Making rail transport more sustainable, comfortable and quiet

If rail is to become a more attractive transport option, there must be a greater focus on:

⚡ reducing the energy consumption of rolling stock and rail infrastructure	🔊 reducing the noise and vibration generated by trains and railway lines

THE CHALLENGE

Massive efforts are underway to make railways even more energy-efficient and quieter. A central challenge is to measure key sustainability and noise and vibration criteria, highlighting impacts of technological innovations.

HOW DO WE DO THIS?

By focusing on two main areas:

1. Improving energy-efficiency and sustainability

Shift2Rail set out to develop a standardised methodology for estimating energy consumption through simulation and measurement

2. Reducing noise and vibration

Researchers developed simulation methodologies for a train's exterior noise – at standstill and pass-by. They improved predictions of ground-vibrations by passing trains.

KEY ENERGY AND SUSTAINABILITY SOLUTIONS

Models and parameters were improved to calculate energy consumption of reference trains more accurately, taking into account five key topics:

- Heating, Ventilation, and Air Conditioning systems, including innovative technologies with heat pumps and natural refrigerants
- Auxiliary power of the train (for lighting, battery charging, traction equipment cooling, air compressors, control and onboard signalling systems)
- Battery-Powered Electrical Multiple Units, with reference parameters for trains/infrastructure
- Generic thermal model of the carriage body, with thermal reference parameters
- Freight trains with updated reference parameters for aerodynamic losses/energy consumption

Shift2Rail's most effective innovations to reduce energy consumption:

- Energy optimised driving with driver advisory systems or Automatic Train Operation, and a capable traffic management system
- Traction and auxiliary converters with highly efficient Silicon-carbide power semiconductors
- Extended freight wagon market with improved aerodynamics
- Optimised container sequence for intermodal freight trains

System Platform Demonstrations

Energy Key Performance Indicators improvement achieved

High speed trains (max 300 km/h or higher, and 250 km/h) .... 3.77% - 5.71%
Regional trains (max 160 km/h, and 140 km/h) .... 12.35% - 14.19%
Metro 12.52%
Suburban 6.46%
Freight mainline .... 19.82% - 24.24%

BENEFITS OF A STANDARDISED METHODOLOGY FOR ESTIMATING ENERGY CONSUMPTION

- Enable a standardised specification of energy-efficient railways
- Achieve and assess Shift2Rail's overall energy reduction
- Demonstrate effective cost-effectiveness and energy-saving features

Solutions developed	Key findings
Methods to identify and separate noise sources from trains passing a measuring point	• Pass-by-analysis: straightforward pass-by spectra at each speed • Microphone array: to pinpoint and quantify individual sources over train's whole length and height; clearly identify contribution of the rail
Use of pass-by noise source separation outputs for simulation	Noise simulation tools used to model the trains and calculate noise: SITARE; TraiNoiS; ProgNoise. Overall pass-by level calculated with accuracy of 2dB or less in 90% of cases
Uncertainty assessment of exterior noise simulations	For test cases of a three-carriage unit at standstill, and pass-by runs at 80 km/h, noise simulation uncertainty was calculated at ±2 dBA
Feasibility of reference track normalisation	New proposals for future revisions of TSI and standards (ISO 3095, EN 15461, TSI-Noise) to enable future transpositions to a virtual reference track
Simulation tool for vibrations	Validating the vibration prediction tool's ability to predict vibrations from railway traffic in buildings next to the track
Software tools for auralisation and visualisation	In listening tests, people struggled to identify which files were measured or auralised: the tool can be used to communicate mitigation measures

Who benefits

Infrastructure managers

Railway operators

? Did You Know?

Many innovations exist to reduce noise and vibration caused by rail transport, including:
- modelling
- prediction using real and virtual testing

⏱ Fast Fact

Railways have become **37%** more energy efficient since the year 2000

Key Finding

The total energy-saving potential of Shift2Rail's innovations is about:
- **10%** for passenger trains
- **30%** for freight trains

WANT TO LEARN MORE?

Solutions developed by Shift2Rail, Europe's Rail's predecessor programme

rail-research.europa.eu