Contributing to the transition of the railway industry **by developing low-carbon rolling stock**

In order to accelerate the decarbonisation of the railway sector, Alstom is developing new solutions to replace diesel-powered trains with trains using more environmentally friendly traction modes.

Starting date of the project	2014 - first hydrogen train project 2018 - first project in France
Project Localisation Places of implementation of the project at this stage and targeted geography if replicable.	France. Possible reproducibility in Europe.
Project objectives Type of climate innovation of the project with a description of the problem/issue addressed	Replacing trains using diesel traction with trains using alternative traction modes, further improving the carbon footprint of rail mobility (hydrogen traction, battery/diesel hybrid traction).
Detailed project description	Rail is currently one of the most environmentally friendly modes of transport (according to ADEME's Carbon Footprint, trains emit 32 times less than cars and 23 times times less than air travel). However, there is room for improvement, as some trains in operation are still powered by diesel. They represent about 20% of the trains running in France, but they cause emissions nearly 10 times higher than those of "electric" trains. Electrification of lines also remains a costly solution, especially for low-density lines. This project led by Alstom aims to: 1. structure and federate a French and European sector of excellence around clean rail technologies to: • Consider the hybridisation of the thermal fleet as a realistic solution both technically and economically to reduce emissions and operating costs, thereby contributing to important steps toward achieving the goals of decarbonisation; • Ensure the emergence of an ecosystem of French/European players in the forefront of clean technologies (H2, battery) in order to avoid dependence to non-EU partners; • Accelerate R&D / innovation in the industrial sector; • Develop a light hydrogen and/or a light battery train for small non-electrified lines 2. Support and accelerate the investment policy of the Mobility Organising Authorities (AOMs - Autorités Organisateurs de la Mobilité) / Operators, by launching a plan to "green" diesel train fleets: • Converting the 650 recent regional diesel or dual-mode trains (AGC, Régiolis) to a hydrogen traction mode; • Replacement of the 300 aging light diesel trains (ATER) in circulation on short lines in the regions. Alstom already has several initiatives underway to replace trains using diesel traction. In 2017, Alstom signed its first contract to supply 14 Coradia iLint™ trains to the region of Lower Saxony in Germany. The first pre-production trains approved by the Federal Association of German Federal Railway Association entered commercial service in September 2018. A new contract was signed with Infraserv GmbH & Co. Höchst KG for the supply of 27 trains for the public transport network of the Frankfurt metropolis, including the supply of hydrogen, maintenance and the provision of spare capacity for the next 25 years. In total, 41 hydrogen trains have already been sold in Germany. In 2020, tests were carried out on the Groningen-Leeuwarden line in the Netherlands and successfully met the 4 objectives set: authorization to operate on the Dutch rail network by the Dutch safety assessment body, no emissions and perfect operation match with the current commercial service, quick and easy refueling, and public awareness with hydrogen mobility. The report concluded that the hydrogen train is a perfectly viable alternative to diesel trains. The Coradia iLint also received official approval from the country's highest railway authority, the Austrian Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and

Technology (BMK) and successfully completed three months testing on the regional lines of the Austrian Federal Railways (ÖBB).
In March 2021, the first order for dual-mode electric-hydrogen trains in France was made by SNCF on behalf of the Auvergne-Rhône-Alpes, Bourgogne-FrancheComté, Grand Est and Occitanie regions. This national first order contributes to the ambition of the energy transitionto reduce greenhouse gas emissions and noise; an issue supported by the French government through its Hydrogen Plan initiated in June 2018.

Main project's drivers for reducing the greenhouse gas emissions

Reduction levers	Details on the aspects of the project
☐ Energy and resource efficiency (including behaviour)	
☒ Energy Decarbonisation	
☒ Energy efficiency improvements	
☐ Improving efficiency in non-energy resources	
☐ Emissions absorption: creation of carbon sinks, negative emissions (BECCS, CCU/S, ...)	
☐ Financing low-carbon producers or disinvestment from carbon assets	
☐ Reduction of other greenhouse gases emission	

Emission scope(s) on which the project has a significant impact and quantification of GHG emission reductions per emission scope

	Aspects of the project contributing to the reduction of emissions by emission category	Quantification of associated GHG emissions by emission category Please follow the quantification methodology used in the Afep guidelines.
Reduction of the company's carbon dependency		
Scope 1 *Direct emissions generated by the company's activity.*		
Scope 2 *Indirect emissions associated with the company's electricity and heat consumption.*		
Scope 3 *Emissions induced (upstream or downstream) by the company's activities, products and/or services in its value chain.*		
Increase of carbon sinks		
Emissions Absorption *Carbon sinks creation, (BECCS, CCU/S, …)*		
GHG emissions avoided by the company at third parties		
Avoided Emissions *Emissions avoided by the activities, products and/or services in charge of the project, or by the financing of emission reduction projects.*		About 500 000 ktCO2eq/year

Clarification on the calculation or other remarks: click here to specify
Every day, 20% of the trains running in France today are diesel trains, thus about 3500 trains (source: SNCF). According to ADEME's carbon base, the carbon emission factor of a diesel train (0.028 kgCO2e/t.km for an average load) is more than 10 times higher than the carbon emission factor of a train with electric traction (0.00124 kgCO2e/t.km for an average average load).

With the SNCF Group's CO2 emissions from rail traction at 1.4 MtCO2 in 2019 (source: SNCF's 2019 corporate social commitment report), the replacement of diesel-powered trains by hybrid or green hydrogen-powered trains in the rail fleet could save at least a third of CO2 emissions, i.e. around 500 million tons of CO2eq/year.

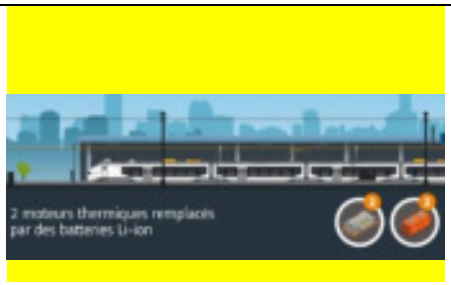
Modality of verification of the quantification

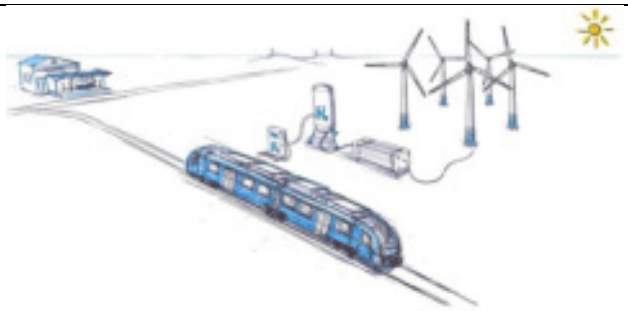
Calculation standard used (ADEME base, GHG protocol, etc.): click here to enter the information
Data based on:
- SNCF's announcements regarding the share of diesel trains in circulation,
- SNCF's carbon emissions described in their 2019 corporate social responsibility report commitment report for 2019,
- ADEME's carbon database.

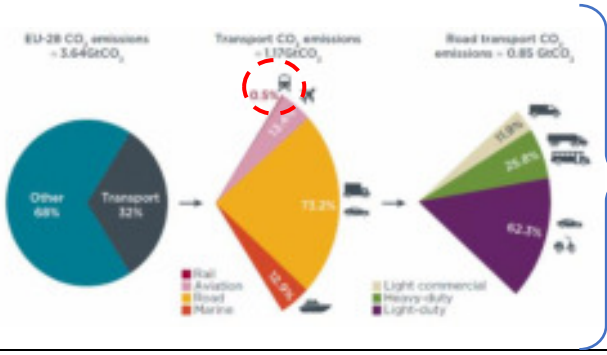
Verification of the calculation (internal or external): Internal click here to enter the information

Other environmental and social benefits of the project

Hybrid vs diesel only benefit: reduction of fuel consumption, reduction of noise emissions (entry into stations), energy recovery during braking, improved sound in passenger areas, reduced maintenance costs.

	H2 vs. diesel benefits: no GHG or particulate emission, reduced interior and exterior train noise, reduced vibrations, reduced maintenance costs. Other benefits include: 1. **Decongesting the road network** through modal shift; 2. **Strengthening the attractiveness of certain areas** thanks to the "short lines" network; 3. **Structuring the French industrial fabric of excellence** around clean technologies; 4. **Creating an ecosystem** (e.g., incubator, start-up) **favorable to innovation** in the field of decarbonisation; 5. **Creating skilled jobs** in the development and production of clean rail solutions; 6. **Massifying the use of decarbonated hydrogen** to reduce production costs and make it available for other uses (e.g. mobility).
Project maturity level	☒ Test in a simulated environment (TRL 5-6) **(for dual-mode hydrogen trains, in 4 French regions)** ☐ Prototype laboratory test (TRL 7) ☐ Real life testing (TRL 7-8) ☐ Pre-commercial prototype (TRL 9) **(for hybrid trains, in 4 French regions)** ☐ Small-scale implementation ☒ Medium to large scale implementation **(for hydrogen trains, in Germany, the Netherlands and Austria)**
Capacity and conditions of the project reproducibility, with associated climate impact mitigation potential	The use of hydrogen in the railway industry allows to massify the production and to reduce the costs to pool distribution points for other forms of mobility in order to facilitate their promotion and thus contribute to the emergence of a hydrogen ecosystem in the territories. The launch of hydrogen technology in public transport requires strong support from public finance.
Amount of investment made (in €)	Not disclosed at this stage
Economic profitability of the project (ROI)	☐ ST (0-3 years) ☐ MT (4-10 years) ☐ LT (> 10 years) **Remarks**: Not disclosed at this stage
Engaged partnerships	Partnerships involved the development of Hybrid trains: - French Regions (Grand Est, Nouvelle Aquitaine, Occitanie, Centre-Val-de-Loire) - SNCF - Ecosystem (local battery suppliers, suppliers of technological bricks, etc.) Partnerships involved in the development of Hydrogen trains - French Regions (Bourgogne Franche Comté, Grand Est, Occitanie) - French State - SNCF - Ecosystem (local H2 suppliers, suppliers of technological bricks...)
Open comments from the project owner	/
More about the project	
Contact the company carrying the project	Sustainability-csr@alstomgroup.com
Project URL links	https://www.youtube.com/watch?v=YzioY5XJWIc
Illustrations of the project	 





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