As a global leader in rail technology, Bombardier places environmental sustainability firmly at the top of the agenda. AeroEfficient Optimised Train Shaping forms part of Bombardier’s ECO4* product range.

The Climate is Right for Trains

Our products and services combine energy-conserving technology with optimal safety, reliability and cost efficiency, which add value for our customers whilst protecting the environment for future generations.

ECO4 – energy, efficiency, economy and ecology

Addressing the growing challenges among operators to reduce Energy consumption, improve Efficiency, protect the Ecology while making sense Economically, ECO4 is the concrete validation of Bombardier’s declaration – The Climate is Right for Trains*.
Reducing the Energy Consumption of Rail Vehicles

In intercity and high-speed trains, 60 per cent of the traction effort is lost due to aerodynamic drag and friction in typical operation cycles. By reducing the drag by 25 per cent, it is possible to save between 8-15 per cent of traction energy.

Bombardier has developed its AeroEfficient Optimised Train Shaping process to ensure that aerodynamics of vehicles can be optimised, reducing drag, saving energy, and ensuring stability at high speeds.

The Natural Appliance of Science and Evolution

Using nature to conserve nature

Bombardier's pioneering approach to aerodynamic efficiency uses the science of "bionics", which focuses on nature as the inspiration for the latest ideas and technological progress. Already successfully adopted within the automotive and aerospace industry to create highly energy-efficient designs, bionics recognises that Nature's own evolutionary processes can help to ensure continuous improvement in a "survival of the fittest" regime.

Rail vehicle aerodynamic enhancement can have a major impact on improving energy efficiency. As well as being aesthetically appealing and dynamic in design, a streamlined train has lower drag – leading to reduced energy consumption.

At high speeds, aerodynamics gain even greater significance as, when velocity increases, cross-wind stability decreases. Bombardier has cross-referenced these potentially conflicting demands when developing its optimised vehicle design paradigm.

Since there is no direct counterpart in nature that can simulate the performance of a high-speed train, Bombardier's aerodynamic experts have gone a stage further. Superimposing the principles of natural pre-selection and evolution to an advanced computer-modelling approach that creates the best possible shape enables the optimisation of the latest vehicle designs – creating the lowest energy consumption and maximum stability.
ZEFIRO – Setting New Standards in Aerodynamic Efficiency

*BOMBARDIER* ZEFIRO* is the new benchmark for high speed trains in terms of low aerodynamic drag combined with high stability, whilst cruising under cross-wind conditions. To achieve this balance, Bombardier has used state-of-the-art Computer Aided Engineering (CAE) methods and tools, incorporating Computer Aided Design (CAD) and Computational Fluid Dynamics (CFD). Our sophisticated modelling introduces as many as 60 different design parameters, taking account of the train’s outer shell, cab, crash structure and ergonomic constraints.

Bombardier’s aerodynamic modelling ensures the optimum configuration of:
- Alternative front and end sections of the train
- Spoilers
- Pantograph integration solutions
- Bogie space envelope and fairings

The graph illustrates the iteration process from the initial design to the optimised shape. In this example, the applied generic algorithm took 14 parameters into consideration to find the optimal design regarding aerodynamic drag.

Example of the variability of the parameterised CAD model
Using a multiple process of continuous, selective improvement, Bombardier can ensure that each generated design automatically improves upon the last. In this way, the final result is honed to perfection.

Bombardier’s model takes account of requirements for crash structure and signal visibility for either sitting and/or standing drivers, as well as bogie movements.

The result of Bombardier’s aerodynamic optimisation is to provide a cluster of optimal designs related to aerodynamic drag and cross-wind stability. Train operators can benefit from the opportunity to choose from a selection of designs to suit particular preferences for styling, but secure in the knowledge that each complies with the principles of optimised energy performance and maximum stability and safety.