIRST

Attractive and comfortable trains are critical to the success of your transport business. To provide optimum comfort, AGV cars are wider than any other very high speed car on the market (in the UIC loading gauge). This will give you the possibility to propose wider seats or wider corridors. The AGV has the largest windows on the VHS market, ensuring luminosity from natural light along with scenic views to enhance the passenger's feeling of spaciousness.

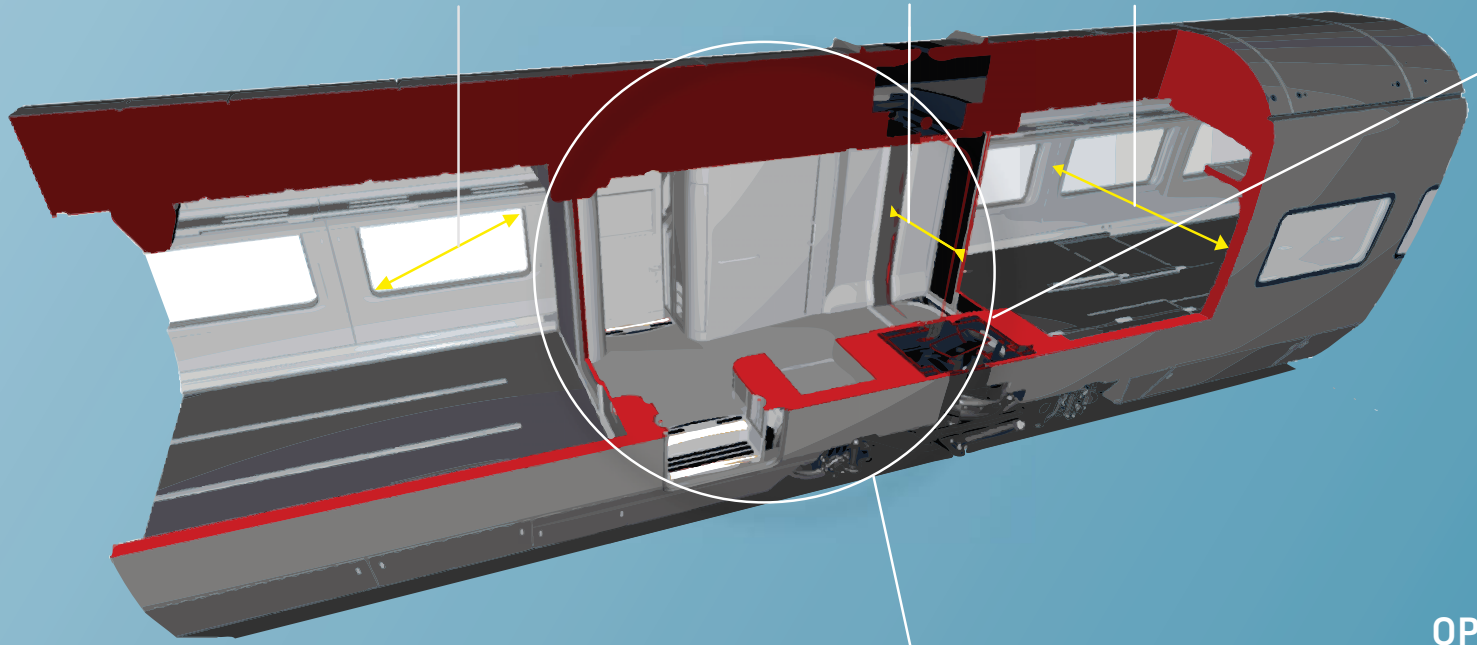
The AGV's floor height allows passengers to enter trains from the platform by two 200mm steps, which is fully compliant with TSI for people with reduced mobility. Special care was taken to keep noise low. Passengers can expect a more comfortable ride with less vibration and less noise, thanks to the trainset's articulated architecture. The heating, ventilation and air-conditioning (HVAC) system is designed to offer the best climatic comfort to passengers, whatever the countries the AGV operates in.

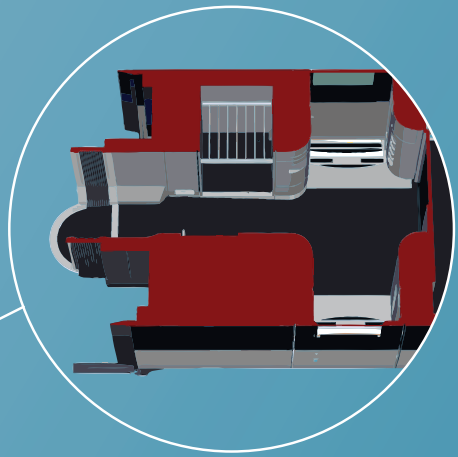
TUBE DESIGN: NEW LEVELS OF COMFORT & OPTIONS

LARGE WINDOWS:
+15% OF SURFACE

WIDE GANGWAYS:
1,000 m

SPACIOUS INTERIOR:
2,750 m





VESTIBULE AREA

OPTIONS IN THE VESTIBULE AREA

CATERING AREA CONFIGURATION: 3 OPTIONS

AUTOMATIC VENDING MACHINE

COFFEE MACHINE

SERVICE AT PLACE INCLUDING HOT MEALS

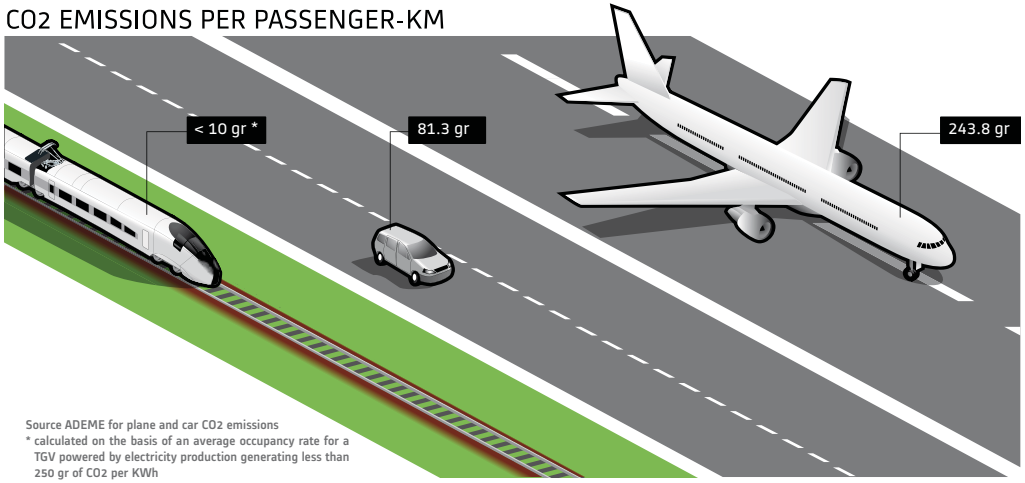
TRAIN MASTER OFFICE

BAGGAGE STORAGE

LUGGAGE STACK

CONFIGURATION WITH PROVISION FOR PASSENGERS IN WHEELCHAIRS

DESIGNED FOR ENVIRONMENTAL AND ECONOMIC EFFICIENCY



Source ADEME for plane and car CO2 emissions
* calculated on the basis of an average occupancy rate for a TGV powered by electricity production generating less than 250 gr of CO2 per KWh

The AGV is designed to meet the environmental and economic challenges of today and tomorrow.

IMPROVED LIFECYCLE COSTS

The AGV delivers superior lifecycle cost performance. Operators can count on:

- Energy consumption savings of 15%: thanks to the train's articulated architecture (less bogies, reduced aerodynamic drag), the permanent magnet motors' improved efficiency and body shape optimized for aerodynamics and thanks to the train's total weight, at 410 tonnes (for a 200 m long AGV), 70 tonnes lighter than competitors.
- Further energy savings: come from the AGV's maximized use of regenerative electrodynamic braking, in which energy is returned in priority to the power supply network during braking phases.
- Maintenance savings of 15%: thanks in particular to less bogies and to the closed, self-ventilated permanent magnet motors.

ENVIRONMENTAL RESPECT

Trains are a naturally environmentally-friendly mode of transport. The AGV goes even further. The AGV's 15% lower energy consumption results in savings of 650 000 kWh for a train travelling 500 000 km a year. Although the AGV generates no CO2 itself, the type of power station that produces the electricity will be a source of CO2 within a full "well-to-wheel" CO2 calculation. Today operators can choose to purchase "carbon-free" electricity and thus eliminate any contribution to their "Carbon Footprint" from the energy used by their electric trains.

The AGV is designed for end-of-life recyclability with a target to use over 90% of recyclable materials. Finally, the AGV makes less external noise as it runs, lessening its environmental impact, thanks to its aerodynamic design and reduced number of bogies.

Designed to facilitate maintenance

The AGV offers low energy consumption, and so lower CO2, reduced maintenance expense, reduced generation of external noise and end-of-life recyclability.

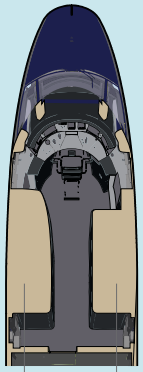
DESIGNED FOR EASY MAINTENANCE

The AGV's vital sub-systems have been designed to minimise the time, and hence cost, of periodic maintenance operations. This redesigning was based on extensive feedback from our maintenance teams and those of our TGV customers, and by the integration of Alstom train maintenance experts within the AGV design team.

The AGV is equipped with our latest TrainTracer solution. By capturing data on the status, location and events of the train and transmitting it in real-time to maintenance managers, preventive and corrective maintenance operations are enhanced and our customers' fleet availability is boosted. The AGV's "e-capability" includes a standard provision for remote train diagnostics to improve the efficiency of train maintenance operations.

A further technological advance is our TCMS (Train Control Monitoring System), which conforms to European standards. A highly modular combination of hardware and software, this system acts as the AGV's brain and nervous system. It is organized into three independent sub-divisions that can be modified, tested or homologated separately.

INTEROPERABILITY FROM THE OUTSET



The AGV driver cab is equipped with 2 signaling cabinets designed to integrate all the relevant signaling equipment

Standard AGV signaling equipment includes ETCS level 2 with GSM-R radio communication. National signaling equipment is chosen by the operator

SETTING HIGHER SIGNALING

The AGV is the first very high speed train to be designed from the outset for international interoperability, fully compliant with the EU's Interoperability Technical Standards:

- The signaling cabinet can house interoperable ETCS (European Train Control system) and national train speed control signaling equipment for operations on any international high speed corridor in Europe.
- The AGV can operate with any of its four distinct power supply voltages (25kV - 15kV - 1,5kV - 3kV) or a combination of those.
- The driver's desk layout and equipment are compliant with international standards for interoperability and designed in keeping with EU-D (European driver) recommendations.

ERTMS, UNITING EUROPEAN RAIL

The EU's new common European Railway Traffic Management System (ERTMS) will allow all rail traffic to flow throughout Europe, freed of yesterday's different signaling technologies. Rail traffic will be faster, safer and more cost-effective.

As manufacturer and systems integrator, Alstom has been a major contributor to ERTMS development from its inception. Today, our train-borne and track-side ERTMS solutions are at work in several European countries, making seamless, cross-border rail operations possible at speeds of 300 km/h and above in total safety. Alstom is the leader in ERTMS operational deployment, with over 1,200 trains equipped and close to 20 million kilometers covered in commercial service.

INTEROPERABLE REFERENCES IN VERY HIGH SPEED

Alstom has played a pioneering role in the development of very high speed rail for international routes, supplying many of Europe's interoperable fleets. We have the skills and knowledge of national network requirements to assure satisfaction.

EUROSTAR

Eurostar, the very high speed rail service linking London, Paris and Brussels, celebrated its 10 millionth passenger at Christmas 2008. An Alstom-led consortium had designed the Eurostar train back in 1989, meeting safety and comfort requirements despite wide disparities in gauge, electrical supply, signaling system and platform heights. Alstom supplied 38 trainsets, each offering a capacity of nearly 800 passengers. We also provided a centralized traffic control system for shuttles and international train operations in the Channel Tunnel, allowing automatic route control for timetabled traffic.

THALYS

French, Belgian, Dutch and German national railways created Thalys International, a high-speed passenger rail service operating on their respective networks in the 1990s. Alstom, renowned in high speed rail and interoperability, was chosen to supply the fleets for this multiple-border, multi-system route. Each of the 17 trains in the Thalys PBKA fleet (Paris – Brussels – Cologne – Amsterdam), based on our classic single-deck TGV, is equipped for four national signaling systems and associated line voltages. Alstom also supplied 10 additional Thalys PBA trains equipped to run between the three capitals. Both fleets, remarkable for their passenger and driver comfort, operate at up to 300 km/h on high speed lines and 220 km/h on standard track.

TGV EAST

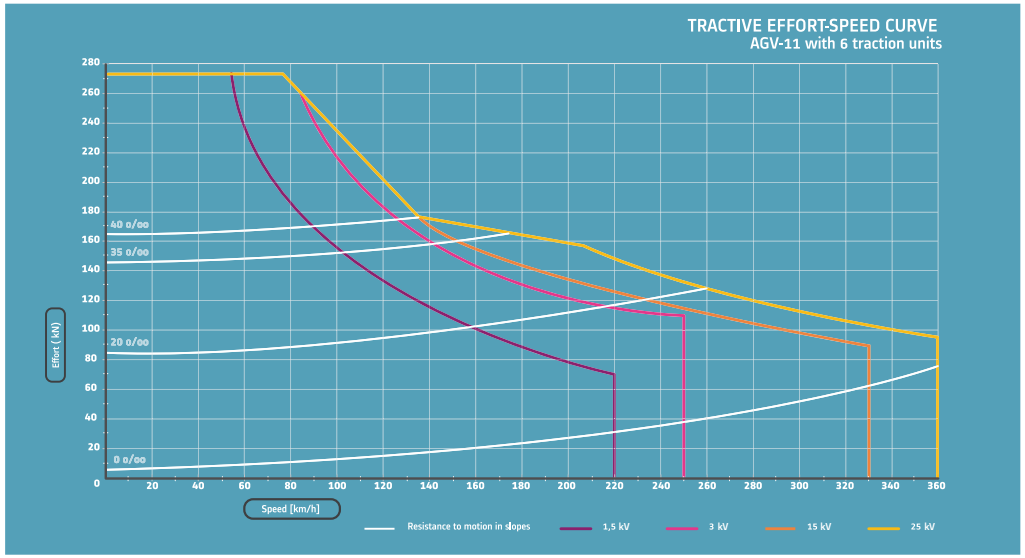
For this new very high speed line linking France and Germany, Alstom is supplying some 38 power cars. The first of these were put into service in 2007. The aerodynamic design of the East European TGV power cars is derived from our THALYS and TGV Duplex trains. The new link will ultimately connect Paris to Strasbourg at speeds up to 320 km/h (300 km/h in Germany). The power car is not only faster but also 7% more powerful than the previous TGV Duplex generation thanks to a new IGBT traction system and asychronous motors.

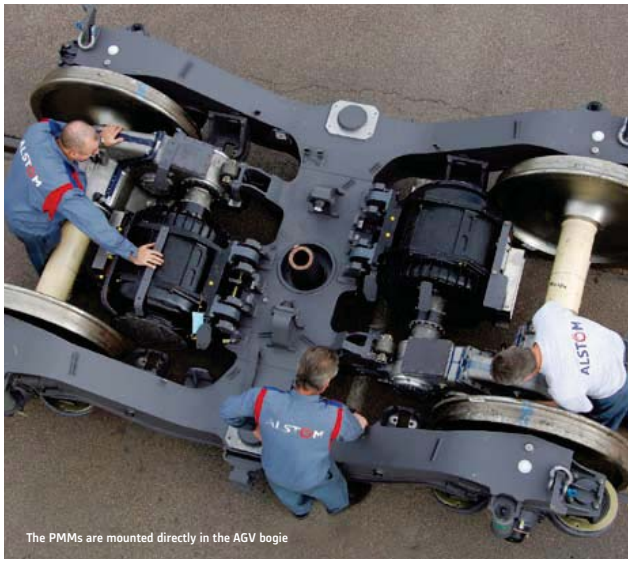
The pantograph

Pantographs can have bows of various widths (1,450, 1,600 or 1,950 mm) and of different materials (pure carbon or a combination of carbon and copper) adapted to the AGV's different routes. The AGV pantograph is equipped with a real-time electronic control system, assuring the bows' constant pressure on the catenary. This was used in the recent world speed record at 574.8 km/h.

The AGV pantograph is equipped with a real-time electronic control system to assure consistent high performance

BOOSTING PERFORMANCE AND RELIABILITY





The PMMs are mounted directly in the AGV bogie

THE TRACTION SYSTEM

The AGV is powered by a new traction system composed of Onix 6.5kV IGBT power modules, a 3600 V power bus and Alstom's innovative Permanent Magnet Motors (PMMs). These motors reduce weight and enhance the AGV's energy efficiency. The new motor is supplied by electrical converters using a high voltage switch, such as IGBT. The PMMs are lighter and more compact than previous asynchronous motors - 1/3 less weight and volume. They have an improved power-to-weight ratio of over 1kW/kg, simplified ventilation circuits and most importantly, lower energy consumption. This is a significant contribution to the AGV's 15% lower energy consumption advantage over competitor VHSTs.

The AGV's specific power can also been scaled to purpose: its huge initial power potential (22.6 kW/ton) can be reduced by limiting the number of traction units for operators that do not intend to run at 360km/h on a daily basis.

The new Onix traction system architecture also improves reliability. Each AGV motor axle is powered by an individual Onix power inverter. An 11-car AGV may be equipped with 6 independent traction units. While enabling the train to generate massive, unparalleled power of 22.6 kW/ton (23% higher than its main competitor), this also means that a failure of one power module will result in the loss of only 1/6 of the effective train traction power, compared to 1/4 for most other high speed trains. This will give the operator superior punctuality capability, by maintaining a high level of performance in the exceptional event of a power module failure.

BOGIES

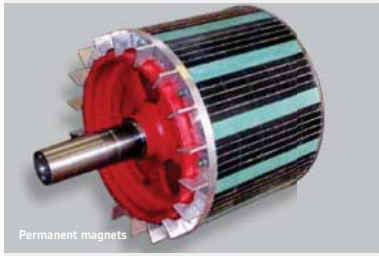
The AGV's new bogie design was based on service-proven TGV bogie technology. The difference lies in the PMMs, mounted directly in the AGV bogie, which allow a simplified drive transmission to the wheels compared to the TGV. With the number of drive bogies reduced and optimized, significant gains were achieved in reliability and train weight. The AGV motor bogie has proved its intrinsic stability and safety at high speed, covering over 700 km in test runs at more than 500km/h during the world high speed record.

BRAKING

Electrodynamic braking with energy recovery offers a host of new possibilities for reducing energy consumption and maintenance costs. The AGV produces its own electricity based on a braking system that features an energy-recovery and rheostatic brake. During braking stages, the electric power, which can reach up to 8 MW, is fed back into the grid. The AGV is designed to use this electrodynamic braking as much as possible in order to reduce friction-generated wear of mechanical parts. Moreover, the AGV's mechanical and rheostatic brake system will ensure safe braking in all conditions, even in the event of a broken catenary, caused, for example, by an earthquake.

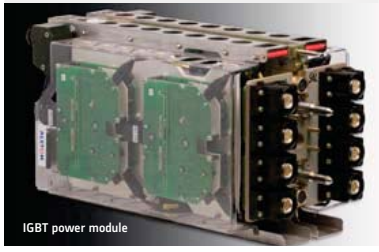
Permanent Magnet Motors...

PMM technology uses magnets in the rotor of a synchronous motor combining the benefits of both synchronous and asynchronous motor technologies. AGV PMMs are sealed and self-ventilated, reducing noise emissions, isolating interior parts from sand or dust, eliminating the need for external cooling fans, and as a consequence, reducing maintenance. PMMs are permanently fluxed, allowing a full availability of electro-dynamic braking for safety.


Permanent magnets

...& IGBT traction converters

The AGV uses water-cooled traction units with new modules that are much more compact and modular than those used on previous generations of very high speed trains. AGV semi-conductors are of the latest generation, proven IGBT rated at 6.5 kV, allowing the main power bus to be set at 3.6 kV, and thus simplifying the multi-voltage power scheme for full interoperability. These volume and weight reductions considerably improve performance and facilitate maintenance.


IGBT power module